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SECTION 100

STANDARD SPECIFICATIONS FOR THE CONSTRUCTION OF PUBLIC IMPROVEMENTS

The City's Standard Specifications shall govern all aspects of Bidding and construction of the Project.

NOTE

With respect to all gender related references: where it is stated, “he” or “his” shall be taken to apply whether the authorizing individual is female or male. Dual gender references were avoided to simplify the understanding of the subject matter.

SECTION 10 – APPLICABILITY OF STANDARD SPECIFICATIONS

The provisions for the competitive Bidding of City Projects and the form of and requirements for the Bidding Documents are governed by the Charter and Ordinances of the City, the Oklahoma Competitive Bidding Act, the City's *Standard Specifications for the Construction of Public Improvements*, Resolution #93-01 of June 22, 1993 and other adopted policies of the City as amended.

Sections 100, 106, 109, 110 111, 112 and 200 through 900 shall apply to all Work (including Public or Private Contracts) performed within the limits of Oklahoma City.

Sections 100 though 900 shall apply to all Work under Contract with the City and/or its Trusts and Authorities including Informal and Emergency Contracts performed within the limits of Oklahoma City.

SECTION 100 – GENERAL PROVISIONS

SECTION 100.01 – DEFINITION OF TERMS

The definitions set forth in these Standard Specifications are applicable to the Bidding Documents and Contract Documents.

A

A.A.S.H.T.O. -

American Association of State Highway and Transportation Officials.

ACCEPTANCE –

After completion of the work, formal recorded acceptance of the work by the City Council of the City of Oklahoma City.

ADDENDUM (ADDENDA) –

Written or graphic instruments issued by the City Engineer prior to the Bid date which modify or interpret the Bidding Documents by additions, deletions, clarifications or corrections.

ADVERTISEMENT –

All of the legal publications pertaining to the Work contemplated or under Contract.

ALTERNATE BID (ADD-ALTERNATE BID, DEDUCT BID OR ALTERNATE BID) –

The amount stated in the Bid to be added to or deducted from the amount of the Base Bid if the corresponding change in the work, as described in the Bidding Documents, is accepted.

AMENDMENT –

A change to the contract document where the unit quantity Bid is increased or decreased and the Unit Price is unchanged. Amendments shall be a part of the Contract Documents upon their approval by the City.

A.N.S.I.-

American National Standards Institute.

ARCHITECT –

That person or firm engaged to prepare the Plans and Specifications and administers the construction of the Work that may be under Contract with the City or other Contracting entity.

A.S.T.M. -

American Society for Testing Materials.

AWARD –

The decision of the City to accept the Bid of the lowest and best Bidder for the work, subject to the execution and approval of a satisfactory Contract and the required Bonds, to such other conditions as may be specified or otherwise required by law.

B

BASE BID –

The sum stated in the Bid for which the Bidder offers to perform the Work described in the Bidding Documents as basis for the Work.

BID DATE AND BID TIME -

The date and time for the receipt of Bids as provided in the Notice to Bidders.

BID BOND –

The security submitted with the Bid which shall either be a certified check, cashier's check or Bid Bond equal to five percent (5%) of the Bid or in the form of an irrevocable letter of credit in the amount of five percent (5%) of the Bid. The Bid Bond is issued in accordance with the provisions of the Public Competitive Bidding Act of 1974, as amended (61 Okla. Stat. 1991, 107). The calculation of the amount of the Bid Bond shall be as provided in the Instructions to Bidders.

BID –

A Bid consists of the required documents or statements duly submitted in accordance with the Notice to Bidders by the person offering to perform the Work contemplated. A Bid is the complete and properly signed offer to do the Work for the sums stated therein and submitted in accordance with the Bidding Documents. A submission shall not be considered a Bid if it is untimely. A submission by a Bidder who is not Prequalified shall not be considered a Bid unless Prequalification is specifically waived in the Bidding Documents.

BID FORM -

The approved City form on which a Bid for the Work is to be prepared and submitted.

BID COMMITTEE –

That committee consisting of the Purchasing Agent, the City Clerk and the City Auditor who shall be responsible for opening all Bids.

BIDDER –

Any person or persons, partnership, company, firm or corporation acting directly or through a duly authorized representative submitting a Bid for the Work contemplated.

BIDDING DOCUMENTS –

Refer to Figure 100.1 for reference. Those documents (hardcopy or electronic) consisting of:

A) Project Plans
B) Standard Specifications
C) Special Provisions
D) Bid Package
    1) Bid Package Cover Sheet
    2) Notice to Bidders
    3) Instructions to Bidders
    4) List of Documents Required for this Bid
    5) Signature Requirements for Bidding Documents
    6) Bid Form including Bid Form with Alternates and/or Detailed or Unit Price Bid Form, if included in the documents
    7) Noncollusion Affidavit
    8) Business Relationship Affidavit
    9) Local Business Utilization Affidavit
    10) Any documents listed in the List of Documents Required for the Bid
E) Bid Security or Bid Bond
F) Addenda
G) Example Contracts and Bonds

BID PACKAGE –

Those documents required to be submitted with the Bid in accordance with the List of Documents Required for Bid as outlined in the Special Provisions.

BID SECURITY –

The "Bid Security" is that security submitted with the Bid which shall be in the form of a certified check, cashier's check or Bid bond equal to five percent (5%) of the Bid or of an irrevocable letter of credit in the amount of five percent (5%) of the Bid and issued in accordance with the provisions of the Public Competitive Bidding Act of 1974, as amended. (61 Okla. Stat. 1991, §107)

BONDS –

The Bid, Performance, Statutory, Maintenance, Defect and any other bond required by the Special Provisions.

C

CITY – THE CITY OF OKLAHOMA CITY, OKLAHOMA –

A municipal corporation, acting through its duly authorized representatives, agents or employees. This definition shall incorporate “Trust” or “Authority” when in the Bidding Documents the Contracting entity is identified as one of the City’s specified trusts, boards, or authorities of which the City is a beneficiary.

CITY AUDITOR –

The City Auditor of the City of Oklahoma City, Oklahoma, or duly authorized representatives or agents.

CITY CLERK –

The City Clerk of the City of Oklahoma City, Oklahoma, or duly authorized representatives or agents.

CITY ENGINEER –

The City Engineer of the City of Oklahoma City, Oklahoma and when so designated by the City Engineer, duly authorized agents, Architects, Engineers, representatives, inspectors or superintendents, acting severally or individually within the scope of the particular duties entrusted to them.

CITY MANAGER –

The City Manager of the City of Oklahoma City, Oklahoma, or duly authorized representatives or agents.

CITY TREASURER –

The City Treasurer of the City of Oklahoma City, Oklahoma, or duly authorized representatives or agents.

COMPLETED –

The Work is constructed in accordance with the Plans and Specifications and other Bidding Documents is fully completed, the Final Inspection(s) have been made, and any corrections made to the satisfaction of the City Engineer.

CONTRACT –

The executed agreement covering the performance of the Work.

CONTRACT DOCUMENTS –

All documents included in the Bidding Documents (Refer to Figure 100.1) and the documents consisting of:

A) Contract,

B) Bonds,
   a. Performance
   b. Statutory
   c. Maintenance
   d. Defect (for companies outside the City Limits)
C) Contractor Identification Numbers
D) Certificate of Insurance
E) Certificate of Nondiscrimination
F) Submittals,
G) Amendments,
H) Field Changes and
I) Change Orders.

CONTRACTOR –

The person or persons, partnership, company, firm or corporation who performs private or public work in the City.

COUNCIL –

The City Council of the City of Oklahoma City, Oklahoma.

D

DETAILED BID FORM –

The City's approved form noting individual pay items, estimated quantities, unit Bid prices and total item prices on which Bids are based.

DEFECT BOND–

The approved City form properly executed by the Contractor and its Surety as a guarantee of the Contractor's intent to perform and maintain Contract Work in accordance with the Contract Documents.

DEFECTIVE BID –

The condition a bid is found to be if not in compliance with the City Resolution 93-01 approved June 22, 1993 or as amended. Also known as irregular.

DEVELOPER –

The owner of a tract of land making improvements in accordance with these Specifications. Any person obtaining permits to perform work in the City. The Developer may operate through an Architect or Engineer.

E

ENGINEER –

That person or firm engaged to prepare the Plans and Specifications and administer the construction of the Work that may be under Contract with the City or other Contracting entity.

EQUIPMENT –

Any tool or operable machinery used in the performance of Contract Work.

EXTRA WORK –

Any work performed by the Contractor not provided for in the Contract Documents.

F

FIELD CHANGE –

A formal method of directing the Contractor to implement a Project change where there is no additional cost to the Project. A Field Change requires written approval by the City Engineer.

FINAL ACCEPTANCE–

That action taken by the City formally accepting the completed project and placing the Maintenance Bonds into effect.

FINAL INSPECTION –

That inspection performed after all punchlist inspection items are completed to the satisfaction of the City Engineer, immediately prior to Project Final Acceptance.

FURNISH –

To supply.

G

GRADE –

The slope of the pavement, channel, pipe or any other item. The rise over the run of the item.

H

HOLIDAY –

Any day so designated by the City of Oklahoma City's City Council.

I

INSPECTOR –

Representative of the City Engineer authorized to make inspections of Contract performance.

IRREGULAR BID –

The condition a bid is found to be if not in compliance with the City Resolution 93-01 approved June 22, 1993 or as amended. Also known as defective bid.

INCIDENTAL WORK -

That work necessary to complete the project or bid item with in the scope or the Work bid and awarded.

ITE –

Institute Of Transportation Engineers

J

JOB SITE –

Work area under the responsibility of the contractor for contracted work.

L

LABOR –

That effort employed by the Contractor to perform Contract Work.

LIQUIDATED DAMAGES –

The amount prescribed in the Standard Specifications to be paid to the City or to be deducted from any payments due or to become due the Contractor for each day's delay in completing the

whole or specified portion of the Work beyond the time allowed in the Contract Documents. Liquidated Damages are not a penalty to the Contractor.

LOCAL BUSINESS UTILIZATION PLAN (LBU) –

The plan that implements the policy established by the City Council of the City of Oklahoma City resolution of November 23, 1993, encouraging all contractors to provide a plan for the utilization of local, small and disadvantaged subcontractors, both minority and otherwise

M

MAINTENANCE BOND –

The approved City form properly executed by the Contractor and its Surety as a guarantee that the Work will be properly maintained as constructed by the Contractor against any failure due to workmanship or defective material for the period required.

MAJOR PAY ITEM –

Any contract pay item that is equal to or exceeds the following values:

Contract Cost	Item Total (% of Original Contract Award Amount)
$0 – 1,000,000	5 %
$1,000,001 – 4.000,000	2 ½ %
$4,000,001 – and above	1 ½ %

MATERIALS –

Those items placed on the Project to complete the Contract (including any purchased equipment).

MAYOR –

The Mayor of the City of Oklahoma City, Oklahoma.

MUNICIPAL COUNSELOR –

The Municipal Counselor of the City of Oklahoma City, Oklahoma, or duly authorized representatives or agents.

MUTCD –

Manual On Uniform Traffic Control Devises

N

NEMA –

National Electrical Manufacturers Association

NONCOLLUSION AFFIDAVIT –

The form signed by the Bidder as a necessary part of the Bid that affirms the Bidder has not colluded with the awarding public entity(ies), their officers or their staff or any other bidder.

P

PERFORMANCE BOND –

The approved City form properly executed by the Contractor and its Surety as a guarantee that the Work will be properly executed and the Contract will be completed in accordance with the Contract terms and conditions.

PERMIT –

The document issued by the City authorizing Work to be performed.

PERSON –

Any individual, legal entity, or corporation, association, partnership, Limited Liability Company, Limited Liability Partnership or any other legal entity.

PLAN OR PLANS –

All of the drawings pertaining to the Contract Documents and made a part thereof, including such supplemental drawings as the Architect and/or Engineer may issue from time to time, in order to clarify other drawings or for the purpose of showing changes in the Work or for illustrating details not shown.

PREQUALIFICATION –

The requirements for the Bidder listed by the Prequalification Review Board (per City Ordinance #20,815, as amended) as Prequalified for the type or types of work required for the project prior to the Bid Date.

PREQUALIFICATION REVIEW BOARD –

Prequalification Review Board as created and established by Ordinance #20,815, as amended.

PROJECT –

All the activities specified, indicated, shown or contemplated in the Contract Documents to construct the improvement, including all labor, materials, tools, equipment and incidentals, contract alterations, permits or other authorized orders of the City Engineer.

PROVIDE –

To furnish, erect or install.

PUNCHLIST INSPECTION –

That inspection performed at the request of the Contractor and at the discretion of the City Engineer. This inspection is performed after Project substantial completion.

PUBLIC IMPROVEMENT WORK –

Any building, highway, street, sewer, pavement, waterline, sidewalk, or any other improvement or structure which is constructed, altered, or repaired under Contract or any instrument with the City. Public Improvement Work includes, but is not limited to, private work in public right-of-way and private work to be conveyed to City. This Work also includes all the activities specified, indicated, shown or contemplated in the Contract Documents to construct the improvement, including all labor, materials, tools, equipment and incidentals, contract alterations, permits or other authorized orders of the City Engineer.

S

STANDARD SPECIFICATIONS –

This term shall mean the directions, provisions and requirements contained in the Standard Specifications as supplemented by the Special Provisions.

SPECIAL PROVISIONS –

The special clauses setting forth conditions or requirements for the specific project involved, supplementing the Standard Specifications and taking precedent over any conditions or requirements of the Standard Specifications with which they may be in conflict.

SPECIFICATIONS –

The directions, provisions and requirements contained in the Standard Specifications together with the Special Provisions pertaining to the method and manner of performing the work or to the kinds, quantities or qualities of materials to be furnished under the Contract Documents and methods of measurement and basis of payment.

STATUTORY BOND –

The approved City form of Surety properly executed by the Contractor and the Contractor's Surety as a guarantee that all bills and accounts for material and labor used in the construction of the work will be paid, as provided by law.

SUBMITTAL –

Drawings or documents submitted for review and approval of items specified in the Bidding Documents.

SUBSTITUTIONS –

A Contractor submitted proposal to modify the Plans, Specifications, or other Contract requirements. The substitution shall not impair in any manner the essential functions or characteristic of the project, including but not limited to:

A) service life,
B) economy of operations,
C) ease of maintenance,
D) desired appearance or design; and
E) safety standards.

SURETY OR SURETIES –

The corporate body or legal entity which is bound by the respective Bonds.

U

UNIT PRICE –

An amount stated in the Bid as a price per unit of measurement for materials, equipment, services or Work as described in the Bidding Documents.

W

WORK –

All the activities specified, indicated, shown or contemplated in the Contract Documents to construct the improvement, including all labor, materials, tools, equipment and incidentals, contract alterations, permits or other authorized orders of the City Engineer.

WORKING DAY –

Any day, other than a legal City holiday, Saturday, or Sunday, on which the approximate normal working forces of the Contractor may proceed for at least six (6) hours toward completion of the Work, unless Work activity is suspended by the City Engineer for causes beyond the Contractor's control, provided that Saturdays, Sundays or holidays on which the Contractor's forces do engage in Work activity will be considered as Working Days.

WORK ORDER-

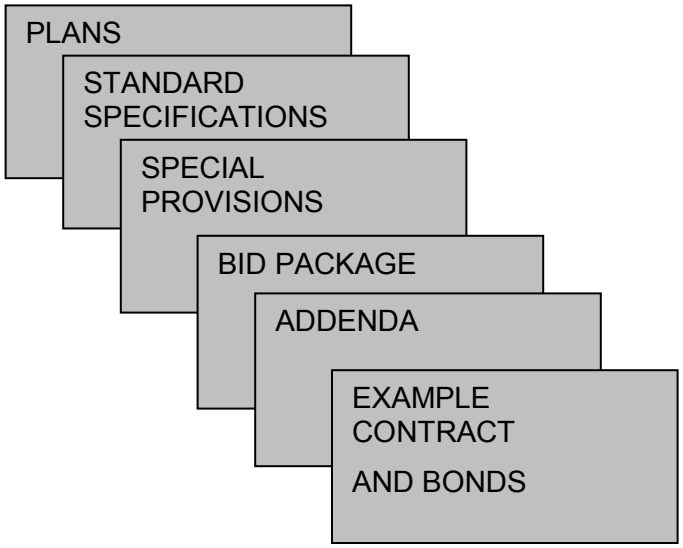
The document issued by City directing commencement of Work.

Figure 100-1

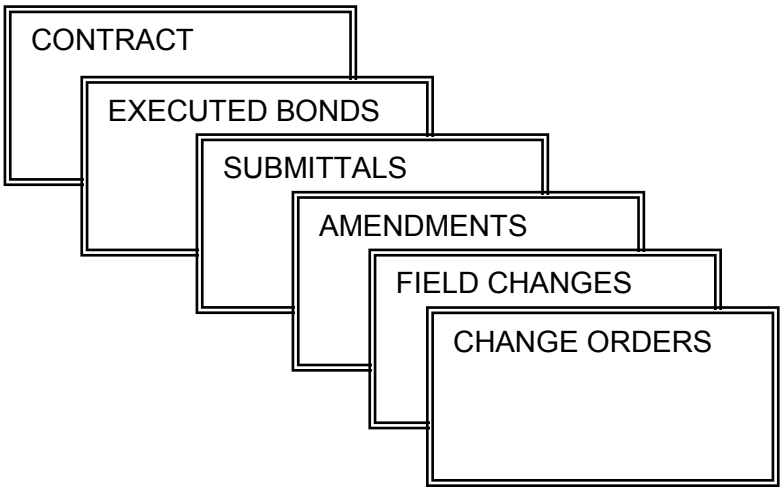
Bidding and Contract Documents

Bidding Documents and Contract Documents

The following figure illustrates the eleven basic components of documents used to communicate what is intended for construction. The Bidding Documents consist of the first six components. Contracts and Bonds are executed after the Award of Contract to the successful Bidder and are considered with the Bidding Documents to comprise the Contract Documents.



Bidding Documents (also Contract Documents for successful Bidder)



Contract Documents for successful Bidder

SECTION 101 – NOTICE TO BIDDERS

The City will receive Bids in accordance with the Notice to Bidders located in the Special Provisions for the Project. Informal Bids will be received in accordance with the City's current Informal Bid policy and procedures, as amended.

SECTION 102 – PREQUALIFICATION OF BIDDERS

The City has by resolution and ordinance adopted standard procedures and requirements for prequalification of contractors and bidders. Copies are available for review in and may be obtained through the Office of the City Clerk, 200 North Walker Avenue, Second Floor, Oklahoma City, Oklahoma 73102.

The City may require prospective bidders to prequalify as responsible bidders prior to submitting bids on a public construction contract. The applicable prequalification requirements shall be set forth in the special provisions for the project.

Regardless of whether or not prequalification is required, any proposed Contractor or Bidder must have obtained any license or licenses required by the City, State or Federal Government which is/are necessary to the accomplishment of the work. Such license(s) must have been obtained prior to the submission of a Bid on the project. Failure to possess the necessary license(s) is reason for a recommendation to the City Council that a Contract not be awarded.

SECTION 103 – BID REQUIREMENTS AND CONDITIONS

Bidders shall comply with all provisions contained in this Section 103 unless modified by the Special Provisions.

103.01 – REQUIREMENTS FOR BIDDERS

Prior to submitting a Bid, Bidders shall comply with the Prequalification requirements as set forth in Section 102 of the Standard Specifications.

No Bidder shall divulge the sealed contents of a Bid to any person whomsoever, except those having a partnership or other financial interest with the Bidder in said Bid, until after the sealed Bids have been opened. A violation on the part of the Bidder shall make void any Contract made by the Bidder with the City based upon such Bid.

103.01.01 – PRE-BID CONFERENCE

The City may require prospective Bidders to attend a Pre-Bid Conference as a prequalification requirement to be eligible to submit a sealed Bid.

103.01.02 – MANDATORY PRE-BID CONFERENCE

When specified, attendance is a prequalification requirement. The Contractor who plans to submit a Bid must attend this conference. The engineer and any consultant for the project must also attend this conference. Failure of the prospective Bidders to attend this conference will cause the City Clerk to return the Bidder's submission unopened. The purpose of the conference is to discuss the plans and specifications.

The Pre-Bid Conference will begin at the designated time; a sign-in sheet will be passed to all attendees; only full-time employees of the prospective Bidder's company will be considered as eligible representatives for attendance; and, five minutes after the meeting is called to order, the sign-in sheet will be closed (late arrivals will not be allowed to sign in). The official timekeeper for closing the sign-in sheet shall be the Engineer or staff member chairing the Pre-Bid Conference.

In the case of a joint venture, an eligible representative from each of the participating organizations in the joint venture must be in attendance. Sub-contractors are not required to attend.

The following will not be eligible to Bid on the project: (1) prospective Bidders leaving the meeting prior

to adjournment of the Pre-Bid Conference; (2) prospective Bidders whose names have been placed on the sign-in sheet, but were not in attendance; or, (3) anyone arriving at the pre-Bid Conference after the sign-in sheet has been closed.

Prospective Bidders leaving the conference prior to adjournment, or whose name has been placed on the sign-in sheet (but was not in attendance), or anyone arriving at the Pre-Bid Conference after the sign-in sheet has been closed, will not be eligible to Bid on the that project.

103.01.03 - PROVISION FOR INTERPRETERS

In compliance with the provisions of the Americans with Disabilities Act, upon twenty-four hours notice to the City Engineer, a sign language interpreter will be provided for the Pre-Bid Conference.

103.02 – CONTENT OF BID FORMS

103.02.01 – BIDDING DOCUMENTS

The Bidding Documents are located at the City Clerk's Office, 2nd Floor, 200 N. Walker Avenue, Oklahoma City, OK 73102, or as designated in the Notice to Bidders. Required deposits will be non-refundable to Bidders in accordance with the Special Provisions

103.02.02 – ADDENDA

The Bidding Documents represent all the information that will be provided by the City. Interpretations and corrections of and/or changes to the Bidding Documents will be made only by Addendum. Addenda shall be issued by the City Engineer and approved or ratified by the City. Interpretations and/or changes made in any other manner will not be binding upon the City and Bidders shall not rely upon them.

Addenda will be mailed, faxed, e-mailed or delivered only to those who have signed and completed the Bidding Document Receipt List for the Project. This list is maintained in the City Clerk's Office.

Copies of Addenda will be made available for inspection in the City Clerk's Office, 2nd Floor, 200 N. Walker Avenue, Oklahoma City, OK 73102.

The following shall be considered proof that a Bidder received an Addendum:

A) Mailed Addendum: The Bidder's signature or Bidder's representative's signature on the Certified Mail Return Receipt.

B) Hand Delivered or Picked-Up Addendum: The Bidder's or Bidder's representative's signature on the Addendum Receipt Signature List.

C) Faxed Addendum: The City's or the Architect and/or Engineer's Fax Confirmation Sheet.

D) E-mailed Addendum: The City's and/or Trust's or the architect/engineer's e-mail delivery receipt verification.

E) It shall be the obligation of the Bidder to ascertain receipt of Addenda prior to the Bid date.

103.02.03 – SUBSTITUTIONS TO BIDDING DOCUMENTS

No substitution will be considered prior to the receipt of Bids unless a written request for approval has been received by the City Engineer no later than seven (7) days prior to the Bid date. Such requests shall include the name of the material, product, or equipment for which it is to be substituted and a complete description of the proposed substitution including drawings, performance and test data and other information necessary for an evaluation. A statement shall be included in the written request setting forth changes in other materials, products, equipment or other portions of the Work including changes in the Work of other Contracts that incorporation of the proposed substitution would require. The burden of proof of the merit of the proposed substitution is upon the Bidder.

If a proposed substitution is approved prior to Bid date, such approval will be set forth in an Addendum

issued by the City Engineer and subsequently approved or ratified by the City Council. Bidders shall not rely upon approvals made in any other manner.

103.03 – INTERPRETATION OF PLANS AND SPECIFICATIONS

The Bidder, by making a Bid, represents that the Bidder has:

A) Scrutinized, compared, read carefully and understands the Bidding Documents;

B) Inspected the site and become familiar with local conditions under which the Work is to be performed;

C) Informed himself by independent research of the difficulties to be encountered and personally judged the accessibility of the Work and all attending circumstances affecting the cost of doing the Work and of the time required for its completion;

D) Correlated the Bidder's personal observations with the requirements of the Bidding Documents and ensures the Bid is made in accordance therewith;

E) Become familiar with and understands all other Projects which may affect the Work or access to the Work site; and

F) Based the Bid upon the materials, equipment, systems or services required by the Bidding Documents without exception.

The Bidder shall communicate to the City Engineer or the Architect and/or Engineer any errors, inconsistencies or ambiguities discovered in the Bidding Documents. All requests for interpretation of the Bidding Documents must be made to the City Engineer.

A Bidder in doubt as to the true meaning of any part of the Bidding documents, may submit to the City Engineer a timely written request for an interpretation thereof. An interpretation of the proposed documents will be made only by Addendum duly issued and a copy of such Addendum will be mailed or delivered to each person on the Bidding Document Receipt List.

Bidders shall be responsible for their plans, estimates, interpretations and assumptions which are necessary for completing the Bid. It is mutually agreed that submission of a Bid will be evidence that the Bidder has made all required examinations and investigations.

103.04 – EXAMINATION OF DOCUMENTS AND WORK SITE

Bidders are advised that the Bidding Documents on file with the City Clerk shall constitute all the information the City will furnish for the Project. Bidding Documents will only be amended by Addenda approved by the City Engineer. It is mutually agreed that submission of a Bid will be representation that the Bidder has made all required examinations and investigations.

103.05 – PREPARATION AND FILING OF BID

Bids must be submitted on the Bid Form and Detailed Bid Form(s) as appropriate. Said forms will be provided by the City and will state the general description of the Work. Bids shall be completed in accordance with the Bidding Documents and will contain all required affidavits.

103.05.01 – BID FORM INSTRUCTIONS

Bids shall be submitted on the Bid Form and Detail Bid Form(s) contained in the Bid Package or photocopies thereof. All blanks on the Bid Form and Detail Bid Form(s) shall be filled in by typewriter or legibly written in ink. All written prices shall be distinctly legible. Where so indicated by the makeup of the Bid Form and/or Detailed Bid Form(s), sums shall be expressed in both words and figures and in case of any discrepancy between the two, the amount written in words shall govern.

Detailed Bid Form(s) are included in the Bid Package when the Work is Bid all or partially on a Unit Price basis. If a Detailed Bid Form is provided, the Bidder is to enter the cost per unit <u>in words and in numerals</u> and then enter the total cost of the item (estimated quantity multiplied by the Unit Price) in the

column under *Item Total.*

The total of the *Item Total* column will be entered at the bottom of the Detailed Bid Form and on the Total Bid line on the Bid Form. Bidders shall insure that the total of the Detailed Bid Form is entered correctly on the Bid Form. In cases of conflict between words and numerals, the words will govern. In cases of conflict between the amount on the Bid Form and the amount on the Detailed Bid Form, the correct total on the Detailed Bid Form will govern. Written Unit Prices shall govern over figures. Written Unit Prices shall govern over Item totals.

There may be a Detailed Bid Form for one or more Alternates. If a Detailed Bid Form is provided for an Alternate, it should be completed in the same manner as the form for the Base Bid. An example of a correctly completed Detailed Bid Form is shown in Figure 103.05.01. Where a Detailed or Unit Price Bid Form for the submission of Unit Prices is provided in the Bidding Documents, the Bidder will complete the Detailed Bid Form and then enter the total amount of the Bid on the Bid Form. The total amount on the Bid Form shall be based upon the Unit Prices. The signer of the Bid must initial erasures and/or corrections on any Bid Form or Detailed Bid Form. A Bid with erasures and/or corrections that are not initialed shall be considered to be irregular.

Figure 103.05.01

Detailed Bid Form Instructions
DETAILED BID FORM ITEMS

PROJECT NO. _____

Item No.	Description	Unit	Estimated Quantity	Unit Price	Item Total
1.	6" P.C. Concrete	SY	45	***$15.00***	***$675.00***
	Fifteen and no/100---------- (Unit Price dollars written)			Dollars	
2.	6" Integral Curb	LF	70	***$1.50***	***$105.00***
	One and 50/100---------- (Unit Price dollars written)			Dollars	
3.	6" Curb Removal	SY	56	***$2.13***	***$119.28***
	Two and 13/100---------- (Unit Price dollars written)			Dollars	
4.	Plug Existing 42" RCP	LS	1	***$300.00***	***$300.00***
	Three Hundred and no/100---------- (Unit Price dollars written)			Dollars	
			Detailed Bid Form Subtotal		$ ***1,199.28***

103.05.02 – SALES TAX EXEMPTION

103.05.02.01 – CITY FUNDED PROJECTS

Title 68 Oklahoma Statutes (1991), Section 1356 (I), exempts sales to a municipality and its Contractors from all sales tax on the sale of "tangible personal property or services." All Bids for City Projects shall be assumed to have been made based on such statutory exemption as effective on the Bid date. The City shall not pay any sales tax and shall not reimburse the Contractor for any tax on purchases by the Contractor except as included in the unit price. No change orders or amendments

shall be approved for reimbursement of sales tax or changes in sales tax. A change in sales tax shall not be deemed a change in conditions of the Contract.

103.05.02.02 – TRUST PROJECTS

For the purposes of a bid and award of contract and pursuant to Oklahoma Tax Commission Rule 710:65-13-140, it is assumed that the materials provided by the contractor are not exempt from applicable sales taxes. All payments including sales tax are deemed to be paid under protest.

103.05.03 – BID SIGNATURE REQUIREMENTS

An authorized agent of the Bidder must properly sign all documents. The City reserves the right to require a Bidder to provide any documentation it may deem necessary to verify authorized signature.

103.05.04 – FILING OF BID

The Bid is to be submitted in a sealed envelope. Each envelope shall bear a legible notation thereon that it is a Bid upon the Project proposed. The Bid shall be submitted to the City Clerk's office in accordance with the dates and times specified in the notice to Bidders.

If the Bid is sent by mail, the sealed envelope, marked as described above, shall be enclosed in a separate mailing envelope with the notation "SEALED BID ENCLOSED" on the face thereof.

The Bid shall include the Bid Form and affidavits, the Bid Security and any other documents required to be submitted with the Bid shall be enclosed in a sealed opaque envelope. The envelope shall be addressed to the City Clerk of Oklahoma City and shall be marked **"SEALED BID FOR PROJECT _____"** and shall state the Bidder's name and address and, if applicable, the Project Description for which the Bid is submitted.

103.06 – BID AFFIDAVITS

Affidavits contained in the Bid Package must be properly signed by an authorized agent of the Bidder. The City reserves the right to require a Bidder to provide any documentation it may deem necessary to verify authorized signature. The Bid will contain all required Affidavits as listed in the “List of Documents Required for this Bid”. Bids shall be completed in accordance with the Bidding Documents.

103.07 – BID BOND

Each Bid shall be accompanied by a Bid Bond for the amount of five percent (5%) of the amount of the Bid. The Bid shall mean the highest combination of the Base Bid plus Alternate Bids for the purposes of determining the amount of the Bid Bond. The Bid Bond is a pledge that the Bidder will enter into a Contract with the City on the terms stated in the Bid and will furnish Bonds covering the faithful performance of the Contract and payment of all obligations. Should the Bidder refuse to execute or fail to furnish other required Contract Documents, the amount of the Bid Bond shall be forfeited to the City as liquidated damages, not as a penalty.

The City has the right to retain the Bid securities of Bidders until either:

A) The required Contract Documents have been executed or submitted by the successful Bidder;
B) The specified time to Award Bids has elapsed so that Bids may be withdrawn in accordance with State law;
C) All Bids have been formally rejected by the City; or
D) A Bidder has been determined to be the successful Bidder.

Bids will not be considered unless the original Bid submitted to the City Clerk’s Office is accompanied by a Bid Bond, or a certified/cashier's check, made payable to the Treasurer of the City of Oklahoma City, in the required amount.

103.08 – NO WITHDRAWAL OR ALTERATION OF BIDS

Permission will not be granted to withdraw or modify any Bid after it has been submitted. Request for non-consideration of Bids must be made in writing, addressed to the City and submitted to the City Clerk before the time set for opening Bids.

103.09 – OPENING OF BIDS

Bids properly submitted and timely received will be opened publicly and will be read aloud. Opened Bids will remain on file in the Office of the City Clerk for at least two (2) days before a Contract is Awarded. A tabulation of Bid information may be made available to the Bidders within a reasonable time.

103.10 – IRREGULAR BIDS

Any Bid that shows any omission, alteration of form, addition, substitution or condition not specified and any unauthorized Alternate Bid shall be deemed irregular. However, the City reserves the right to waive irregularities and make the Award in the best interest of the City.

103.11 – REJECTION OF BIDS

The City will consider and reserves the right to reject any or all Bids and all Bids submitted are subject to this reservation. A Bid shall be rejected for any of the following specific reasons:

A) The Bid Form is not signed by the Bidder or Bidder's authorized agent

B) The Noncollusion Affidavit, as required by the City Charter and the Oklahoma Competitive Bidding Act, has not been submitted with the Bid; the text of the affidavit has been altered; and/or the affidavit is not properly signed and/or notarized. (61 Okla. Stat. (1991) § 115 and Oklahoma City Charter, Article IX § 4)
C) The Business Relationship Affidavit, as required by the Oklahoma Competitive Bidding Act, has not been submitted with the Bid; the text of the affidavit has been altered; has not entered requested information, if any in the blanks provided; and/or the affidavit is not properly signed or notarized. (61 Okla. Stat. (1991) §108)
D) The Bid Security or Bid Bond, as required by the Oklahoma Competitive Bidding Act, is not attached to the Bid. (61 Okla. Stat. (1991) §107)
E) The Bid fails to comply with any other requirements of City, State, or federal law and/or any other forms required by the Bidding Documents are not properly completed and submitted.

A Bid may be rejected based on the following reasons:

A) The Bid is received after the time limit for receiving Bids as stated in the advertisement, or before designated time for submittal.
B) A Bid price obviously unbalanced.
C) Total Bid price above the Architect and/or Engineer's estimate of total cost.
D) Bids that are incomplete, such as required signatures or material irregularities.
E) Bidder is not prequalified unless prequalification is waived in Special Provisions.

103.12 – NONCOLLUSION

A Noncollusion Affidavit shall accompany each Bid. Bids will not be considered unless a properly and fully executed Noncollusion Affidavit accompanies the Bid submitted to the City Clerk. The Noncollusion Affidavit is a sworn statement, which provides that the bidder has not made any agreement or colluded with the City or any bidders or prospective bidders in restraint of freedom or competition or has agreed to bid at a fixed price or to refrain from bidding. Violation of a provision of the Noncollusion Affidavit shall render the bids of such bidders void and persons willfully violating this requirement shall be guilty of a felony. Bidders must use the Noncollusion Affidavit provided by the City in the project specifications. The text of the Noncollusion Affidavit may not be modified. The Bidder may, however,

adapt the signature block to provide for additional signatures.

103.13 – BUSINESS RELATIONSHIP

A Business Relationship Affidavit shall accompany each Bid. Bids will not be considered unless a properly and fully executed Business Relationship Affidavit accompanies the Bid submitted to the City Clerk. The Business Relationship Affidavit is a sworn statement which discloses the following information: the nature of any business relationships then in effect or which existed within one (1) year prior to the date of such statement with the architect, engineer or any officer or director of the architectural or engineering firm or other party to the project; and the names and positions of all persons having any such business relationships. Bidders must use the Business Relationship Affidavit provided by the City in the project specifications. The text of the Business Relationship Affidavit shall not be modified. The Bidder may; however, adapt the signature block to provide for additional signatures.

103.14 **- SMALL AND DISADVANTAGED LOCAL BUSINESS PROGRAM**

The City of Oklahoma City has adopted a program to encourage and promote the use of small and disadvantaged local businesses as subcontractors on public construction contracts as set forth in the Oklahoma Public Competitive Bidding Act. The successful bidder awarded a public improvement contract by the City must provide the City a small and disadvantaged local business subcontracting plan setting forth the Contractor's efforts and strategies to provide and extend opportunities for small and disadvantaged local business participation in the performance of subcontracts on City projects. The Contractor's plan must be submitted to the City Engineer before a notice to proceed with work will be issued. The plan must set forth the Contractor's outreach efforts and internal efforts. The Contractor must create and maintain records demonstrating its efforts and the success of its efforts. The Contractor must provide a report on the progress and success of its small and disadvantaged local business subcontracting plan to the City Engineer as a condition precedent to final payment and release of retainage. The project will neither be deemed substantially complete nor be accepted for final payment until the Contractor submits a report on the progress and success of its small and disadvantaged local business subcontracting plan. Provided, however, on emergency projects, the public construction contractor may be permitted to submit its small and disadvantaged local business subcontracting plan after the issuance of the notice to proceed.

SECTION 104 – RESERVED

SECTION 105 – EMPLOYMENT PRACTICES

105.01 – NONDISCRIMINATION

Contractors shall execute and comply with the provisions of the Non-Discrimination Affidavit. Contractors shall conspicuously post a copy of the Non-Discrimination Affidavit at the local place of business. Contractors shall include a similar requirement in all Sub-Contracts.

Copies of the "Notice of Equal Employment Opportunity" poster issued by the City Clerk will be given to the Contractor at the Pre-Work Conference. The poster must be exhibited in a central and public location at the place of business by the Contractor and each subcontractor while the Contractor and any subcontractors are performing work on the project.

SECTION 106 – RESERVED

SECTION 107 – AWARD AND EXECUTION OF CONTRACT

107.01 – AWARD OF CONTRACT

107.01.01 – ACCEPTANCE OF BID

It is the intent of the City to Award a Contract to the lowest and best Bidder provided the Bid has been submitted in accordance with the requirements of the Bidding Documents.

The City reserves the right to select alternates in any order or combination, unless otherwise specifically stated in the Bidding Documents. The lowest and best Bidder shall be determined on the basis of the sum of the Base Bid and selected Alternate Bids.

107.01.02 – AWARD OF CONTRACT

The Awarding of a Contract upon a successful Bid shall give the Bidder no right to action or claim against the City upon such Contract until the same shall have been reduced to writing and duly signed by the Contracting parties.

Should a Bidder who is Awarded a Contract upon a Bid fail to execute and provide the Contract and bonds or to provide the required certificates of insurance and/or any other required documents, the City Council reserves the right to rescind the award and offer the Contract to the Bidder deemed to be the next lowest and best Bidder.

Should a Bidder who is awarded a Contract fail to execute and furnish the required Contract Documents, the City Council has the right to Award the Contract to the Bidder deemed to be the next lowest and best Bidder.

The Bidder has no right to action or claim against the City until the Contract is executed by all parties

The successful Bidder will be provided one (1) complete set~~s~~ of the Project Contract Documents. The successful Bidder will execute all one (*1*) set~~s~~ in original signatures and return within seven (7) calendar days following the City's notification of its intent to Award Contract, unless that time is extended by the City Engineer. All Bidders should arrange with their respective insurance and Bonding company(s) to complete all required insurance and Bond documents. The Contract shall not be operative nor shall any payments be due until approval of the Contracts and Bonds by the City.

The City is not required to award a contract to the low bidder. The City may Award a contract to the lowest and best bidder or bidders (lowest responsible bidder). Awards are made within thirty (30) days after the opening of bids. Provided that the City may, by formal recorded action and for good cause shown, authorize a reasonable extension of that period to the extent permitted by law. The City reserves the right to not award a contract, to reject any or all bids, and to solicit new or different bids. No bidder shall obtain any property right in a contract awarded until the contract has been fully executed by both the bidder and the City.

107.02 – CONTRACT BONDS REQUIRED

A Surety may be rejected that is in default or delinquent on any Bond, or is interested in any litigation against the City. All Bonds shall be executed on forms furnished by the City (or photocopies thereof) and shall be executed by Surety companies licensed to do business in the State of Oklahoma and conform to the requirements of Ordinance No. 5928. The Contractor and the Surety shall execute each Bond which shall remain continuously in full force and effect in accordance with the bonding requirements.

Should any Surety be determined unsatisfactory at any time by formal City resolution, notice will be given and the Contractor shall substitute a new Surety satisfactory to the City. No payment will be made under the Contract until the new Surety, as required, has been accepted by the City. The Bidder shall require the attorney-in-fact who executes the required bonds on behalf of the surety to affix

thereto a certified and current copy of the power of attorney.

The cost of all Bonds shall be included in the amount of the Bid. The successful Bidder shall at its own cost procure and submit the following Bonds as required in the Bidding Documents:

107.02.01 – PERFORMANCE BOND

The Performance Bond guarantees completion of the Project intended in the Contract Documents and guarantees the Contractor's full and faithful execution of the Work and performance of the Contract. A Performance Bond also guarantees protection of the City, and all property owners against any neglect, damage by reason of acts or omissions of the Contractor or the improper execution of the Work or the use of inferior, non-compliant and/or defective materials or equipment. A Performance Bond shall be executed in favor of the City.

107.02.02 – STATUTORY BOND

The Statutory Bond guarantees the Contractor will make payment for all labor, materials and equipment used in or for the Project and/or for the performance or provision of the Work. The Statutory Bond shall be executed in favor of the State of Oklahoma.

107.02.03 – MAINTENANCE BOND

The Maintenance Bond guarantees the maintenance in good condition of the Workmanship and materials and the operation of the Project as intended in the Contract Documents for a specified period after the completion and Acceptance of the Project by the City. The term of the Maintenance Bond is provided in the Contract Documents. The Maintenance Bond will be in the amount equal to one hundred percent (100%) of the Contract amount for the following terms: Unless otherwise provided in the Bidding Documents, the term of the Maintenance Bond shall be as follows:

1 Year: Street resurfacing Projects.

2 Years: All buildings, park Projects and traffic control Projects. All streets, bridges, environmental, water, sanitary sewer and storm drainage Projects.

The Maintenance Bond shall be executed in favor of the City.

In addition, a maintenance bond executed in favor of the City is required whenever a contractor enters a contract with a federal, state, or local government entity or with a private entity relating to facilities or improvements to be owned and operated by the City or its Trusts.

107.02.04 – DEFECT BOND

The Defect Bond guarantees the Contractor shall timely repair any defect and maintain or provide for the timely maintenance of any repair on the Project for the term of the Maintenance Bond. The Defect Bond will be in an amount equal to one hundred percent (100%) of the Contract amount. The Defect Bond shall be executed in favor of the City.

The Contractor shall comply with one of the following provisions:

A) The Contractor has shown proof of the Contractor’s intentions to perform and maintain for the specified period of Maintenance Bond tenure by establishing within a forty (40) mile radius of the office of the City Engineer, 420 W. Main Street, Oklahoma City, Oklahoma, 73102,

   1) A business address (as defined in the Oklahoma City Municipal Code)

   2) With a telephone (staffed by competent employees approved by the City Engineer under whose supervision the Work will be performed) and

   3) A yard (as defined in the Oklahoma City Municipal Code) equipped with sufficient necessary equipment available 24 hours-a-day to perform and maintain all classes and subclasses of Work for which the Contractor is pre-qualified to Bid.

   4) This office and yard as equipped shall have been established prior to the time the applicant

submits the Contractor's application for qualification.

B) The Contractor opts to have the City retain a sum equal to fifteen percent (15%) of the total Contract amount for the extent of the maintenance period (said funds may be used by the City).

C) The Contractor opts to provide a properly executed Defect Bond. The duration of the Defect Bond shall be the same duration as the Maintenance Bond.

107.03 – EXECUTION OF CONTRACT DOCUMENTS

107.03.01 – EXECUTION OF CONTRACTS

The Contractor will submit the properly executed Contract Documents, within seven (7) calendar days following the City Engineer's notification of intent to Award Contract, unless said time is extended by the City Engineer. All documents listed in the "List of Contract Documents" are required to be properly executed and submitted. No Work shall commence until the Contract Documents are properly executed and submitted and a Work Order has been issued by the City Engineer.

No Contract shall be binding on the City until it has been executed or ratified by the City and delivered to the Contractor.

107.03.02 – EXECUTION OF BONDS

The date blanks on the Bonds shall be left blank. The dates will be inserted by the City upon approval.

The Bidder shall require the attorney-in-fact executing the required Bonds on behalf of the Surety to affix thereto a certified and current copy of the power of attorney.

The provisions for the competitive Bidding of City Projects and the form of and requirements for the Bidding Documents are governed by the Charter and Ordinances of the City, the Oklahoma Competitive Bidding Act, Resolution #93-01 of June 22, 1993 and other City Policies as amended.

107.04 – FAILURE TO EXECUTE CONTRACT

Failure of the Bidder to properly execute and timely submit the required Contract Documents may be considered a default. By reason of such failure by the Bidder, the City at its option may: (1) award the Contract to another Bidder; and/or (2) enforce and collect the Bid Bond as liquidated damages, not as penalty, and/or (3) seek other legal or equitable relief as the City deems appropriate.

Notwithstanding any other or additional rights of the City, should the successful bidder fail to fully and properly execute and timely return the contract and bonds or fail to provide the required insurance and certificate within seven (7) days of notification of the award, the City may rescind the award and re-advertise for new or different bids.

SECTION 108 – SCOPE OF WORK

108.01 – INTENT OF PLANS, SPECIFICATIONS AND SPECIAL PROVISIONS

The Plans, Specifications and Special Provisions describe the Work or Project in accordance with the Bidding Documents. The Contractor shall perform all Work as provided in the Contract Documents and shall perform such necessary and incidental Work to complete the Project in a satisfactory and acceptable manner. The Contractor shall furnish all labor, materials, tools, equipment and incidental work necessary and will be responsible for acquiring, copying and distributing documents for the completion of the Project.

108.02 – PRE-WORK CONFERENCE

The City shall hold a pre-work conference. The conference will be at a time and place established by the City Engineer. The Contractor must attend pre-work conferences and may include any superintendents and subcontractors.

108.03 – AMENDMENTS, CHANGE ORDERS AND FIELD CHANGES

The Contractor will be provided a minimum of one (1) record set of Contract Documents (executed documents). Additionally, the Contractor will be provided a minimum of three (3) reference sets of Plans, Specifications, Addenda, Amendments, Change Orders, and Field Changes. The Contractor shall have a set of Plans and Specifications available at the Project site at all times.

The City reserves the right to make changes in the Contract Documents, or the character of the Work as may be necessary to insure completion of the Project in the most satisfactory manner. The City reserves the right to alter the quantities of Work to be performed or the time for the Project completion. No such alterations shall waive or invalidate any condition or provision of the Contract Documents.

The Contract Documents may be changed only by an Amendment and/or Change Order as approved by the City or by Field Change as approved by the City Engineer.

All changes shall be in writing and shall, except in case of emergency, be approved by the City Council before the Work commences.

108.03.01 – AMENDMENTS

Amendments are changes to the Contract Documents that are based on Unit Bid Prices which were provided with the Bidding Documents. The Item Unit Quantity may be increased or decreased by any amount. Amendments are not subject to Contract cost limits set in the Oklahoma Competitive Bidding Act, 61 O.S. (1991) Section 121. Amendments shall be binding when approved by the City.

108.03.02 – CHANGE ORDERS

Change Orders are changes to the Contract Documents when a Lump Sum price was provided with the Bidding Documents or when a Unit Price has not been established for a particular item or items of Work. A Change Order may authorize an addition, deletion, or revision in the Work, authorize an adjustment of the Contract Price or adjust the Contract time. The cumulative amount of Change Orders shall not exceed the Contract cost limits set in the Oklahoma Competitive Bidding Act, 61 O.S. (1991) Section 121. Change Orders shall be binding when approved by the City.

Where an actual emergency exists, wherein the delay caused by submitting the Amendment or Change Order to the City for approval would jeopardize the interest of the City or the public, the City Engineer may approve the Amendment or Change Order in writing. However, Amendments or Change Orders approved by the City Engineer under the circumstances outlined above shall be submitted to the City for consideration as soon as practical.

Amendments and Change Orders submitted to the City for approval shall bear the approval of the City Engineer and shall be prepared in five (5) copies, distribution as follows:

A) Four (4) copies to the City
B) One (1) copy to the Consultant (Architect or Engineer)

Change Orders shall include the following:

A) Complete detail and scope of the Work contemplated.
B) Estimated cost of the Work as contemplated by the Change Order.
C) Complete justification.
D) Any time impact to the Work caused by the Change Order.
E) Statement as to whether the prices shown are Contract Bid prices or agreed prices.
F) Statement signed by the Contractor that he is willing to perform the Work at the prices in the Amendment or Change Order.

108.03.03 – FIELD CHANGES

Field Changes are changes to the Contract Documents when Unit Prices were provided with the Bid and when the overall Contract amount is not changed. Field Changes shall be binding when approved by the City Engineer.

108.04 – POST CONTRACT AWARD SUBSTITUTIONS

Substitutions may be considered after the Award of Contract unless specifically prohibited in the Bidding Documents. However, any Bidder basing a Bid on a substitution not approved by pre-Bid Addendum does so at the risk of being required to provide the materials designated in the Bidding Documents.

The materials, products and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by any proposed substitution.

Substitutions must be submitted in writing to the City Engineer for approval. The Contractor shall submit any additional information required by the City for review of the substitution. The City reserves the right to accept or reject any Post Contract Award Substitutions.

SECTION 109 – CONTROL OF THE WORK AND MATERIALS

109.01 – WORK ORDER

All Work shall be accomplished under authority of a written Work Order issued by the City Engineer. No Work Order shall be issued until the required Contract Documents have been executed by the Contractor and approved by the City.

109.02 – AUTHORITY OF CITY ENGINEER

All Work shall be done under the supervision and approval of the City Engineer. The City Engineer shall be the final authority regarding all questions which arise, including, but not limited to, the following:

A) The quality and acceptability of materials furnished.
B) Work performed.
C) Manner of performance.
D) Rate of progress of the work.
E) Interpretation of the plans and specifications.
F) Acceptable fulfillment of the contract.
G) Compensation.
H) Mutual rights between contractors under these specifications and suspension of work.

The City Engineer shall have the right to establish any sequence or priority of operation in the interest of desirable cooperation with other Work.

The authority of the City Engineer shall be in writing and not be construed to waive, revise or modify Contract Documents.

109.03 – CONFORMITY WITH PLANS

All Work shall conform to the lines, grades, cross sections and dimensions shown in the Contract Documents. Any changes from the Contract Documents shall be accomplished by Amendments, Change Orders or Field Changes.

109.04 – ORDER OF CONSTRUCTION

Site Preparation - The site of work, where deemed necessary by the City Engineer, shall be cleared of trees, brush, fences, buildings and obstructions occupying space needed for construction operations. Provided that no building or structure partially encroaching on the right-of-way or located in such a manner as not to interfere with construction operations shall be moved unless specifically noted on the plans for removal or directed by the City Engineer to be removed. Salvaged material shall be stored as directed by the Engineer.

Access Road - Where work is not accessible from existing streets and roads, the Contractor shall prepare necessary roads and grade or otherwise smooth uneven terrain along the right-of-way so that material may be transported and power equipment moved to and operated on and along the site of the work. Any

work done under the foregoing requirements will be subject to the Engineer's approval.

When trenching or disturbing existing ground cover, unless otherwise directed by the Engineer, the Contractor shall leave no more than nine hundred feet (900') maximum, or as designated by the Engineer, between backfilling operations and the complete restoration of paving, paving repairs, fencing, sodding, etc.

When temporary surfacing is provided for in the contract documents, the Contractor shall complete temporary paving repair immediately as soon as practical before adjacent work is completed.

109.05 – ADJUSTMENT OF EXISTING STRUCTURES AND UTILITIES

109.05.01 – GENERAL

The Contractor, at his expense, shall provide an electrical or mechanical device or use such other means he may select to locate any hidden utility line, oil or gas pipeline, water pipeline, sewer pipeline, telegraph and telephone line, and locate such lines or structures shown on the plans and any uncharted line or structure whether shown on the plans or not and protect, adjust to grade, disconnect and replace, relocate and replace, remove, provide supports during the construction and settlement of backfill and protect against freezing or unnecessary damage by the elements of existing utility lines, oil or gas pipelines, water pipelines, sewer pipelines, telegraph and telephone lines, railroad right-of-way lines and other structures and shall pay all fees to County, City, State or Federal agencies which may be required in the performance of this work.

The Contractor shall make satisfactory arrangements with the owners of such structures for performing the work. The Contractor shall not be entitled to any additional payment for such work under these specifications except where specific contract unit prices are provided in the proposal.

Where specific contract unit prices are not provided in the proposal, then such work shall be considered incidental to the construction except as hereinafter provided and where the City is legally liable for the payment of such cost in the construction work to be performed under these specifications, any cost involved shall be reflected in such other contract prices as are provided in the proposal.

109.05.02 – SEWER CONNECTIONS

The connecting of sewers or sewer appurtenances to other sewers or to sewer appurtenances shall be made in accordance with the plans or under the direction of the Engineer. The work shall be done in a workmanlike manner in such a way as not to damage any of the structures involved. No sewer shall project beyond the inside wall line of other sewers or of sewer appurtenances.

109.05.03 – SEWER GRADES

General - The grade line shown on the plans is the elevation of the invert or flow line of the sewer. The sewer grade shall be established by use of batter board, laser beam, or other methods approved by the Engineer.

Batter Boards - When batter boards are used they shall be set at grade stakes not farther than fifty (50) feet apart. Not less than three (3) batter boards shall be maintained in correct position continuously during the construction of the sewer. Batter boards shall be of good, straight, sound material, fastened to substantial stakes or uprights. Batter boards ten (10) feet or less in length shall not be smaller than one (1) by four (4), and when longer than ten (10) feet shall not be smaller than one (1) by six (6) or two (2) by four (4). Stakes shall not be smaller than two (2) by four (4). Steel stakes with suitable clamps may be used when approved by the Engineer.

A suitable fine cord or wire approved by the Engineer, shall be stretched tightly between batter boards over the exact centerline of the sewer. A graduated pole or rod shall be provided for measuring from the cord stretched between batter boards to the bottom of the trench while the trench is being prepared and to the sewer invert while the sewer is being placed. When the vertical distance from the cord between batter boards to the invert of the sewer exceeds ten (10) feet, a line shall be set at the bottom

of the trench for aligning the pipe and establishing the grade.

Laser Beams - When laser beams are used to establish line and grade, they shall first be calibrated in accordance with the equipment manufacturers recommended procedures. The Contractor shall establish horizontal and vertical controls (offset stakes) with a transit or theodolite. The Contractor may then proceed to establish line and grade using the laser equipment. In conjunction with the laser beam, the Contractor may also be required to provide temporary benchmarks at intervals as specified by the Engineer.

109.06 – BORING TEST HOLE INFORMATION

Test hole information, when shown on the plans or included in the specifications, shall only represent subsurface characteristics to the extent indicated, and only for the point location of the test hole.

Each bidder shall make his own interpretation of the character and condition of the materials, which will be encountered, between test hole locations. Each prospective Bidder may, at his own expense, make additional surveys and investigations as he may deem necessary to determine conditions which will affect performance of the work.

109.07 – WATER USAGE

The Contractor may obtain from the City of Oklahoma City a flush meter for access to water hydrants for the purposes of cleaning and other work items requiring water. No fire hydrant shall be obstructed or used when there is a fire in the area. The Contractor shall be responsible for the water meter and all related set-up charges, including the water usage bill. All expenses shall be considered incidental.

109.08 – AUDIO-VIDEO RECORDING PRE- AND POST-CONSTRUCTION

These recordings will serve as a record of pre-construction and final conditions. All Audio Video recordings shall be recorded in a manner that logically follows the entire project path in a continuous manner. The audio-video record shall become the property of the City and shall be delivered prior to commencing construction and prior to final payment. Contractor must submit recording to the Engineer for review and approval.

A) Pre-construction Audio-Video Recording

The Contractor shall be required to record above ground topography and existing amenities located along project area before clearing and construction operations begin.

B) Post-Construction Audio-Video Recording

The Contractor shall be required to record above ground topography and existing amenities located along project area after construction is completed

C) Audio-Video Recording Quality

The Audio-video recording shall be in color and recorded digitally on DVD, or format as approved by the Engineer. The audio-video record shall be high quality and detailed enough to settle disputes that may arise.

If not specified with a pay item the cost of audio-video recording shall be included in other items.

109.09 – SEDIMENT AND EROSION CONTROL

The Contractor shall minimize the amount of land disturbed to minimize the loss of the sediment from the job site onto neighboring properties or into area waterways and streams. The most effective and direct means of controlling erosion during and after construction is to attain a good vegetative cover over all soil surfaces laid bare or disturbed. Permanent vegetative cover shall be established promptly after completion and acceptance of areas of work. Practices to minimize erosion and trap sediment carried by site runoff are to be utilized by the Contractor. All work shall comply with the Contractor's Erosion Control Plan.

The Contractor shall designate a full-time employee on the job site to be responsible for implementation of erosion and sediment control measures. The Contractor's designated employee shall inspect and document the condition of all erosion control structures on a weekly basis. In the event of rainfall in excess of one-half inch, an inspection of all structures shall be made within 24 hours of the one-half inch rainfall event.

109.09.01 - STORM WATER CONSTRUCTION ACTIVITIES PERMIT

When applicable, in order for the City of Oklahoma City to remain in compliance with the Environmental Protection Agency (EPA), Oklahoma Department of Environmental Quality (ODEQ) regulations, and maintain its own NPDES permit, the City must ensure all construction activities within its corporate boundaries are in compliance under the following regulations.

Environmental Protection Agency

Code of Federal Regulations (40 CFR, Part 122)

Clean Water Act

Oklahoma Department of Environmental Quality

Oklahoma Pollutant Discharge Elimination System Act (OPDES) 27A O.S. 2-6-201

ODEQ General Permit OKR10

City of Oklahoma City

Oklahoma City Municipal Code

A copy of the City's Best Management Practices Manual can be downloaded at http://www.okc.gov/pw/storm.html or a copy can be picked up at the City of Oklahoma City's City Clerk's Office, 200 N. Walker, 2nd Floor, Oklahoma City, Oklahoma 73102.

As a part of this project the contractor will be required to submit a completed Notice of Intent (NOI), a Storm Water Pollution Prevention Plan (SWPPP) and an Erosion Control Site Plan for permitting purposes. The Contractor shall be required to follow the plans as submitted and approved at all times during construction of the project. Along with the above stated items the Contractor shall also provide a check payable to the City of Oklahoma City in an amount required by this project. This permit must be issued before the Contractor will be allowed to obtain the building/construction permit. Permits issued may be renewed annually upon filing of a renewal application and payment of permit fee, provided that the applicant's activity, and the location where it is carried on are the same as originally permitted. In addition, the application for renewal shall be subject to all the requirements pertaining to original permit. (Oklahoma City Municipal Code 48-33)

The following note shall be on every plan submitted to the City of Oklahoma City:

Construction activities that result in land disturbance of equal to or greater than one (1) acre, or less than one (1) acre if they are part of a larger common plan of development or sale that totals at least one (1) acre must also obtain a permit from ODEQ (form 605-002a) for Storm Water Discharge from Construction Activities. This means that land disturbing of one (1) acre or more must permit with ODEQ and the City of Oklahoma City, Storm Water Quality.

109.10 – EXISTING STRUCTURES NOT SHOWN IN CONTRACT DOCUMENTS

The Contract Documents show the location of known surface and subsurface structures. The City assumes no responsibility for failure to show any or all structures on the Contract Documents or to show them in their exact location. No claim for Extra Work will be considered unless the unforeseen structures encountered necessitates substantial changes in the lines or grades or requires the building of a special structure for the Project to function as intended in the Contract Documents. Nothing herein shall relieve the Bidder of the responsibility to thoroughly inspect the proposed Work site prior to

submitting Bids.

109.11 – COORDINATION OF THE CONTRACT DOCUMENTS

The City's Standard Specifications shall govern all aspects of Bidding and construction of the Project. Exceptions or additions to the Standard Specifications will be set forth in the Special Provisions. The Standard Specifications are available for review or purchase in the City Clerk's Office. The Contract Documents as shown in Figure 100-1 describe the Work to be performed under the Contract. A requirement occurring in any of the Contract Documents is binding. In case of discrepancies the following shall apply:

A) Figured dimensions shall govern over scaled dimensions
B) Plans shall govern over Special Provisions and Standard Specifications
C) Special Provisions shall govern over Standard Specifications
D) Details, drawings and quantities shown on the Plans shall govern over quantities shown in the Detailed Bid Form.

The Contractor shall take no benefit from any apparent error or omission in the Contract Documents. The City Engineer shall be permitted to make necessary corrections or interpretations to fulfill the intent of the Contract Documents. The Contractor shall immediately notify the City Engineer of any apparent discrepancies or errors in the Contract Documents.

109.12 – COOPERATION OF CONTRACTOR

The Contractor shall give consistent attention to the Work and shall cooperate with the City Engineer and with other Contractors. The Contractor shall provide a competent superintendent on the Work site at all times who is fully authorized and in control of the Work. Such superintendent shall be capable of reading, thoroughly understanding the Contract Documents and shall receive and fulfill instructions from the City Engineer.

The Contractor shall provide all reasonable facilities to enable the City Engineer to inspect the Workmanship, materials and equipment entering into the Work.

109.13 – CONSTRUCTION STAKES

The Contractor shall provide all construction stakes in accordance with the City's Standard Specifications, Section 801 Construction Staking, unless otherwise provided in the Contract Documents.

Prior to commencing Work, the City Engineer will furnish the Contractor permanent horizontal alignment and vertical control points throughout the Work and permanent benchmarks within two hundred feet (200') of the beginning and the end of the Work limits. The City Engineer will also provide bridge centerline horizontal and vertical control points if applicable to the project.

The Contractor shall have the sole responsibility for the preservation of all horizontal alignment and vertical control stakes, benchmarks and construction stakes. The Contractor shall, at its own expense, replace any horizontal alignment, vertical control, construction stakes and benchmarks when damaged, lost, displaced or removed.

109.14 – MEASUREMENTS

Before ordering any material or doing any Work, the Contractor shall verify and be responsible for accuracy of all measurements. Errors, inconsistencies or omissions discovered shall be immediately reported to the City Engineer. No extra charge or compensation will be allowed due to any difference between actual dimensions and the measurements indicated on the drawings.

109.15 – SUBMITTALS AND SHOP DRAWINGS

The Contractor shall not start delivery of any materials until the City Engineer has approved any

required submittals and shop drawings. Only materials conforming to the requirements of the Contract Documents shall be used in the Work.

The Contractor shall transmit a minimum of five (5) copies of each submittal and shop drawing to the City Engineer for review. Each transmittal shall be sequentially numbered and shall include the City's project number, Contractor's name, Specification number and all required information. The Contractor shall also affix its approval stamp to each submittal, shop drawing and product booklet. The approval stamp must certify that "the Contractor has determined and verified all dimensions, quantities, field dimensions, relations to existing work, coordination with work to be installed at a later date, coordination with information on previously approved submittals and verification of compliance with the Contract Documents". The accuracy of all information is the responsibility of the Contractor. The Contractor's approval stamp may be reviewed and approved by the City Engineer prior to use on the project.

In reviewing and approving submittals and shop drawings, the City Engineer is entitled to rely upon the Contractor's representation that all information is accurate and correct. The Contractor shall not be relieved of any responsibility for deviations, errors or omissions of the submittals and shop drawings by the approval of the City Engineer. Upon receipt, the City Engineer shall be allowed up to fourteen (14) days for review. Submittals and shop drawings that meet the requirements of the Contract Documents will be approved by the City Engineer. The City Engineer will retain at least four (4) copies and will return a minimum of one (1) copy of the submittal or shop drawing to the Contractor. Submittals and shop drawings that do not meet the requirements of the Contract Documents will be returned to the Contractor for correction and re-submittal. The date indicated on the City Engineer's transmittal letter shall be considered the date returned to the Contractor. The Contractor shall keep at least one (1) approved copy of all submittals and shop drawings at the Work site.

The Contractor shall furnish approved materials from other sources, if, for any reason, the product from any source at any time proves unacceptable.

109.16 – MATERIALS

109.16.01 – DELIVERY

Construction materials shall not be delivered to the work site more than three (3) days in advance of the start of construction. The contractor shall be held responsible for all construction materials delivered.

109.16.02 – MATERIALS AND CONSTRUCTION METHODS NOT SPECIFIED

Request for approval of other materials and construction methods not approved and specified herein shall be made in writing along with supporting documents, by the contractor, no later than seven (7) days before the bid opening date. If approved, an addendum shall be issued.

All oral, telephone, telegraph, or fax approval of materials are invalid and shall not receive any consideration.

109.16.03 – CONCRETE AND STEEL REINFORCEMENT

Unless otherwise specified, all concrete used in construction of sanitary sewers and their appurtenances shall have a minimum twenty-eight (28) day compressive strength of thirty-five hundred pounds per square inch (3,500 psi). All steel reinforcement used shall be grade sixty (60) with a minimum yield strength of sixty thousand pounds per square inch (60,000 psi).

109.16.04 – SAMPLES

The Contractor shall provide samples of materials, finish, appliances, etc., when required by the City Engineer and all such samples must be approved by the City Engineer in writing before the Work is executed. All Work shall conform in all respects to the approved samples. Any Work that does not conform to the approved samples will be rejected and shall be removed and replaced by Work that does so conform.

109.16.05 – TESTS

The City Engineer will provide a test schedule for the Work and shall designate which samples must be taken or tests be conducted and which must be taken or conducted in the presence of an inspector. The City Engineer may require such additional tests, as necessary to the proper construction of the Project. All tests will be made in accordance with the appropriate Specifications. The Contractor shall provide such facilities as the City Engineer may require for collecting and forwarding samples. All tests shall be performed at a laboratory designated by the City. All costs of tests on materials that meet Specifications shall be at the expense of the City. All costs of tests that fail to meet the Specifications shall be at the expense of the Contractor. Upon written notification from the designated laboratory of failure to pay for failed tests, the City shall hold subsequent payment voucher claims from the contractor until verification has been provided of payment for failed tests. No claim for damages shall be made to the contractor for any delays associated with the resolution of payment for failed tests.

109.17 – MATERIALS CERTIFICATIONS

The Contractor, in all cases, shall furnish required samples without charge. A laboratory designated by the City shall perform all tests. When the Standard Specifications require testing of prefabricated products or any other materials, the City Engineer may waive local testing requirements in lieu of a certification from the manufacturer that the material or product furnished conforms to the appropriate Specifications as called for in the Standard Specifications.

109.17.01 – GENERAL REQUIREMENTS

The Contractor shall be responsible for obtaining all certifications and arranging for their delivery to the proper destinations as required by this specification. A responsible representative of the company that issues the certification shall sign materials certifications. The official company title of the signer must be clearly shown immediately beneath the Contractor's signature.

All certifications shall be furnished in duplicate and each copy shall show the following information:

A) City's Project Number
B) Name of Contractor
C) Identification Markings on Shipment
D) Quantity of Material Represented by the Certification

When certified mill tests are submitted as a Type A certification the quantity information need not be furnished provided that the identifying heat number is permanently rolled, stamped or otherwise permanently affixed to each individual piece of material in the shipment covered by the certification.

109.17.02 – TYPES OF CERTIFICATIONS

Unless otherwise specified, a certification shall be one of the following types:

A) Type A certification shall be prepared by the manufacturer and shall consist of a certified copy of a report covering tests conducted by an approved laboratory. Such tests shall have been conducted on samples obtained from the lot or lots of material in the shipment.

B) Type B certification shall consist of a certification prepared by the manufacturer and shall show the limits of test values as determined by an approved manufacturer's laboratory, a qualified commercial laboratory or other approved laboratory.

C) Type C certification shall be prepared by the manufacturer and shall certify that the material in the shipment conforms to the same formula and/or is essentially the same as the material previously approved by the City Engineer.

D) Type D certification shall be prepared by the manufacturer and shall state that the materials meet the applicable Specifications. These Specifications shall be listed by number, section reference or other appropriate identification acceptable to the City Engineer.

E) Type E certification shall be prepared by the fabricator to cover a composite item incorporating two (2) or more materials which have been previously approved on an individual basis for City Projects, but which lose their identity when they are incorporated into the composite item. All materials used in the fabrication shall be listed and identified. The certification shall state that all materials used in the fabrication of the item in question were previously approved for City use. The fabricator shall keep test reports and/or other pertinent identifying records of the individual items incorporated into the composite item until the item has been approved and accepted by the City Engineer.

109.17.03 – DISTRIBUTION OF CERTIFICATIONS

Certifications shall be mailed in duplicate to:

City Engineer, City of Oklahoma City
Certifications for Project No. _____
420 West Main, Suite 700
Oklahoma City, OK 73102

These certifications will be checked for conformance with the applicable Specifications.

109.17.04 – BASIS OF ACCEPTANCE

Whenever a certification as defined above is required or requested by the City Engineer, such material may be accepted on the basis of certification provided that all applicable requirements are met. Visual inspection at delivery and installation shows the Workmanship and condition of the material to be satisfactory.

All material furnished under certification shall be tagged, stenciled, stamped or otherwise marked with a lot number, heat number, order number, or other appropriate identification which can be readily recognized and checked against the certification. Material accepted on certification shall not be incorporated in the Work until the City Engineer has approved the certificates.

Testing shall be done only on written order of the City Engineer on test order forms provided by the City. Unless otherwise provided, nothing in these Specifications shall be construed as requiring a specific number of tests to be made. Except on Assessment Paving Projects, the minimum schedule of satisfactory tests, listed herein, will be furnished by the Contractor upon written order of the City Engineer and performed by a testing laboratory designated by the City.

Tests for asphalt extraction and gradation, asphalt cement analysis and Hveem stability will be made only as directed by the City Engineer or as specified in the test schedule.

The reference made herein to the A.S.T.M., A.A.S.H.T.O. and O.D.O.T. are to establish a standard for quality of material and shall not be construed as requiring tests for compliance with these Specifications except on the written order of the City Engineer as provided above.

An example of the schedule of tests to be furnished by the Contractor is summarized as follows:

EXAMPLE SCHEDULE OF TESTS ACCEPTANCE OF PLANT MIX ASPHALT CONCRETE PAVEMENT	
Asphalt Extraction And Gradation	1000 tons Asphalt Pavement
Roadway Density Of Asphalt Mix	4 Per 2000 Tons Asphalt Pavement or as directed by the City Engineer
Hveem Stability Test And Density Of Molded Specimen	1 Per 2000 Tons Asphalt Pavement
Maximum Theoretical Specific Gravity Of Asphalt Mix	1 Per 2000 Tons Asphalt Pavement

A satisfactory test is defined as being a test that shows that the quality of the materials or Workmanship meets the requirements of the Specifications. Where tests reveal that the quality of the materials or Workmanship does not meet the requirements of the Specifications, additional tests shall be made as directed by the City Engineer until the number of satisfactory tests called for in the schedule have been

made. The reports of these tests shall constitute the evidence referred to above. The cost of all testing provided for in the schedule, including the furnishing and taking of all samples, shall be included in the Unit Prices Bid for the various items listed in the Bid.

The City Engineer may order tests in addition to the number provided for in the schedule to be made if, in his opinion, such additional tests are necessary. The cost of all tests ordered, in addition to the number of satisfactory tests provided for in the schedule, which show that the materials or Workmanship conform to the Specifications shall be paid for by the City. The Contractor shall pay for all such tests that reveal that the materials or Workmanship do not conform to the Specifications.

In the event that any concrete cylinders on a Project have a compressive strength at twenty-eight (28) days of less than thirty-five hundred pounds per sq. inch (3500 psi) or as otherwise specified, the procedure as provided in Section 304 Portland Cement Concrete will apply and payment will be adjusted as provided. On all Work where the City is, or is not, a party to the Contract, the difference between the Contract price and the price as adjusted because of strength and/or thickness deficiencies shall be paid the City as liquidated damages to cover the higher cost of maintenance anticipated to result from slab so deficient. All costs of coring, testing of cores and repair of core holes, shall be borne by the Contractor.

109.17.05 – STORED MATERIALS

Stored materials shall be located and protected to preserve their quality and fitness for the Work. Materials shall be placed on wooden platforms or other hard, clean surfaces and not on the ground and shall be placed under cover as required. Stored materials shall be located to facilitate prompt inspection. The City assumes no responsibility for materials located on the site or off-site. The Contractor assumes full responsibility for any damage or loss to any stored materials. No stored material shall be located off-site unless approved by the City Engineer. Material located off-site shall be insured prior to payment for stored materials.

All aggregates shall be handled in such a manner as to preserve their quality, gradation and fitness for the work. The provisions for transporting aggregates shall be such to assure a continuous and adequate supply of material to the work. Aggregate stockpiles shall be built up in such a manner that acceptable materials will be delivered to the plant or the Project. Aggregates from different sources and different gradations shall not be stockpiled together. The gradation requirements, for the individual stockpiles and proportioning from the stockpiles, shall be the responsibility of the Contractor. Aggregates that have become segregated, or mixed with earth or other foreign material, shall be considered unacceptable, and will not be utilized in the work until Contractor causes aggregate piles to be integrated, and all foreign materials to be removed.

109.18 – INSPECTION

The City Engineer shall at all times have reasonable access and opportunity to inspect the Work. The Contractor will provide proper and safe access for all City and regulatory inspections. The City may maintain inspectors on the job site for the purpose of inspecting materials, equipment, Workmanship and conditions of Work. The Contractor shall notify the Field Services twenty-four (24) hours prior to:

A) Pouring Concrete
B) Covering Work
C) Working on waterlines and
D) At any other times required in the Special Provisions.

The Field Services office is open between 8:30 a.m. and 4:30 p.m., Monday through Friday and can be contacted at 297-3571.

It is the Contractor's responsibility to arrange for and complete all inspections required by the City's Building, Plumbing, Electrical, Mechanical, Fire and Zoning Codes.

The Contractor shall at any time remove and uncover such portions of the finished Work as may be

directed by the City Engineer.

A) Should the Work prove acceptable, the cost of removing uncovering and restoring covered Work may be reimbursed to the Contractor. Payment may be paid as a Change Order.

B) Should the Work prove unacceptable, the cost of removing uncovering and restoring covered Work shall be at the Contractor's expense.

C) Any Work completed, covered up, or materials used without inspection by the City may be ordered uncovered, removed, replaced and covered at the Contractor's expense.

109.19 – REMOVAL OF DEFECTIVE AND UNAUTHORIZED WORK

All Work that has been rejected or condemned shall be removed and/or replaced at the Contractor's expense. The following items list causes for removal of Work:

A) Work completed without lines and grades;

B) Work performed beyond the lines or not in conformity with the grades shown in the Contract Documents;

C) Work performed without proper inspection; and,

D) any extra or unauthorized Work done without written authority of the City Engineer.

The City Engineer shall, after giving written notice to the Contractor, have the authority to cause defective Work to be remedied or removed and replaced or to cause unauthorized Work to be removed and to deduct the cost thereof from any compensation due or to become due the Contractor. If the City deems it inexpedient to correct defective or unauthorized Work, an equitable deduction from the Contract amount shall be made.

109.20 – PUNCHLIST

The Contractor shall notify the City Engineer once all work has been completed in accordance with the Contract Documents. Upon completion, the Contractor must schedule a final walk-through of the project with the City Engineer.

The Contractor is required to generate the punch list which contains all items of work identified during the final walk-though not in conformance with the Contract Documents. The punch list will identify the date of issue, the City's project number, the Contractor's name and will describe in detail, in numerical order, all items of work that require correction, repair or replacement. A "corrected" column will be incorporated on the punch list for date and initial by the City Engineer to verify the correction.

All items of work recorded on the punch list must be corrected, repaired or replaced prior to Final Acceptance of the project by the City.

109.21 – FINAL INSPECTION

The Contractor shall advise the City Engineer when the Work is completed and ready for Final Inspection. The City Engineer shall make Final Inspection of all Work included in the Contract or any portion thereof as soon as practicable after the Work is completed and ready for Acceptance. If the Work is not acceptable to the City Engineer at the time of such inspection, the Contractor shall be informed as to the particular defects to be remedied before Acceptance can be made.

109.22 – FINAL CLEAN UP

Upon completion of the Project and prior to final Acceptance by the City, the Contractor shall clean and remove from the Work site surplus, discarded materials, temporary structures, stumps or portions of trees and debris of any kind. The Contractor shall leave the Work site in a neat and orderly condition acceptable to the City. Waste materials removed from the Work site shall be disposed of at locations satisfactory to the City Engineer and in compliance with Federal, State and City requirements.

109.23 – CORRECTION OF WORK AFTER FINAL PAYMENT

Neither the final certificate nor payment nor any provision in the Contract, Bonds or any other Contract documents shall relieve the Contractor of responsibility for faulty materials or workmanship and, unless otherwise specified, the Contractor shall remedy any defects due thereto and pay for any damage to other Work resulting there from, which shall appear within a period of one (1) year from the date of formal acceptance or duration of Maintenance Bond, whichever is longer, by the City. The City shall give notice of observed defects with reasonable promptness after discovery.

109.24 - FINAL ACCEPTANCE OF PRIVATE DEVELOPMENT PROJECTS

For final acceptance of private development projects, the contractor in addition to successful completion of all work items, punch list items, final clean-up, and final inspection, must submit a completed copy of the test schedule with results of all tests and copies of all applicable test reports to the Field Services Division.

Failure to perform the required tests in compliance with these Standard Specifications and the test schedule will result in a penalty equal to three times the cost of each uncompleted test. The penalty amount for each uncompleted test will be based on the price under the City's annual testing contract.

SECTION 110 – LEGAL RELATION AND RESPONSIBILITY TO THE PUBLIC

110.01 – LAWS TO BE OBSERVED

The Contractor shall observe and comply with all Federal and State laws and regulations and all City Ordinances, Codes and regulations which in any manner affect the conduct of the Work. The Contractor shall observe and shall comply with all existing orders and decrees or which may be issued. No plea of misunderstanding or ignorance will be considered.

110.02 – PERMITS AND LICENSES

The Contractor must secure, at its own cost, all permits, licenses and fees required by City ordinances, State statutes or Federal laws. Required permits, licenses and fees include, but are not limited to, building and other related permits, other fees, charges, taxes, licenses and inspections necessary for proper execution and completion of the Work. The Contractor is also required to give all notices necessary for the lawful prosecution of the work.

The Contractor must also secure, at its own cost, all certificates of inspection and occupancy that may be required by authorities having jurisdiction over the Work. No claims for delay may be made with reference to this section.

110.03 – PATENTED DEVICES, MATERIALS AND PROCESSES

If the Contractor is required or desires to use any design, device, material or process covered by letters, patent or copyright, the Contractor shall provide for such use by suitable legal agreement with the patentee or owner. The Contractor shall provide to the City Engineer a copy of any such agreement. The agreement shall be to the benefit of the City and the Contractor. The Contract prices shall include all royalties or costs arising from patents, trademarks and rights in any way involved in the Work.

110.04 – SANITARY PROVISIONS

The Contractor shall establish and enforce policies and procedures in regard to cleanliness and disposal of garbage and waste. The Contractor will prevent the inception and spread of contagious or infectious diseases about the Work or any public or private property. The Contractor shall construct (secluded from public observation), maintain and ensure the use of necessary sanitary conveniences for the use of laborers on the Worksite.

110.05 – PUBLIC CONVENIENCE AND SAFETY

The Contractor shall establish and implement safety measures, policies and standards conforming to those required or recommended by governmental authorities including, but not limited to, the requirements of the United States Occupational Safety and Health Act.

The Contractor shall take such special precautions for the safety of the Work and the traveling public as may be necessary, including, but not limited to, sheeting, bracing and thoroughly supporting the sides of any excavation and supporting and protecting any adjacent structures.

The Contractor shall not cause an obstruction to the traveling public. The Contractor shall, at the Contractor's own expense, make provisions for the diversion of traffic and the traveling public. The City reserves the right to remedy, at the Contractor's expense, any neglect on the part of the Contractor regarding the public convenience and safety upon twenty-four (24) hours written notice regarding failure to respond. In cases of emergency, the City shall have the right to remedy without notice, at the Contractor's expense.

110.06 – STREETS, ALLEYS, OR RIGHTS-OF-WAY

Streets, lanes of streets, or alleys may be closed only upon the prior approval of the City Engineer. Should a street, lanes of streets, or alley closing be approved, the Contractor is responsible for notifying the following at least twenty-four (24) hours in advance of the closing. Notification by Fax is preferred.

	FAX #	Telephone #
Field Services	682-7067	297-3571
Traffic Engineer	297-3365	297-2531
Police Support Services	297-1718	297-1283
Fire Department	297-3329	297-3314
Emergency Operations Center	424-1609	297-2255

110.06.01 – DETOURS

The City Engineer may approve all detour routes during construction. The Contractor shall provide and maintain all detour routes, signs and devices which shall conform to the requirements of the "Manual on Uniform Traffic Control Devices."

110.06.02 – OCCUPYING STREETS, ALLEYS, RIGHT OF WAY OR CITY PROPERTY

a) During Work the Contractor will be allowed to occupy such portions of streets, alleys, rights-of-way or City Property as provided for in the ordinances of the City, the Contract Documents or as allowed by the City Engineer. The City Engineer may approve a reasonable amount of tools, materials and equipment for construction, which may be stored in such space but not more than is necessary to avoid delay in the construction. Streets, alleys, rights-of-way and/or City property shall be free and unobstructed at all times unless otherwise approved by the City Engineer, including, but not limited to, excavated and waste materials, stored materials, equipment, etc. Other Contractors of the City may, as required by their Contracts, enter the Project. The Contractor shall provide other City Contractors all reasonable access and assistance for the performance of the adjoining Work. Any additional Project area desired by the Contractor shall be acquired at the Contractor's expense. The Contractor while in control of the project site shall maintain the site to be clean of trash and weeds or grass to be cut or mowed, acceptable to the City Engineer, at a minimum of every two weeks.

b) **USE OF CITY LAND & PROPERTY FOR STORAGE OR STAGING OPERATIONS ON PUBLIC CONSTRUCTION PROJECTS:**

The Contractor must obtain the prior written approval of the City Engineer to utilize any City property, easement, or right-of-way outside of the project site for construction storage or staging

operations during the performance of public construction projects. Additionally, approval by the Director of the Parks and Recreation Department must be obtained prior to utilizing City park property.

The Contractor must request such approval by written correspondence. The correspondence must include a description of the requested storage or staging activity and a brief description of the property with a location map (aerial/topographic/pictures/diagrams) of the specific area for which the request is being made.

The City Engineer with the Director of Parks and Recreation, where applicable, is authorized to grant permission and to negotiate and establish the consideration received by the City. Construction storage includes storage of construction materials, excavation materials, equipment, and vehicles to the extent and upon the conditions set by the City Engineer; provided all materials, equipment and vehicles must be removed upon completion of the project and all reparations and restoration of the property must be completed within ten working days of the completion of the project. This policy does not authorize the use of City property, easement, or right-of-way for private projects.

If approval is granted, the following requirements shall be adhered to by the Contractor:

1. No vehicular traffic or stockpiling of equipment, soil or other materials within the drip line of mature trees or within five (5) feet of the water pan for young trees. The drip area of trees is to be protected by a safety fence.
2. Unless otherwise directed, the Contractor shall repair disturbed land with approved slab sod on top of a prepared subgrade. Random excavation material will not be allowed in lieu of topsoil. The Contractor shall be responsible for watering the sod until approved growth has been established to the satisfaction of the City Engineer.
3. Approval by the Director of the Parks and Recreation Department shall be received prior to all tree trimming. Trees shall be trimmed by a licensed tree serviceman approved by the Director of the Parks and Recreation Department. The Contractor shall pay the cost of tree.
4. Contractor shall restrict all construction operations to occur within the boundary of "planned construction limits". No staging or parking will be allowed outside of the planned construction limits. Any variance to the construction limits must be approved by the City Engineer.
5. Total area required for staging (including parking of all contractor equipment, material storage, employee parking , job shack, etc.) must be secured by fencing for the protection of park uses outside of the staging area and to clearly delineate the approved area.
6. Construction or equipment fluids must not be drained onto the ground. Any resulting spills must be completely mitigated by removing the contaminated soil, replacement with quality top soil, and completely solid slab sodded.
7. The area inside of the "staging area" must be regularly maintained by the contractor. This means all litter must be picked up and removed, kept from encroaching out onto the park, and the area mowed and trimmed as necessary.
8. Any storage of dirt should be protected by silt fence.
9. Any gravel storage areas must be completely cleaned of any gravel debris so that none remains to become projectiles from mowing/ trimming activities.

Any disturbed areas (equipment parking areas, haul roads, storage areas, etc.) must be disked to a depth of 8 inches to alleviate compaction and completely solid slab sodded. No seeding, sprigging, or hydro-mulching will be allowed. Newly sodded areas must be completely watered in and viable upon inspection prior to turning back over to the City.

110.06.03 – BARRICADES AND WARNING SIGNS

Where Work is performed adjacent to or on any street, alley, right-of-way, or public place the Contractor shall at its own expense, furnish, erect and maintain barricades, fences, lights, warning signs and signals. The Contractor shall provide such flagman or watchmen and take such other precautionary measures for the protection of persons or property and of the Work as may be necessary. A sufficient number of barricades shall be erected to keep pedestrians and vehicles from entering on or into the Project. From sunset to sunrise, the Contractor shall furnish and maintain at least one operating light on each barricade. All devices shall also be in conformance with the "Manual on Uniform Traffic Control Devices."

The Contractor shall provide a twenty-four (24) hour phone number to the City's Emergency Operations Center and to the Field Services Division to be used for notification to promptly repair signs, barricades, other warning or control devices. Failure to comply with these requirements may result in the issuance of a Stop Work Order until the deficiencies are corrected.

The City reserves the right to remedy any neglect on the part of the Contractor regarding the public convenience and safety, upon twenty-four (24) hour written notice. In cases of emergency, the City shall have the right to remedy without notice at the Contractor's expense.

110.07 – RAILWAY CROSSINGS

When the Project encroaches upon any railway right-of-way, the City will secure for the Contractor all the necessary Contracts and/or easements of authority to enter upon such right-of-way for the prosecution and completion of the Project. If the Project area is occupied by railway tracks, the Work shall be carried on in such manner as not to interfere with the railway operation. Where railway tracks are to be crossed, the railway company, may construct the necessary bridges, trestles, cribs or other structures for the safe operation of trains or cars across any excavation during the time or construction of the Work. The cost of the construction of such bridges, trestles, cribs or other structures shall be paid to the railway company by the Contractor. This cost shall include the necessary cost of any supervision or other incidental expenses that may be required by the railway company while the Work is in progress on the right-of-way of the railway company. The Contractor submitting a Bid shall take all railway coordination costs into consideration.

The Contractor shall coordinate and cooperate with the City and Railway in all ways possible to complete the Project. In case of delay due to the railway coordination, only an extension of time may be considered.

110.08 – USE OF EXPLOSIVES

Should the Contractor elect to use explosives for any purpose in the prosecution of the Work, all affected or concerned City departments and all utility companies shall review the type of explosive to be used and proposed use.

Prior to any blasting, the Contractor shall receive written permission of the City Fire Marshall and the City Engineer. Written permission shall not be issued until the Contractor obtains a release from all utility companies. Prior to any use of explosives, the Contractor shall notify the proper representative of all utility companies having service connections within the area. This notification shall include the date, time and location.

The City Fire Marshall and the City Engineer may require detailed information on all progress toward the use of explosives and may require additional safety precautions.

All precautions shall be taken by the Contractor as required by the City and the State relative to use of explosives. Necessary provisions shall be made for the protection of the Project. All use of explosives shall be conducted to protect persons or property. The Contractor shall keep only sufficient quantities of explosives necessary for the immediate day's Work on hand. Storage of explosive devices shall be

done strictly in compliance with applicable laws, industry standards and/or as directed by the City Engineer.

110.09 – PROTECTION AND RESTORATION OF PROPERTY

The Contractor shall not enter upon private property for any purposes without first obtaining permission from the property owner. The Contractor shall be responsible for the preservation of public or private property. The Contractor shall use every precaution necessary to prevent damage to all trees, fences, culverts, bridges, pavements, driveways, sidewalks, etc., and to all water, sewer, gas or electric lines or appurtenances thereof and to all other public or private property along or adjacent to the Work. The Contractor shall notify the proper representatives of any public utility, any company or any individual not less than twenty-four (24) hours in advance of any Work which might damage or interfere with the operation of their property, along or adjacent to the Work. The Contractor shall be responsible for all damage or injury to property of any character resulting from any act, omission, neglect or misconduct in the manner or method of executing the Work. The Contractor shall be responsible for the non-execution of the Work and any time due to defective Work or materials and said responsibility shall not be released until the Work is completed and accepted. When and where any direct or indirect damage or injury is done to public or private property on account of any act, omission, neglect or misconduct in the execution of the Work the Contractor shall restore the property at the Contractor's expense.

The Contractor shall be responsible for the consequence of the non-execution of the Contract and shall restore at the Contractor's own expense such property to a condition similar or equal to that existing before such damage or injury was done. The Contractor shall repair, rebuild or otherwise fix the property as may be directed, or the Contractor shall make good such damage for injury in an acceptable manner.

In case of the failure on the part of the Contractor to restore such property or make good such damage or injury, the City Engineer may, upon forty-eight (48) hours written notice, under ordinary circumstances, proceed to restore such property. The City Engineer may without notice restore such property when a nuisance or hazardous condition results. The cost for the City's Work will be deducted from any monies due or to become due the Contractor under the Contractor's Contract.

110.10 – PROTECTION AND PRESERVATION OF LAND MONUMENTS AND PROPERTY LINE MARKS

The Contractor shall protect carefully from disturbance or damage all land monuments and iron pins or other markers that establish property or street lines. Where such monuments or markers must, of necessity, be disturbed or removed in the performance of the Contract, the Contractor shall first give ample notice to the City Engineer, so replacement of such monuments or markers may be witnessed or referenced by the City Engineer. Should the Contractor disturb, remove or damage any established land monument or property or street line mark without first giving the City Engineer ample notice, the City Engineer may deduct the cost of re-establishing such monuments or marks from any monies due or to become due the Contractor.

110.11 – RESPONSIBILITY FOR DAMAGE CLAIMS

The Contractor and the Contractor's Surety shall defend, indemnify and save harmless the City and any applicable Trusts and all its officers, agents and employees from all suits, actions or claims of any character, name and description brought for or on account of any injuries or damages received or sustained by any person or persons or property by or from the said Contractor or employees or by or in consequence of any negligence in safe-guarding the Work or through the use of unacceptable materials in constructing the Work or by or on account of any act or omission, neglect or misconduct of the Contractor or by or on account of any claim or amounts recovered by an infringement of patent, trademark or copyright, or from any claims or amounts arising or recovered under the Workmen's Compensation Law or any other law, ordinance, order or decree and so much of the money due the said Contractor under and by virtue of the Contractor's Contract as shall be considered necessary by

the City may be retained for the use of the City or in case no money is due, the Contractor's Surety shall be held until such suits or suit, action or actions, claim or claims, for injury or damage as aforesaid shall have been settled and satisfactory evidence to that effect furnished to the City. Provided, however, the Contractor need not release, defend, indemnify or save harmless the City of Oklahoma City or their officers, agents and employees, from damages or injuries resulting from the sole negligence of the officers, agents or employees of the City of Oklahoma City.

110.12 – CONTRACTOR'S CLAIM FOR DAMAGES

Should the Contractor claim compensation for any alleged damage by reason of the acts or omissions of the City, he shall within ten (10) days after the sustaining of such damage, make a written statement to the City Engineer setting out in detail the nature of the alleged damage. On or before the 25th day of the month succeeding that in which any such damage is claimed to have been sustained, the Contractor shall file with the City Engineer an itemized statement of the details and amount of such damage and upon request shall give the City Engineer access to all books of account, receipts, vouchers, bills of lading and other books or papers containing any evidence as to the amount of such damage. Unless such statement shall be filed as thus required, the Contractor's claim for compensation shall be waived and he shall not be entitled to payment on account of any such damage.

110.13 – PUBLIC UTILITIES AND PUBLIC PROPERTY TO BE CHANGED

The Contractor shall not prevent free access to all utilities or emergency devices, services and access. The cost of adjusting water mains or services to grade shall be included in the Bid prices except where a specific item for this Work is included in the Bid.

An effort has been made to locate and show on the Plans, existing utilities. Should the Contractor encounter any utilities whether or not shown on the Plans, it will be the Contractor's responsibility to protect the liens during construction. If there is any interference from alignment or elevation, it will be the responsibility of the Contractor to have these utilities relocated to permit construction to continue. All necessary relocation or adjustment of utilities will be accomplished without expense to the Contractor except when otherwise provided in the Special Provisions or included in the Project. The Contractor shall be required to coordinate the Contractor's Work with that of the utility companies or the City so that the relocation or adjustment of utilities and the Work on the Project can proceed in an orderly and timely manner. Any damage to new or existing utilities or other facilities on the Project site shall be repaired by the Contractor in accordance with the provisions of the Contract or as directed by the City Engineer. No additional payment will be allowed for such Work. It shall be the responsibility of the Contractor to be fully informed as to the extent of the limits of the Work to be performed by other Contractors of the City and to coordinate this Work with them. Should there be any conflicts as to the limits or staging of the Work, the matter shall be presented to the City Engineer or representative and any decision thereon shall be final.

Traffic signals and appurtenances are not located by the OKIE one-call system. Contractors must call 297-2648.

BEFORE YOU DIG CALL OKIE.

How to use CALL OKIE.

1. Contractor dials CALL OKIE CENTER.
2. Operator at center records necessary information, tells caller who will be notified and gives caller the Locate Request Number.
3. Locate Request message is transmitted by computer to owners of utilities.
4. Location of facilities is marked at site by owners:

Statewide	1-800-522-6543
Out-of-state	1-800-654-8249
Local - Oklahoma City	1-405-840-5032

110.14 – TEMPORARY SEWER AND DRAIN CONNECTIONS

When existing sewers have to be taken up or removed the Contractor at the Contractor's own expense, shall provide and maintain temporary outlets and connections for all private or public drains, sewers or sewer inlets. The Contractor shall take care of all sewage and drainage that will be received from these drains, sewers and sewer inlets; and for this purpose the Contractor shall provide and maintain at the Contractor's expense, adequate pumping facilities and temporary outlets or diversions. The Contractor shall construct such trough, pipe or other structures necessary and be prepared at all times to dispose of drainage and sewage received from these temporary connections until such time as the permanent connections are built and in service. The existing sewers and connections shall be kept in service and maintained under the Contract, save where specified or ordered to be abandoned by the City Engineer. All water or sewage shall be disposed of in a satisfactory manner so that no nuisance is created and that the Work under construction will be adequately protected.

110.15 – ARRANGEMENT AND CHARGE FOR WATER FURNISHED BY THE CITY

If the Contractor desires to use City water, the Contractor shall pay the rate established by City ordinance for such service and shall make complete and satisfactory arrangements with the City Water Department for so doing. Meters will be used and the Contractor shall deposit the cost of the water meter with the Water Department and will pay for all repairs and maintenance of the meter for the period which he has the meter in the Contractor's possession.

110.16 – USE OF FIRE HYDRANTS

The Contractor or employees shall not open, turn off, interfere with, attach pipe or hose to, or connect anything with any fire hydrant, stop valve, or stop cock or tap any water main belonging to the City, unless duly authorized to do so by the Water Department.

110.17 – USE OF A SECTION OR PORTION OF THE WORK

Whenever, in the opinion of the City Engineer, any portion of the Work or any structure is in suitable condition, the suitable portion may be put into use by the written order of the City Engineer. Such usage shall not be held to be in any way Acceptance of said Work or structure or any part thereof. The usage of a portion of the Work in use is not a waiver of any of the provisions of these Specifications of Contract. Pending Final Acceptance of the Work, all necessary repairs and renewals on any section of the Work so put into use due to defective material or Workmanship, to natural causes other than ordinary wear and tear or to the operations of the Contractor, shall be performed by and at the expense of the Contractor.

110.18 – CONTRACTOR'S RESPONSIBILITY FOR THE WORK

110.18.01 – GENERAL

Until Final Acceptance by the City, the Work shall be under the charge and care of the Contractor. The Contractor shall take every necessary precaution to prevent injury or damage to the Work or any part thereof by the action of the elements or any other cause whatsoever, whether arising from the execution or non-execution of the Work. The Contractor shall at the Contractor's own expense rebuild, repair, restore and make good all injuries or damage to any portion of the Work occasioned by any of the foregoing causes before Final Acceptance of the Work by the City.

110.18.02 – SAFETY AND OSHA RULES AND REGULATIONS

All work shall be done in conformance with applicable Occupational Safety and Health Administration (OSHA) Rules and Regulations.

110.19 – PERSONAL RESPONSIBILITY OF PUBLIC OFFICIALS

In carrying out any of the provisions contained herein or in exercising any power or authority granted to him by the Contract, there shall be no liability upon the City Engineer or authorized assistants, either

personal or as officials of the City, it being understood that in such matters he acts as the agent and representative of the City.

110.20 – WAIVER OF LEGAL RIGHTS

Inspection by the City Engineer or by any of his duly authorized representatives, any order, measurement, or certificate by the City Engineer, any order by the City for the payment of money, any payment for or Acceptance of any Work or any extension of time or any possession taken by the City, shall not operate as waiver of any provisions of the Contract or any power therein provided. Any waiver of any breach of Contract shall not be held to be a waiver of any other or subsequent breach. The City reserves the right to correct any error that may be discovered in any estimate that may have been paid and to adjust the same to meet the requirements of the Contract and Specifications. The City reserves the right to claim and recover by process of law sums as may be sufficient to correct any error or errors or make good any deficiency in the Work resulting from such error or deficiency, dishonesty or collusion discovered in the Work after the final payment has been made.

110.21 – INDEMNIFICATION

The Contractor shall indemnify, defend and save harmless the City and any participating public trust from any and all losses, expenses, costs, damages, penalties, or any injuries, including death, directly or indirectly resulting from acts or omissions of the Contractor and its agents, employees, and subcontractors and/or from any penalties for violation of any law, ordinance or regulation by the Contractor and its agents, employees, and subcontractors. The presence of or inspections by employees or agents of the City and or participating public trust shall not limit, affect, waive, release, or extinguish any duty, obligation, or responsibility of the Contractor. The obligations imposed by this paragraph shall not be limited, affected, waived, or extinguished by any obligation to provide insurance or by the provision or procurement of insurance.

110.22 – CONTRACTOR'S INSURANCE

(a) During the entire term of the Contract (from the approval of the Contract to the final acceptance of the fully completed project by formal action of the City) and for such additional period thereafter as specifically required herein, the Contractor shall provide, pay for, and maintain the following types of insurance:

(i) Worker’s Compensation. The Contractor must maintain, during the term of the Contract, Worker's Compensation Insurance as prescribed by the laws of the State of Oklahoma, and Employer's Liability Insurance for all of its employees at the project sites. If any work is subcontracted, the Contractor shall require the subcontractor similarly to provide Worker's Compensation and Employer's Liability Insurance for all the subcontractor's employees at the project sites, unless such employees are covered by the insurance purchased by the Contractor. In the event any class of employees engaged in work performed under the Contract or at the project sites are not protected under such insurance heretofore mentioned, the Contractor shall provide or shall cause each subcontractor to provide adequate insurance for the protection of the employees not otherwise protected.

(ii) Commercial General Liability Insurance. Contractor shall carry a policy of commercial general liability insurance. If the Contractor's Commercial General Liability coverage is written in a "claims-made" form, Contractor shall also provide tail coverage that extends a minimum of two years from the expiration of this Contract.

(iii) Automobile Liability Insurance. The Contractor shall maintain insurance coverage

as to the ownership, maintenance, and use of all owned, non-owned, leased or hired vehicles.

(b) The Contractor must carry and maintain the required insurance policies and may not canceled, fail to be renewed, nor decrease its limits without 30 days written notice to the City and any participating public trust. The Contractor must provide properly executed Certificates of Insurance evidencing insurance coverage as required by the Contract for this project. The Certificates of Insurance must specifically state the project number and description. An authorized representative of the insurance companies listed on the Certificates of Insurance must sign the Certificates. The Contractor must attach to the Certificates of Insurance such documentation as will demonstrate the authority of the insurance agent to sign the Certificates. Additionally, the Contractor must provide a covenant from the insurance agent that the insurance agent will provide to the City and any participating public trust 30 days advanced written notice prior to any cancellation, lapse, reduction, limitation, or non-renewal of any insurance coverage or policy required for this project. The Contract will provide the Certificates of Insurance to the City with its signed Contract and Bonds. The City Engineer will not issue Notice to Proceed and the Contractor may not commence work or occupancy of the project sites until the required Certificates of Insurance have been received and verified, however, working days may commence and may accrue or be accruing pending presentation of the required insurance certificates and documentation and the effectuation of the required insurance coverage. Certificates of Insurance must be standard industry forms, such as ACORD, or in the form included in these specifications.

(c) The minimum liability coverage for each liability and each property insurance policy shall not be less than the greater of the following amounts: (i) $1,000,000, (ii) the cumulative maximum liability limit for the City and each participating public trust under the Governmental Tort Claims Act (51 O.S. §§151 et seq.), or (iii) the minimum amount required by the Contractor's prequalification classification. All liability and property policies as to which the City is not a named insured must, to the extent allowed by law, provide an endorsement or appropriate coverage language to make the City and any participating public trust "additional insureds." The required policies of insurance must be enforceable in Oklahoma and will be construed in accordance with the laws of the State of Oklahoma.

(d) In the event of a reduction in any aggregate insurance coverage or limits below the coverage required by this specification, the Contractor shall take immediate steps to have the full amount of the required insurance coverage reinstated. If at any time the City requests a written statement from the insurance company(s) as to any impairments to the aggregate coverage or limits, the Contractor hereby agrees to promptly authorize and have delivered to the City such statement. The Contractor shall remove or cover any impairment to insurance coverage as soon as known to it. The Contractor authorizes the City to confirm with the Contractor's insurance agents, brokers, surety and insurance carriers all information necessary to confirm or evidence the Contractor's compliance with bonding and insurance requirements. The Contractor's insurance coverage shall be primary to any insurance or self-insurance program carried by the City or any participating public trust.

(e) Any deductibles or self-insured retentions in excess of $25,000, or any other risk-management scheme other than a fully insured program of commercial general liability and automobile liability insurance must be declared by the Contractor prior to contract award and must be addressed to the satisfaction of the City and any participating public trust in advance of contract award. At the option of the City and any participating public trust, the Contractor may be required to: (1) reduce or eliminate such deductibles or to establish self-insured retentions with respect to the liability coverage for the City and any participating public trust, or (2) procure and provide a bond or irrevocable letter of credit guaranteeing payment to the City and any participating public trust for claims, losses, expenses, and

other related costs of investigations, claims administration, and defense expenses not otherwise covered by Contractor's insurance because of deductibles or self-insurance retentions, or (3) provide owner's protection liability coverage with the City and any participating trust as the named insureds, for the commercial general liability requirement, in a combined single-limit bodily injury and property damage amount of One Million Dollars ($1,000,000.00).

(f) All insurance policies shall be issued by insurance companies licensed and authorized to do business in Oklahoma with an A.M. Best rating of A- VII or better. The Contractor must timely provide to the City certified, true, and exact copies of all insurance policies required for this project whenever requested by the City. In addition, Contractor must require each insurance company that issues a certificate of insurance to the City to provide a copy of the policy to the City upon request.

110.23 – BUILDER'S RISK INSURANCE

On all building projects the successful bidder will provide Builder's Risk Insurance (all risk coverage for building or facility construction and renovation projects). The Contractor shall procure and shall maintain, during the term of the Contract, builder's risk insurance (broad form coverage, including theft, fire coverage on building construction or renovation) in the amount of one hundred percent (100%) of the construction cost. Such insurance shall remain in effect until 11:59 p.m. on the date of final acceptance of the entire fully completed project by formal action of the City, whether or not the project is substantially completed or whether or not the building or some part thereof is occupied in any manner prior to final formal acceptance. The Contractor shall be named as insured and the City and any participating public trust (as their interests may appear) shall be named as additional insureds. The coverage shall provide protection for the Contractor, the City, and any participating public trust, respectively, against property damage and damage claims which may arise from activities, omissions, or operations by the Contractor or its subcontractors under the Contract and also against any of the special hazards which may be encountered by the Contractor or its subcontractors in the performance of the Contract. Neither the Contractor nor any of its subcontractors, employees, or agents shall commit any act, operation, or omission that would vitiate, invalidate, or impair the insurance coverage hereunder. The insurance coverage must also include all stored materials, supplies, and equipment when stored off site.

110.24 – LIENS

Neither the final payment or any part of the retained percentage shall become due until the Contractor, if required, delivers to the City a complete release of all liens arising out of this Contract. The Contractor may, if any subcontractor refuses to furnish a release or receipt in full, furnish a Bond satisfactory to the City, to indemnify him against any lien. If any lien remains unsatisfied after all payments are made, the Contractor shall refund to the City all monies that the City may be compelled to pay in discharging such a lien, including all costs and a reasonable attorney's fee.

SECTION 111 – PROSECUTION AND PROGRESS

111.01 – SUBLETTING OF WORK

The City will not recognize any subcontractor on the Work. The Contractor shall not employ any subcontractor on the Work without prior written approval of the City Engineer. The Contractor shall at all times when Work is in operation be represented either in person or by a qualified superintendent or other qualified designated representative. If the Contractor sublets any part of the Work the Contractor will not, under any circumstances, be relieved of the Contractual responsibility and obligations. All communication of the City Engineer shall be with the Contractor. Subcontractors will be considered only in the capacity of employees or Workmen and shall be subject to the same requirements as to character and competency of the Contractor.

111.02 – ASSIGNMENT OF CONTRACT

The Contractor shall not assign, transfer, convey or otherwise dispose of the Contract or right, title or interest in or to the same or any part thereof without the previous consent of the City Engineer in writing, approved by the Council and concurred in by the Surety. If the Contractor does, without such previous consent, assign, transfer, convey, sublet or otherwise dispose of the Contract or of the Contractor's right, title or interest therein or any part thereof to any person or persons, partnership, company, film, or corporation, or by bankruptcy, voluntary or involuntary, or by assignment under the insolvency laws of any state, attempt to dispose of the Contract or make default in or abandon said Contract, then the Contract may, at the option of the City, be revoked and annulled unless the Surety shall successfully complete said Contract and any monies due or to become due under said Contract shall be retained by the City as liquidated damages for the reason that it would be impracticable and extremely difficult to fix the actual damages.

111.03 – PROSECUTION OF WORK

111.03.01 – GENERAL

The Contractor shall perform the Work under the Contract within the time limit stated in the Notice to Proceed, Bid and Contract and shall conduct the Work in such a manner and with sufficient equipment, materials and labor as is necessary to insure its completion within the time limit set forth in the Advertisement, Bid and Contract. The sequence of all construction operations shall at all times be as directed by or approved by the City Engineer. Should the prosecution of the Work for any reason be discontinued by the Contractor, he shall notify the City Engineer at least twenty-four (24) hours in advance of resuming operations.

111.03.02 – PROJECT SCHEDULE

As directed by the Engineer, the Contractor shall furnish the Engineer with a tentative schedule, in Microsoft Project, Excel, Primavera, or any other format, setting forth in detail the procedure he proposes to follow, and giving the dates on which he expects to start and to complete separate portions of the work. If at any time, in the opinion of the Engineer, proper progress is not being maintained, such changes shall be made in the schedule of operations which will satisfy the Engineer that the work will be completed within the period stated in the proposal, or extension thereof made as herein provided. The schedule shall be updated monthly by the Contractor and submitted to the Engineer for review and approval. Failure to provide monthly updates (or as directed by the Engineer) to the schedule will result in a delay of processing the payment until the update is received, reviewed and accepted.

Before work begins, the Contractor shall prepare a project schedule and submit the same to the City for approval. The project schedule shall be submitted at the time of pre-work conference. This project schedule shall show the order in which the Contractor proposes to build all items of work included in the contract. After approval of the project schedule, the Contractor shall notify the City of his intent to start each of the various portions of the work included in the project schedule not less than seven (7) days prior to commencement thereof.

111.04 – LIMITATION OF OPERATIONS

The Contractor shall conduct his Work so as to create a minimum amount of inconvenience to the public. At any time when in the judgment of the City Engineer the Contractor has obstructed or closed or is carrying on operations on a greater portion of the street or public way than is necessary for the proper execution of the Work, the City Engineer may require the Contractor to finish the section on which Work is in progress before Work is started on any additional section.

111.05 – CHARACTER OF WORKMEN AND EQUIPMENT

The Contractor shall employ such Superintendents, Foremen and workmen as are careful and competent. The City Engineer may demand the dismissal of any person or persons employed by the Contractor, in, about or on the Work who misconducts himself, or to be incompetent or negligent in the

proper performance of his or their duties. Neglect or refusal to comply with the directions of the City Engineer may result in the dismissal of the employee. Such person or persons shall not be employed on City Work again without the written consent of the City Engineer. Should the Contractor continue to employ or again employ such person or persons without the written consent of the City Engineer, then the City Engineer may withhold all monies which are or may become due or may suspend the Work until such orders are complied with.

All employees shall have sufficient skill and experience to properly perform the Work assigned them. All employees engaged on special Work or skilled Work or in any trade shall have sufficient experience in such Work to properly and satisfactorily perform it and operate the equipment involved and shall make due and proper effort to execute the Work in the manner prescribed in these Specifications. Otherwise, the City Engineer may take action as above prescribed.

In the employment of labor, preference shall be given, other conditions being equal, to bona fide residents of the City of Oklahoma City, but no other preference or discrimination among citizens of the United States shall be made.

The Contractor shall furnish such equipment as is considered necessary for the prosecution of the Work in an acceptable manner and at a satisfactory rate of progress. All equipment, tools and machinery used for handling materials and executing any part of the Work shall be subject to the approval of the City Engineer and shall be maintained in a satisfactory Working condition. Equipment on any portion of the Work shall be such that no injury to the Work or adjacent property will result from its use.

111.06 – DAY'S WORK AND WORKING HOURS

Work shall be done only during regular and commonly accepted and prescribed working hours. No Work shall be done nights, Saturdays, Sundays or regular holidays unless a special order or Permit is given by the City Engineer to do so. Eight (8) hours shall constitute a day's Work and the Contractor shall observe all State laws and City ordinances governing the hours of Work.

111.07 – TIME OF COMMENCEMENT AND COMPLETION

If the satisfactory execution and completion of the Contract should require Work or materials in greater amount or quantities than those set forth in the Contract, then the Contract time may be increased by the City Engineer. No allowance shall be made for delays or suspensions of the prosecution of the Work due to the fault of the Contractor.

The Contractor shall perform the Work within the time specified in the Notice to Proceed, Bid and Contract and the rate of progress shall be such that the whole Work will be performed and the premises cleaned up in accordance with the Contract, Plans and Specifications within the time limit, where such time limit is stated in the Notice to Proceed, Bid and Contract, unless an extension of time be made in the manner hereinafter specified.

111.08 – EXTENSION OF TIME OF COMPLETION

The Contractor shall be entitled to an extension of time, as provided herein only when claim for such extension is submitted to the City Engineer in writing by the Contractor within seven (7) days from and after the time when any alleged cause of delay occurs. Only when such claim is approved by the City Engineer and the Council or Contracting Public Entity. In adjusting the Contract time for the completion of the Projects, all strikes, lockouts, unusual delays in transportation or any condition over which the Contractor has no control and also any suspensions ordered by the City Engineer for causes not the fault of the Contractor, shall be excluded from the computation of the Contract time for completion of the Work. If the satisfactory execution and completion of the Contract should require Work or materials in greater amount or quantities than those set forth in the Contract, then the Contract time shall automatically be increased in the same proportion as the cost of the additional Work contracted for. No allowance shall be made for delays or suspension of the prosecution of the Work due to the fault of the

Contractor.

111.09 – FAILURE TO COMPLETE WORK ON TIME

The time of completion is of the essence of the Contract. For each Working Day that any Work shall remain uncompleted after the time agreed upon in the Bid and the Contract, or as automatically increased by additional Work or materials ordered after the Contract is signed, or the increased time granted by the City for the completion of said Work, the sum per day given in the following schedule, unless specified otherwise in the Bid or Special Provisions, will be deducted from the monies due the Contractor, not as a penalty but as liquidated damages.

Amount of Contract	Minimum Amount of Liquidated Damages per Day
Less than $100,000	$300.00
$100,000 and less than $1,000,000	$400.00
$1,000,000 and over	$500.00 or up to 0.052% of the contract price per day

The sum of money thus deducted for such delay, failure or non-completion is not to be considered as a penalty but should be deemed, taken and treated as reasonable liquidated damages since it would be impracticable and extremely difficult to fix the actual damages.

111.10 – TEMPORARY SUSPENSIONS

The City Engineer shall have the authority to suspend the Work wholly or in part for such period or periods as he may deem necessary, due to unsuitable weather or such other conditions as are considered unfavorable for the suitable prosecution of the Work.

If it should become necessary to stop Work for an indefinite period, the Contractor shall store all materials in such manner that they will not obstruct or impede the traveling public unnecessarily nor become damaged in any way and he shall take every precaution to prevent damage or deterioration of the Work performed and shall provide suitable drainage about the Work and erect temporary structures where necessary.

The Contractor shall not suspend Work without written authority from the City Engineer and shall proceed with the Work promptly when notified by the City Engineer to resume operations.

111.11 – SUSPENSION OF WORK AND ANNULMENT OF CONTRACT

The issuance of a Stop Work Order shall not act to defer or suspend counting Working Days for the Project. The Work or any portion of the Work under Contract shall be suspended, immediately, on written order of the City Engineer or the City Council, a copy of such notice to be served upon Contractor's Surety, or the Contract may be annulled by the City Council, for any good cause or causes, among others of which special reference is made to the following:

A) Failure of the Contractor to start the Work within the time limit specified.

B) Substantial evidence that the progress being made by the Contractor is insufficient to complete the Work within the specified time.

C) Failure of the Contractor to provide sufficient and proper equipment for properly executing the Work.

D) Deliberate failure on the part of the Contractor to observe any requirements of these Specifications or to comply with any orders given by the City Engineer, as provided for in these

Specifications.

E) Failure of the Contractor promptly to make good any defects in materials or Workmanship or any defects of any other nature, the correction of which has been directed in writing by the City Engineer.

F) Substantial evidence of collusion for the purpose of illegally procuring a Contract or perpetrating fraud on the City in the construction of Work under Contract.

When Work is suspended for any one of the causes itemized above, or for any other cause or causes, the Contractor shall discontinue the Work or such part thereof as the Council shall designate, whereupon the Surety may, at its option, assume the Contract or that portion thereof which the Council has ordered the Contractor to discontinue and may perform the same or may, with the written consent of the City Engineer, approved by the Council, sublet the Work or portion of the Work so taken over; provided, however, that the Surety shall exercise its option, if at all, within two (2) weeks after the written notice to discontinue Work has been served upon the Contractor and upon the Surety or its authorized agent. The Surety, in such event, shall assume the Contractor's place in all respects and shall be paid by the City for all Work performed by it in accordance with the terms of the Contract and, if the Surety, under the provisions hereof, shall assume said entire Contract, all monies remaining due the Contractor at the time of the Contractor's default shall thereupon become due and payable to the Surety as the Work progresses, subject to all the terms of the Contract.

In the event the Surety does not, within the time herein before specified, exercise its right and option to assume the Contract, or that portion thereof which the Council has ordered the Contractor to discontinue, then the City shall have the power to complete by Contract or otherwise as it may determine, the Work herein described, or such part thereof as it may deem necessary and the Contractor hereby agrees that the City shall have the right to take possession of and use any of the materials, plant, tools, equipment, supplies and property of every kind provided by the Contractor for the purpose of the Contractor's Work and to procure other tools, equipment and materials for the completion of the same and to charge to the account of the Contractor the expense of said Contract for labor, materials, tools, equipment and expenses incident thereto. The expense so charged shall be deducted by the City out of such monies as may be due or may at any time thereafter become due the Contractor under and by virtue of the Contract or any part thereof. The City shall not be required to obtain the lowest Bid for the Work of completing the Contract but the expense to be deducted shall be the actual cost of such Work. In case such expense is less than the sum which would have been payable under the Contract, if the same had been completed by the Contractor, the balance shall operate as liquidated damages, as herein above set out. In case such expense shall exceed the amount which would have been payable under the Contract, if the same had been completed by the Contractor then the Contractor and the Contractor's Surety shall pay the amount of such excess to the City on notice from the Council of the excess so due. When any particular part of the Work is being carried on by the City by Contract or otherwise under the provisions of this section, the Contractor shall continue the remainder of the Work in conformity with the terms of the Contract and in such manner as in no wise to hinder or interfere with the performance or Workmen employed as above provided by the City.

111.12 – TERMINATION OF CONTRACT

The Contract will be considered fulfilled, save as provided in any Bond or Bonds or by law, when all Work has been completed, the Final Inspection made by the City Engineer and Final Acceptance and final payment made by the City.

111.13 - PROJECT CLOSE-OUT (FOR BUILDING/FACILITY PROJECTS ONLY):

Prior to final formal acceptance and release of retainage by the awarding public agency, the Contractor shall deliver to the Owner via the Architect/Engineer three copies of a neatly bound Operations and

Maintenance manual organized in a manner corresponding to the Division within the Specifications and containing the following information:

a. A Directory containing the firm name of each subcontractor and material supplier on the project, subcontractor's and material suppliers address, telephone number, and representative to contact for repair and/or maintenance.

b. A copy of the Architect/Engineer's Color and Finish Schedule with any subsequent revisions duly noted. Information must include project manufacturer's name, style name and product number, for all paints, flooring and other finish products used on the project.

c. Guarantees, warranties and/or operating instructions for materials, equipment, or installations as required by other Divisions of the Specifications.

SECTION 112 – MEASUREMENT AND PAYMENT

112.01 – MEASUREMENT OF QUANTITIES

The determination of quantities of Work acceptably completed under the terms of the Contract, as directed by the City Engineer in writing, will be made by the City Engineer based on measurements taken by the designated representative. These measurements will be taken according to the United States Standard Measurements. When materials are measured in the vehicle, the measurement will be taken at the point of delivery. When required by the City Engineer, the capacity of all vehicles shall be plainly marked on each vehicle and the capacity or markings shall not be changed without the permission of the City Engineer.

112.02 – SCHEDULE OF VALUES (FOR LUMP SUM CONTRACTS ONLY)

Contractor will submit schedule of Unit Prices of various parts of the Work within ten (10) days after the Contract is awarded. Schedule shall be a complete breakdown of labor and materials required for the job showing quantities and Unit Prices, the whole aggregating the total sum of the Contract. The City Engineer will furnish the Contractor a list of the certain items on which Unit Prices and quantities are desired which will be included in this schedule. This schedule, when approved by the City Engineer, shall be used as a basis for monthly payments to the Contractor. In applying for payments, the Contractor's statement shall be broken down in conformity with this schedule.

112.03 – SCOPE OF PAYMENT

Partial payments shall be made based on the Work completed. Up to ten percent (10%) of the partial payments shall be held as retainage. At the time the Contractor has completed in excess of fifty percent (50%) of the total Contract amount, the retainage shall be reduced to five percent (5%) of the amount earned to date if the public Contracting entity determines that satisfactory progress is being made.

Applications for payment shall be made upon the forms provided by the City or photocopies thereof and such forms must be properly completed, signed and notarized. Applications for payments shall have attached thereto the Contractor's invoice and other supporting detail. Contractor must supply invoices for any stored materials for which payment is claimed.

The Contractor shall receive and accept the compensation as herein provided in full payment for furnishing all labor, materials, tools, equipment and incidentals, for performing all Work contemplated and embraced under the Contract; for all loss or damage arising out of the nature of the Work or from the action of the elements, for any unforeseen defects or obstructions which may arise or be encountered during the prosecution of the Work and before its Final Acceptance by the City Engineer, for all risks of every description connected with the prosecution of the Work; for all expenses incurred by or in consequence of suspension or discontinuance of such prosecution of the Work as herein specified; for any infringement of patents, trademarks or copyrights and for completing the Work in an acceptable manner according to the Plans and Specifications.

The payment of any current or partial estimate prior to Final Acceptance of the Work by the City shall in no way constitute an acknowledgment of the Acceptance of the Work nor in any way prejudice or affect the obligation of the Contractor to repair, correct, renew, or replace at the Contractor's expense any defects of imperfections in the construction or in the strength or quality of the materials used in or about the construction of the Work under the Contract or its appurtenances nor any damage due to or attributed to such defects, which defects, imperfections or damage shall have been discovered on or before the Final Inspection and Acceptance of the Work. The City Engineer shall be the sole judge of such defects, imperfections or damage and the Contractor shall be liable to the City for failure to correct the same as provided herein.

112.03.01 – VERIFICATION AND INSPECTION OF PAYROLL RECORDS

If required by contract or directed by the Engineer, the Contractor shall keep weekly records, permit inspection of records, and certify and provide copies of payroll records and Contracts and subcontracts. Example forms are available from the Public Works Department for the convenience of the Contractor.

112.03.02 – REPORTS

If required by contract or directed by the Engineer, the Contractor shall submit certified weekly payroll information to the City. Receipt of the certified payroll information shall be a pre-condition for the City to process the final pay application or claim voucher. The City may submit a copy of such certified payroll information to the Oklahoma State Department of Labor and the Wage and Hour Division of the Employment Standards Administration of the United States Department of Labor.

112.04 – PAYMENT FOR EXTRA WORK

The Extra Work done by the Contractor, as authorized and approved by the City Engineer and the City Council, will be paid for in the manner described. The compensation shall be accepted by the Contractor as payment in full for all labor, materials, tools, equipment and incidentals and all employees' services, all insurance and all other overhead expense incurred in the prosecution of the Extra Work.

Payment for Extra Work will be made by one or more of the following methods:

A) Unit Prices agreed on in writing by the City Engineer and the Contractor and approved by the Council before said Work is commenced, subject to all other conditions of the Contract.

B) A Lump Sum price agreed on in writing by the City Engineer and the Contractor and approved by the Council before said Work is commenced, subject to all other conditions of the Contract.

C) The actual cost including labor, materials, tools, equipment and field supervision of such Extra Work plus fifteen percent (15%). Fifteen percent (15%) is hereby understood and agreed to include all overhead expense and profits, when agreed upon in writing by the City Engineer and the Contractor and approved by the Council before said Work is commenced; subject to all other conditions of the Contract.

D) Any substantial change(s) in quantities required to complete the Work will require a Contract Amendment based on the Unit Prices bid.

E) Any addition, deletion, revision or adjustment to the Contract price shall be made with a Change Order or Amendment as defined in Section 108.

The Contractor shall, on or before the 10th day of the month succeeding that in which any Extra Work shall have been performed, file with the City Engineer the Contractor's claim and an account giving the itemized cost of such Work and shall give the City Engineer access to all accounts, bills and vouchers relating thereto.

112.05 – PARTIAL ESTIMATES

It is understood that the estimates from month to month will be approximate only and all partial monthly

estimates and payments will be subject to correction in the estimate rendered following discovery of an error in any previous estimate and such estimate shall not, in any respect, be taken as an admission of the City of the amount of Work done or of its quality or sufficiency nor as an Acceptance of the Work or the release of the Contractor of any of the Contractor's responsibility under the Contract. No partial estimates will be made on assessment paving Projects except where the City is paving a portion of these Projects and the money is available.

Partial payments shall be made based on the Work completed. Unless otherwise provided in the Special Provisions, where Unit Prices are Bid, partial payments and final claims will be based on actual quantities used.

112.06 – RETAINAGE

Partial estimates on Work done and/or materials furnished in accordance with the provisions of Subsection 112.05 shall provide that ten percent (10%) of all such partial estimate made shall be withheld as retainage. Provided, however, that at any time the Contractor has completed in excess of fifty percent (50%) of the total Contract amount the retainage shall be reduced to five percent (5%) of the amount earned to date. Provided further, however, that the City has determined that satisfactory progress is being made and upon approval by the Surety.

112.07 – SUBSTITUTE SECURITIES FOR RETAINAGE

The City Manager, acting on behalf of the Council of the City of Oklahoma City, may approve Agreements and Amendments for Acceptance of Certificates of Deposit or Securities to be held in lieu of retainage when such forms are in substantial compliance with requirements of the City.

The bank from which the Securities of Deposit are purchased shall hold such Securities or Certificates of Deposit in safekeeping for the City. The original safekeeping receipt shall be deposited with the City Treasurer with a photostatic copy furnished to the City Clerk to be attached to the Agreement.

Following are procedures for Securities to be held in lieu of retainage:

A) Contractor should purchase from banking institution located in Oklahoma City a Certificate of Deposit having par value equal to or exceeding the amount of retainage to be withdrawn. The Owner named must be The Council of the City of Oklahoma City.

B) The Certificate of Deposit shall be deposited in a banking institution in Oklahoma City with instructions to transfer the Certificate to the custody of the Owner upon the Contractor's subsequent direction.

C) Execute five (5) copies of the Agreement and deliver to the City Engineer.

D) Simultaneously, a request for payment should be initiated (through the Project Engineer) for the retainage in an amount not to exceed the amount of the Securities.

E) After the Agreement and the Certificate of Deposit have been examined and are found to be in proper order, the Agreement will be forwarded to the City Manager's Office for approval and execution.

F) After approval and execution of the Agreement, the Contractor will be notified of such action and instructed to direct the bank to transfer custody of the Certificate to the Owner upon presentation to the bank of a fully executed copy of the Agreement.

G) After the above has been completed, the claim for the retainage will be processed through the City for approval.

NOTE: The claim should not be notarized prior to the Manager's approval of the Agreement or the transfer of custody of the Certificate.

Upon completion of the Work, the Contractor shall submit with the Contractor's final claim a request for the Owner to execute the Certificate of Deposit and the City will instruct the bank to transfer custody

back to the Contractor.

112.08 – PAYMENTS WITHHELD

The City Engineer may withhold, or on account of subsequently discovered evidence, nullify the whole or a part of any Certificate to such extent as may be necessary to protect the City from loss on account of:

A) Defective Work not remedied.

B) Claims filed or reasonable evidence indicating probable filing of claims.

C) Failure of the Contractor to make payments properly to subcontractors or for materials or labor.

D) A reasonable doubt that the Contract can be completed for the balance then unpaid.

E) Damage to another Contractor.

F) When the above grounds are removed, payment shall be made for amounts withheld because of them.

112.09 – STATE TAX

Title 68 Oklahoma Statutes (1991), Section 1356 (I), exempts sales to a municipality and its Contractors from all sales tax on the sale of "tangible personal property or services." All Bids for City Projects shall be assumed to have been made based on such statutory exemption as effective on the Bid date. All Municipal Trust projects are exempt from this provision and must pay sales tax.

The Contractor will be responsible for and bear the expense of all Sales Tax and other State tax pertaining to this Project, the cost of such tax being included in the Contractor's original Bid.

112.10 – ACCEPTANCE AND FINAL PAYMENT

When the Contract Work is completed satisfactorily and all parts of the Work have been approved by the City Engineer. The Engineer shall prepare the final payment for the Work. The final payment shall be based on the final measurements of the Work completed. All prior estimates, upon which payments have been made, are subject to corrections or revisions in the final payment. The Work is accepted by the City and the Maintenance Bond is filed. The payment for the accepted Work, less any sums that have been deducted or retained under the provisions of the Contract, will be paid to the Contractor as soon as practical after the Final Acceptance. When requested by the City Engineer, the Contractor shall furnished to the City satisfactory evidence that all sums of money due for any labor, materials, apparatus, fixtures or machinery furnished for the purpose of such improvement or liens have been paid or that the person or persons to whom the same may respectively be due have consented to such final payment.

The acceptance by the Contractor of the last payment shall release the City from all claims or liability under the Contract for anything done, furnished, or relating to the Work under the Contract, or for any act or neglect of said City relating or connected with the Contract.

112.11 – FINAL MEASUREMENTS AND FINAL ESTIMATES

Final measurements will be taken and final estimates compiled as soon as Work has progressed to a point where the final measurements may be taken accurately.

112.12 – WAGE RATES

See Special Provisions for approved minimum wage rates.

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SECTION 200 – EXCAVATION

200.01 – DESCRIPTION

This section covers work consisting of excavation, disposal or compaction of all material not being removed under other items which are encountered within the limits of the work necessary for the construction of the project in accordance with these specifications and in conformity with the lines, grades and cross sections shown on the plans or established by the Engineer. All excavation will be classified as "unclassified excavation", "excess excavation" or "unsuitable material excavation" as hereafter described. Before beginning any excavation or embankment, the provisions of Section 200 shall be satisfied.

200.02 – MATERIALS

A) **UNCLASSIFIED EXCAVATION** shall consist of all the work as described herein which is necessary for the preparation and construction of the project, embankments, subgrade, shoulders, parking, curb trenches, drainage ditches, channels, cross street and alley approaches, sidewalks, driveways, private entrances, etc. Unclassified excavation shall include the removal and satisfactory disposal of all trees, brush, stumps, posts, fences, weeds, rock, concrete, existing pavement, gravel or macadam, sidewalks, curbs, pipes, culverts, sewer manholes and inlets where required, and all other structures, materials or debris; the stripping and removing of the top soil or sod to be piled separately from other materials and later restored to its original place when backfilling is completed; the completion of all necessary backfilling, tamping, compacting, and refilling; the restoring of all streets, alleys, right-of-ways or other lands, either public or private, damaged or occupied by the Contractor in the performance of the contract, to as good of condition as they were prior to the beginning of the work.

B) **EXCESS EXCAVATION** shall consist of all excavation not designated for embankment or stockpiling on the project and is to be removed from the limits of the project.

C) **UNSUITABLE MATERIAL EXCAVATION** consists of the removal and disposal of soft, spongy material below the finished grade, either saturated or unsaturated which will not be suitable for foundation material regardless of moisture content, extending downward to firm earth. The Contractor shall not begin backfill operations until cross section of the excavation has been determined and approved by the Engineer.

200.03 – EQUIPMENT

Excavating and grading equipment shall be approved types and designs, and shall be maintained in first class condition. Equipment used for disposing of excavated materials outside of the limits of the work shall be such as will avoid scattering or wasting material along the line of haul. The Contractor shall immediately clean up all material wasted or scattered.

200.04 – CONSTRUCTION METHODS

200.04.01 – GENERAL

All grass or weeds or other vegetation shall be cut and properly disposed of in a satisfactory manner before the ground is broken for grading and excavation. All existing structures, such as manholes and sewer inlets, which are to remain in place shall be adjusted or rebuilt and care shall be taken not to damage existing structures during grading or construction operations.

After the site of the work has been properly cleared and cleaned, excavation and grading of the

roadway shall proceed in conformity with the plans and the specifications.

Rock, boulders or existing structures which are abandoned, shall be removed to a depth of not less than twelve inches (12") below the subgrade elevation. Soft, spongy or other unsuitable material shall be removed to such a depth as may be necessary to permit the preparation of an acceptable subgrade. The determination of unsuitable material shall be made by the Engineer. All excavation below subgrade elevation shall be backfilled with approved select materials, placed in layers not exceeding nine inches (9") in thickness (loose measure). These layers shall be rolled or tamped, or both, to a density of ninety-five percent (95%) Standard Proctor at ±2% of optimum moisture content. (Per ASTM D698-00a)

This item will be used if unstable soil is encountered which cannot be stabilized by conventional dewatering operations. The trench shall be excavated to a depth not to exceed 2-1/2 feet below the pipe flowline until that depth or stable soil is reached. The area excavated will then be filled with crushed rock meeting either ASTM No. 57 gradation or the gradation of rock used for the underdrain cover aggregate.

Payment will be by the cubic yard, which shall include both excavation and fill material. The Contractor and City Engineer will agree each day on the depth and linear feet of unsuitable material. Quantities will be computed based on the specified trench width as shown on the typical section.

Care shall be taken not to disturb the ground below the required finish subgrade elevation except for necessary structures, and where provision is made for uniformly scarifying or loosening the ground below subgrade. Excavation outside the curb lines, or beyond the slab edges shall not be made wider than necessary for the setting of the forms or string lines. The finish grade, slopes and edges of the excavation on all parking, cross street or private driveway approaches, etc., shall be backfilled where necessary, using approved material thoroughly compacted in layers and dressed off uniformly in a neat and workmanlike manner. Slab edges shall be backfilled for a width of not less than two feet (2') measured at the level of the top of slab. Ample provision will be made at all times for completely and readily draining the subgrade and all excavations.

200.04.02 – STRUCTURES REMOVED AND SURPLUS EXCAVATED MATERIALS

All structures removed and surplus excavated materials are the property of the City. In general, all manhole frames and covers, sewer inlet frames and gratings, and all pipes, culverts, etc., salvaged from the work shall be hauled to and stored at the City facility designated in special provisions and approved by the Engineer. Gravel or Macadam surfacing material shall, as nearly as practicable, be removed separately from earth or other excavated materials, and when desired by the City for use on other streets, alleys, etc., shall be disposed of on sites designated or selected by the Engineer. In selecting locations for the disposal of surplus excavated materials the requirements for filling abutting or adjacent property shall be given priority in the order named. The disposal of all excavated materials other than as specifically mentioned above, shall be at the sites approved by the Engineer.

200.06 – METHOD OF MEASUREMENT

The quantities of unclassified excavation for which payment will be made shall be the quantities shown on the plans, provided the project is constructed essentially to the lines and grades shown on the plans.

When the plans have been altered, the quantities involved shall be measured from the original plan cross sections. Additional original cross sections may be interpolated or determined by other approved methods at points where necessary to more accurately determine the quantities. When quantity is not specified by the plans, all accepted excavation and borrow shall be measured in its original position by cross sectioning the area excavated. Volume will be computed from the cross section measurements by the average end area method, or other approved methods.

The Contractor and City Engineer will agree each day on the depth and linear feet of unsuitable material. Quantities will be computed based on the specified trench width as shown on the typical section. Unsuitable material Excavation will be measure the material removed. Replacement material will be measured and paid by the item used to replace the unsuitable material.

200.07 – BASIS OF PAYMENT

Excavation will be paid for at the contract/unit price for the items classified for payment for:

UNCLASSIFIED EXCAVATION	C.Y.
UNSUITABLE MATERIAL EXCAVATION	C.Y.
EXCESS EXCAVATION	C.Y.

which shall be full compensation for all items of work specified and, for which no separate unit prices are included in the contract, including all labor, materials, tools, equipment and incidentals necessary to complete the work in accordance with the plans and specifications.

SECTION 201 – EMBANKMENT

201.01 – DESCRIPTION

This section will cover construction of roadway embankments, including preparation of the areas upon which they are to be placed; the construction of dikes within or outside the right-of-way; the placing and compacting of approved material within roadway areas where unsuitable material has been removed; and the placing and compacting of embankment material in holes, pits and other depressions within the roadway area, in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer. Only approved materials shall be used in the construction of embankments and backfills.

201.04 – CONSTRUCTION METHODS

All grass, weeds, trees, stumps and existing structures shall be removed in a satisfactory manner from the entire area to be occupied by the embankment. All embankments shall be formed of good sound earth, gravel or other acceptable materials, and shall be built to sufficient heights and width that after full shrinkage, will conform to the lines, grades and cross sections shown on the plans, or called for in these specifications. Rocks may be placed in embankment provided they are not placed in piles, and provided no rock larger than three inches (3”) is placed nearer the finish grade than twelve inches (12”). No sticks, weeds, trash or other vegetable matter, nor any other unsuitable materials shall be placed in embankments. Embankments shall not be constructed on or of frozen material.

All excess or unsuitable excavated material, including rock and boulders larger than eight inches (8”) in the largest dimension, that cannot be used in embankments shall become the property of the Contractor and disposed of by him to the satisfaction of the Engineer.

Embankments constructed of material of which a large portion is rock of such a nature that, in the opinion of the Engineer, construction in nine inch (9”) layers is not feasible shall be constructed in layers the depth of which shall not exceed the maximum size of the rock present in the material, and in no case shall the thickness of the layer exceed twenty-four inches (24”). End dumping will be required. The rock shall be dumped near the end of the existing lift and pushed over the end. Compactive effort on the rock and rocky material shall consist of making multiple coverings of each layer with a tamping type roller or with a vibratory roller as approved by the Engineer. Each layer shall be leveled and smoothed with suitable leveling equipment and by distribution of spalls and finer fragments of earth. The top twelve inches (12”) of embankment shall be constructed with approved materials, smoothed and placed in layers not exceeding nine inches (9”) in loose thickness and compacted as specified for embankments.

The surface layer of the roadbed shall not be wetted or compacted until final finish grade stakes have been set and all embankment material is in place. The surface layer of the entire embankment shall then be manipulated by scarifying and the moisture corrected as specified for embankments, after which the entire surface layer shall be compacted to not less than 95 percent of Standard Proctor Density. (Per ASTM D698-00a)

Material in embankments shall be placed in layers not exceeding nine inches (9") in depth measured when loose, and extending the entire width and length of the embankment. Each succeeding layer shall be uniformly spread over the surface, then thoroughly compacted. Areas inaccessible to the roller shall be thoroughly hand tamped until the degree of compaction is equivalent to that of the rolled area. Hand tampers shall have a tamping surface not exceeding twenty-five square inches (25 in^2) square inches, shall weigh not less than one pound per square inch (1 psi), and shall be of a design approved by the Engineer.

If the embankment can be deposited on only one side of abutments, wing walls, piers or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause overturning of or excessive pressure against the structure.

201.06 – METHOD OF MEASUREMENT

The quantities of embankment for which payment will be made shall be the quantities shown on the plans, provided the project is constructed to the lines and grades shown on the plans.

201.07 – BASIS OF PAYMENT

Embankment will be paid for at the contract/unit price for the item classified for payment for:

Embankment C.Y.

which shall be full compensation for all items of work specified and for which no separate unit prices are included in the contract, including all labor, materials, tools, equipment and incidentals necessary to complete the work in accordance with the plans and specifications.

SECTION 202 – BORROW

202.01 – DESCRIPTION

This section covers borrow which consists of required excavation, removal, and proper utilization of materials obtained from designated or approved sources. Compaction of embankments constructed from borrow, as provided herein, shall conform to the requirements of Section 201.

202.02 – MATERIALS

Where shown on the plans, selected materials will be utilized in the formation of embankment or to improve the roadbed. Borrow material shall be suitable for the embankment purpose desired, as determined by the Engineer.

202.04 – CONSTRUCTION METHODS

All suitable materials removed from the excavation shall be used, in so far as practicable, in the formation of embankments as required by the governing item for "Embankments", or shall otherwise be utilized as indicated on the plans or as directed, and the completed work shall conform to the established alignment, grades, and cross section. During construction, the borrow sources shall be kept drained, in so far as practicable, and the work shall be prosecuted in a neat and workmanlike manner.

Payment will not be allowed for excavation for any material which is used for purposes other than those

designated, except as provided in the governing specifications under Section 108.04.

Site of the borrow operations shall be left in a suitable and sightly condition, such as to provide proper drainage where practical. Where indicated on the plans, the sides and/or ends of borrow pits shall be sloped to the dimensions indicated on the plans.

202.06 – METHOD OF MEASUREMENT

Borrow will be measured in a compacted condition in its final position and the volume computed in cubic yards by the method of average end areas.

202.07 – BASIS OF PAYMENT

Borrow will be paid for at the contract/unit price for the items classified for payment for:

BORROW C.Y.

which shall be full compensation for all items of work specified and, for which no separate unit prices are included in the contract, including all labor, materials, tools, equipment and incidentals necessary to complete the work in accordance with the plans and specifications.

SECTION 210 – TRENCH CONSTRUCTION

SECTION 211 – DEWATERING

211.01 – DESCRIPTION

This section covers dewatering of trenches, pits, and all other excavation areas. The Contractor shall provide and maintain ample equipment with which to remove all water from every source that enters excavations for structures and pipelines. Dewatering operations shall ensure dry excavations and preservation of the elevations of excavation bottoms shown on the drawings. Surface drainage shall not be allowed to enter excavated areas.

Where areas to be excavated are located under water surfaces or near banks of flowing streams or other bodies of water, the Contractor may adopt and carry out any method of dewatering he may deem feasible for the performance of excavation work and for protection of the work thereafter, provided that method and equipment to be used results in completed work which complies with the specifications and is acceptable to the Engineer. In such cases, the excavation areas shall be effectively protected from water damage during the excavation period and until all contemplated construction work therein has been completed.

Prior to beginning excavation for pipes and structures, which are to be constructed at or below the ground water table, groundwater levels shall be lowered and maintained at a level at least two feet (2') below the bottom of trench or such structures until construction and backfilling operations have been completed.

The Contractor shall be responsible for damage to structures caused by hydrostatic displacement during construction operations.

211.04 – CONSTRUCTION METHODS

211.04.01 – SUBMITTALS

When requested by the Engineer, the Contractor shall submit the following, but not limited to, for review and approval:

A) Proposed dewatering method.

B) Well and pump layout, and depth of penetration.

C) Points of discharge.

211.04.02 – METHODS

A) **Bailing, Sump or Trench Pumping** - For trench or structural excavations, and for small quantities of water, a sump or trench pump may be used to pump excess water from the low end of the excavations. When, as determined by the Engineer, soil conditions are such that dewatering may readily be accomplished by ordinary bailing and use of trench pumps, well systems shall not be used.

B) **Well Systems** - When required, the Contractor may utilize the following methods of dewatering:

1) **Deep Pumped Wells Method** - In locations where the water table is deep, pumped filtered wells may be used for lowering the water level or for controlling artesian pressures in aquifers beneath excavations.

2) **Well Points Method** - Well points are small-diameter wells with one or more slotted or screened sections of pipe attached to riser pipes that are connected through swing joints to header pipes. Where a single row of well points is not enough to lower the water level adequately, then two (2) or more rows of well points shall be used as directed by the Engineer.

3) **Vacuum Method** - Soils that are too fine-grained for gravity drainage may be dewatered by application of a vacuum to filters surrounding well points.

4) **Electroosmosis Method** - Dewatering of soils by electro osmosis may be achieved by installing a line of metal well points serving as negative electrodes to attract water and allow it to be removed by suction and a line of rods serving as cathodes.

211.06 – METHOD OF MEASUREMENT

A) Dewatering trenches using a well system shall be measured as the length of trench dewatered plus twenty feet (20') from each end well, or forty feet (40') for one well.

B) Dewatering of excavations using a well system shall be measured as the length of the perimeter of the structure such as clarifiers or basins.

C) Dewatering for pits and/or shafts excavated for construction operations such as those needed for trenchless construction methods shall be measured per length of pit along the line.

D) All dewatering performed using bailing and trench or sump pumping shall be considered incidental work and NOT be paid for directly, but shall be included in the cost of other items.

211.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

DEWATERING L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 212 – TRENCH EXCAVATION AND BACKFILL

212.01 – DESCRIPTION

This section covers trench excavation for pipelines and consists of excavation necessary for construction of all underground work and all appurtenant facilities, including site preparation, placement of embedment material, backfilling, and compaction of pipe trenches and around structures and disposal of waste materials, all of which shall conform to the applicable provisions of these specifications.

Trench excavation shall be made in open-cut and true to the lines and grades shown on the plans or established by the Engineer.

212.04 – CONSTRUCTION METHODS

212.04.01 – EXCAVATION IN ADVANCE OF CONSTRUCTION

The length of trench excavated approximately to grade shall not exceed one hundred-fifty feet (150') and no trench excavation whatsoever shall be made farther than three hundred feet (300') in advance of completed backfill.

212.04.02 – TRENCH WIDTHS

A) **General -** Trenches shall be excavated to a width which will provide adequate working space and sidewall clearances for proper pipe installation, joining, and embedment. Stipulated minimum trench widths are not minimum average widths, but are minimum widths that shall be required. Stipulated maximum trench widths shall not be exceeded. Trench width shall be the width of the trench excavation measured from bank to bank at the top of the pipe. For rigid pipes, when the maximum trench width is exceeded, the Contractor shall be required to provide a higher strength pipe or higher bedding classification, singly or in combination as directed by the Engineer, at the Contractor's expense. Any additional foundation material and/or embedment material required due to over-excavation, beyond the maximum trench width shall be at the Contractor's expense. Minimum and maximum permissible trench widths shall be as shown in table below.

Pipe Nominal Size (Inches)	Minimum Trench Width (Feet)	Maximum Trench Width (Feet)
? 12	3.00	5.00
16	3.25	5.00
18	3.25	5.00
21	3.75	5.25
24	4.00	6.00
30	4.50	6.75
36	5.25	9.00
42	6.25	9.50
48	7.00	10.00
54	8.00	10.50
60	9.00	11.00
64	9.75	11.50
66	9.75	11.50
72	10.50	12.00
78	10.50	12.50
84	11.00	13.00
90	11.50	13.50

B) **Trenches Requiring Sheeting and Shoring -** Where trenches are excavated in soil of such nature as to require sheeting and shoring to assure proper installation, and safety of the workmen and any adjacent structures or other objects, the Contractor shall provide the necessary sheeting and shoring. Where possible, shields designed to be portable and moved along as work progresses may be used. The contract pay widths shown in the above shall apply to all trenches with or without sheeting or shoring.

C) **Trenches With Stepped Sides -** Where the work is located in open areas, if the right-of-way is of sufficient width and soil conditions are suitable, the Contractor may at his option, upon approval of the Engineer, excavate trenches with sloping or stepped sides provided that no additional compensation

for excavation and backfilling will be allowed for work performed outside the maximum trench widths designated in the above Table.

D) T**renches at Tunnels -** Where the water line is in a tunnel, the trench excavation shall be measured to the faces of the tunnel.

E) E**xcavation for Valve Boxes and Other Waterline Structures -** When structural excavation is listed as a separate pay item, excavation for valve boxes and other waterline structures shall be computed in cubic yards using dimensions of the net prescribed area outside trench width excavation where the length of trench is measured through or partially through structures. When structural excavation is not listed as a pay item, cost shall be included in the cost of other items.

F) **Exterior forms with or without sheeting and shoring** are used, the excavation shall be computed for a width five feet (5') greater than the exterior dimension of the structure.

G) **Excavation for Trenchless Construction Methods -** Excavation shall be considered a part of the trenchless work per linear foot, and shall not be paid for separately.

Any sheeting, shoring, bracing or sheet piling left in place, in conformity with the plans and specifications or as directed by the Engineer, shall be paid for separately.

212.04.03 – PERFORMANCE REQUIREMENTS

A) **General Excavation -** Excavation shall be made in open-cut from the surface of the ground and shall be made no larger than necessary to permit proper construction of the work in accordance with the plans and specifications. The entire foundation area in the bottom of all excavations shall be firm, stable and of uniform density as nearly as practical, and unless necessary, materials shall not be disturbed below grade. Where trenches are excavated in soft, unsuitable materials, or rock, trench bottom may be stabilized in accordance with Section 200.04.01, when directed by the Engineer. Where depth of trenching and other excavations are greater than twenty feet (20'), and when not provided for in the plans, an engineer shall be retained by the Contractor to design bank protection as per OSHA rules and regulations. The bank protection design, signed and sealed by a Professional Engineer registered in the State of Oklahoma, shall be submitted to the Engineer for approval.

B) **Sheeting, Shoring, Bracing and Sheet Piling -** The sides of all excavations shall be sufficiently sheeted, shored and braced so as to prevent slides, cave-ins, settlement or movement of the banks. In wet, saturated or flowing ground where it is necessary to install tight sheeting or cofferdams, wood or steel sheet piling of approved design and type shall be used. All sheeting, shoring and bracing shall have sufficient strength and rigidity to withstand the pressures exerted and maintain the walls of the excavation properly in place and protect all persons or property from injury or damage. When excavations are made adjacent to existing buildings or other structures, or in paved streets or alleys, particular care shall be taken to adequately sheet, shore, and brace the sides of the excavation to prevent any undermining of or settlement beneath the structures or the pavement. Underpinning of adjacent structures, when necessary, shall be done in an approved manner. The foundation material that is undermined shall be replaced and compacted in accordance with the requirements of this section. Sheeting, shoring, and bracing shall not be left in place unless otherwise shown on the plans or authorized by the Engineer. The removal of sheeting, shoring and bracing shall be done in such a manner as not to endanger or damage either the new structure or any existing structure or property, either private or public, and so as to avoid cave-ins or sliding of the banks. If for any reason the Contractor, with the approval of the Engineer, leaves in place any sheeting, shoring or bracing, no payment will be allowed for such material left in place unless it is classified as a contract pay item. All holes or voids left by the removal of sheeting, shoring or bracing shall be satisfactorily filled and compacted in accordance with the requirements of this section.

C) **Pumping, Dewatering and Draining -** The Contractor shall remove immediately any surface or seepage water or water from sewers, drains, creeks, or other sources which may accumulate during the excavation and construction work by doing the necessary pumping, dewatering or draining by ditch or other means. The Contractor shall have available at all times sufficient equipment in proper working order for doing the work herein required. All water removed from excavations shall be disposed of in an approved manner so as not to create unsanitary conditions nor to cause injury to persons or damage to the work in progress or to other property, either public or private, nor to interfere unduly with the use of streets, alleys, or of private drives and entrances.

D) **Disposal of Excavated Materials -** Excavated materials, so far as needed and of a suitable character, shall be piled adjacent to the work to be used for backfilling as required. Excavated materials unsuitable for backfilling or in excess of that required for backfilling shall be disposed of in an approved manner at locations designated or approved by the Engineer. Desirable topsoil, sod, etc., shall be carefully piled separately from other excavated materials so that it can be replaced to its original position when required. Excavated materials shall be handled at all times in such a manner as to cause a minimum of inconvenience to public travel and to permit safe and convenient access to private and public property adjacent to or along the line of the work.

212.04.04 – BACKFILLING

A) **Description -** Backfill is that portion of the total trench backfill down to but not including the pipe embedment material. The backfill shall be only material approved by the Engineer consisting of loose earth, free of clods, stones, organic matter, debris or other objectionable materials.

All backfilling shall be done in such a manner as not to disturb or injure the pipe or structures over or against which it is being placed. Any pipe or structure injured, damaged or moved from its proper line or grade during backfilling operations shall be opened up and repaired and then re-backfilled as herein specified.

The placing of backfill material shall not begin until approval for so doing has been given by the Engineer, but backfilling about structures or portions of structures shall be done immediately when so ordered by the Engineer. The top surface or slopes of all backfill shall be neatly graded off where select topsoil, sod or other material is removed and piled separately; such material shall be carefully replaced in a manner satisfactory to the Engineer. The top twelve inches (12”) of backfill material shall be of as good quality as the original topsoil that was removed.

B) **Compaction Requirements -** All backfill shall be placed and compacted in six inch (6”) lifts for hand-tamped equipment and eighteen inch (18”) lifts for self-propelled or power-driven equipment to the following minimum percent of Standard Proctor Density or Relative Density as determined by ASTM D-698, "Tests for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures".

Cohesive backfill material shall reach the indicated compaction levels at plus or minus (±) three percent (3%) of optimum moisture content. The lift thickness shall be reduced, if necessary, to meet the compaction requirements specified herein.

General Location	Percent Compaction (%)
	Standard Proctor Test (ASTM D-698)
Under Traffic Area or Improved Existing Surfaces	95
Urban and Residential Areas	90
Undeveloped and Other Areas	85

C) **Compaction Methods -** Compaction methods may vary depending on the material or as approved by the Engineer.

1) **Cohesive Materials** - Compaction of cohesive materials may be obtained by use of impact type equipment. In confined areas, pneumatic tampers and engine driven rammers may also

be used. In relatively narrow trenches, self-propelled rammers may be used. In wide trenches, sheepsfoot rollers may be used.

2) **Cohesionless Materials** - Cohesionless materials are granular materials classified as non-plastic. In general, vibratory equipment may be used for proper compaction. In confined areas, vibratory plates may be used. For wider trenches, vibratory rollers may be used.

3) **Flooding (Jetting)** - When approved by the Engineer, backfill materials may also be compacted or settled by flooding where adequate quantities of water are available from the City's water system, privately owned ponds, creeks or other sources located within three hundred feet (300') of the trench. Water shall be used to produce a semi-fluid mass but an excessive amount shall not be used which may cause flowing of the mass along and out of the trench at stream crossings or other places of abrupt changes in ground profile. The Contractor shall make necessary arrangements with the City for purchase of water from the City mains, and with owners for water procured from privately owned sources.

   No additional compensation shall be allowed the Contractor for settling the backfill by flooding. The cost of such work shall be absorbed in the unit bid price for trench excavation and backfill or other pay units the Contractor may elect.

D) **Testing of Backfill -** All backfill shall be tested by an approved laboratory for compliance of the compaction requirements given in these specifications.

E) **Surface Restoration -** Upon completion of backfill, the Contractor shall replace all surface materials and shall restore paving, curbing, sidewalks, gutters, shrubbery, fences, sod, and other surfaces disturbed to a condition equal to that before the work began, furnishing all labor, tools, equipment, materials and incidentals thereto as provided elsewhere in these specifications.

212.06 – METHOD OF MEASUREMENT

General Bid prices for "Trench Excavation and Backfill" and "Structural Excavation" shall be full compensation for all labor, materials, tools, equipment and incidentals necessary to complete the work in accordance with the plans and these specifications.

Trench Excavation and Backfill The Contractor shall be paid for "Trench Excavation and Backfill" on a linear foot basis for depths from zero feet (0') to ten feet (10') , zero feet (0') to fifteen feet (15') , zero feet (0') to twenty feet feet (20'), zero feet (0') to twenty-five feet (25') , and zero feet (0') to thirty feet (30') . The price established shall be full compensation for trench excavation and backfill, and shall include all necessary sheeting, shoring, bracing and incidental dewatering, pumping, draining, and disposition of any surplus excavated material not needed unless otherwise provided.

Trench, Lineal Measurement For the purpose of determining pay quantities, trenches shall be measured through valve boxes and similar structures, based on the applicable width of trench for size of waterline under consideration unless otherwise designated. Should size of waterline change at a valve or other structure, the appropriate width of trench for each size shall apply, with the consideration for the purpose of ascertaining pay quantity, that the change of size takes place at the centerline of the valve or structure.

Structural Excavation When classified as a pay item, "Structural Excavation" shall be paid for on a cubic yard basis. The price established shall be full compensation for all necessary dewatering, sheeting, shoring, excavation and backfilling and disposal of surplus material. When not classified as a pay item, it shall be included in the cost of other items.

212.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

TRENCH EXCAVATION AND BACKFILL – ZERO (0') TO TEN FEET (10') L.F.

TRENCH EXCAVATION AND BACKFILL – ZERO (0') TO FIFTEEN FEET(15')	L.F.
TRENCH EXCAVATION AND BACKFILL – ZERO (0') TO TWENTY FEET (20')	L.F.
TRENCH EXCAVATION AND BACKFILL – ZERO (0') TO TWENTY-FIVE FEET (25')	L.F.
TRENCH EXCAVATION AND BACKFILL – ZERO (0') TO THIRTY FEET(30')	L.F.
TRENCH LINEAL MEASUREMENT	L.F.
STRUCTURAL EXCAVATION	C.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications. In the absence of this Pay Item in a contract, the cost shall be considered incidental and no additional compensation shall be made for this work and the cost of same shall be included in the other pay items.

SECTION 213 – CRUSHED ROCK FOUNDATION

213.01 – DESCRIPTION

This section covers proper treatment of unsuitable and soft foundation materials. A crushed stone mat shall be provided for waterline support where directed by the Engineer. Stone shall be hand or mechanically tamped to obtain a firm support.

213.02 – MATERIALS

Gravel containing rounded aggregates shall not be acceptable for this work. The aggregates for crushed rock pipe foundation shall be a uniformly graded crusher run material meeting the following gradation requirements:

Nominal Sieve Sizes	Percentage Passing
2 inch	100%
½ inch	< 30%

213.04 – CONSTRUCTION METHODS

The crushed stone mat shall be six (6") to twelve inches (12”) thick and shall be hand or mechanically tamped to obtain a firm support.

213.06 – METHOD OF MEASUREMENT

Measurement for "Crushed Rock Foundation" shall be per cubic yard or ton. The price established shall be full compensation for furnishing and placing of all materials, labor, tools, equipment, and any incidentals necessary to complete this item of work.

213.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

CRUSHED ROCK FOUNDATION	C.Y.
CRUSHED ROCK FOUNDATION	TON

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 214 – LEAN MIX CONCRETE FOUNDATION

214.01 – DESCRIPTION

This section covers proper treatment of unsuitable foundation materials. A concrete mat shall be used for soil stabilization as a pipe support where directed by the Engineer.

214.02 – MATERIALS

The concrete mat shall be constructed using one (1) part Portland cement to twelve (12) parts of sand mix. A six inch (6") stabilizing mat shall be prepared by blending equal proportions of concrete mix and soil. The mat shall be placed at proper elevation to permit installation.

214.04 – CONSTRUCTION METHODS

A six inch (6") stabilizing mat shall be prepared by blending equal proportions of concrete mix and soil. The mat shall be placed at proper elevation to permit installation.

214.06 – METHOD OF MEASUREMENT

The unit price for "Lean Mix Concrete Foundation" shall be based on the volume of concrete used and not the volume of the finished concrete soil mat. The price established shall be full compensation for furnishing and placing of all materials, labor, tools, equipment, and incidentals necessary to complete this item of work.

214.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

LEAN MIX CONCRETE FOUNDATION C.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 215 – EMBEDMENT MATERIAL

215.01 – DESCRIPTION

This section covers furnishing and placement of material for embedment of both rigid and flexible pipes. The embedment is that material to be placed from a minimum of six inches (6") below bottom of the pipe to the springline (half pipe diameter) or to a minimum of six inches (6") above top of pipe for rigid and flexible pipes, respectively. The remaining material to be placed over the embedment is considered backfill. Refer to Section 505.04.01 of these Specifications for Pipe Embedment Material requirements used in waterline construction.

215.02 – MATERIALS

General - Embedment material shall meet the requirements ASTM C-33 No. 67 and gradations shown below:

Nominal Sieve Sizes	No. 67
1 inch	100%
¾ inch	90 to 100 %
½ inch	……
3/8 inch	20 to 55%
No. 4	0 to 10%
No. 8	0 to 5%
No. 200	……

215.04 – CONSTRUCTION METHODS

Compaction Requirements - All embedment material shall be placed and compacted in six inch (6") lifts to the following minimum percent of Standard Proctor Density or Relative Density as determined by ASTM

D-698, "Tests For Moisture-Density Relations of Soil-Aggregate Mixtures.

Compaction Test	Compaction Requirement
Minimum Standard Proctor Density	95%

Compaction Methods - All embedment materials shall be compacted in accordance with the methods described in Section 212.04.04.

215.05 – TESTING

All embedment material shall be tested by an approved laboratory for compliance of compaction requirements given in Section 212. Following acceptance of compaction, the Contractor may proceed with placing remaining backfill.

215.06 – METHOD OF MEASUREMENT

The unit price for "Embedment Material" shall be based on the volume or tonnage of material used. Contractor shall submit material delivery tickets and shall be verified by the Engineer. The price established shall be full compensation for furnishing and placing of all materials, labor, tools, equipment, and incidentals necessary to complete this item of work.

215.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

EMBEDMENT MATERIAL	C.Y.
EMBEDMENT MATERIAL	TON

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications. In the absence of this Pay Item in a contract, the cost shall be considered incidental and no additional compensation shall be made for this work and the cost of same shall be included in the other pay items.

SECTION 216 – CONCRETE CRADLES

216.01 – DESCRIPTION

This section covers concrete cradle, Bedding Class "A", ASCE Manual No. 60, to be constructed as called for on the plans or as directed by the Engineer. Cradle shall be constructed beneath rigid pipes, to increase load bearing capacity of pipe-soil embedment system, either plain or reinforced, in accordance with the "Standard Details for Plain and Reinforced Concrete Cradle".

216.02 – MATERIALS

Before cradle is constructed, the subgrade shall be prepared and properly shaped at the required grade. All concrete shall be placed in a dry trench. Where concrete is placed in a wet trench, the work shall be done strictly as directed or approved by the Engineer.

216.04 – CONSTRUCTION METHODS

The pipes shall be firmly bedded in the concrete to proper grade. The concrete shall be so placed as not to damage the joints or disrupt any pipes. Backfilling shall be done in a careful manner and at such time after the concrete is placed as not to damage the concrete in any way.

216.06 – METHOD OF MEASUREMENT

Payment for "Concrete Cradle" shall be made at the unit price bid per cubic yard of concrete for each type. Quantity shall be computed based on the neat lines for concrete cradle (Plain, Type I Reinforcement, or Type II Reinforcement) as shown on the plans. The price established shall be full compensation for all materials, including concrete and steel reinforcement (if required), labor, tools, equipment and incidentals necessary to complete the work.

216.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

CONCRETE CRADLE PLAIN	C.Y.
CONCRETE CRADLE TYPE I REINFORCEMENT	C.Y.
CONCRETE CRADLE TYPE II REINFORCEMENT	C.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 217 – CONCRETE ARCHES

217.01 – DESCRIPTION

This section covers concrete arch, Bedding Class "A", ASCE Manual No. 60, to be constructed where shown on the plans or as directed by the Engineer. Concrete arch shall be constructed over top of rigid pipes, to increase load bearing capacity of pipe-soil system, either plain or reinforced, in accordance with the "Standard Detail for Concrete Arch".

217.04 – CONSTRUCTION METHODS

Before arch is constructed, the embedment material shall be placed and compacted to the pipe springline (one-half pipe diameter) as specified elsewhere in these specifications. The top of the embedment material shall be then prepared for placement of the concrete arch. All concrete shall be placed in a dry trench. Concrete shall be so placed as not to damage the joints or disrupt any pipes. Backfilling shall be done in a careful manner and at such time after the concrete is placed as not to damage the concrete in any way.

217.06 – METHOD OF MEASUREMENT

Payment for "Concrete Arch" shall be made at the unit price bid per cubic yard of concrete for each type. Quantity shall be computed based on the neat lines for concrete arch (Plain or Type I Reinforcement, or Type II Reinforcement). The price established shall be full compensation for all materials, including concrete and steel reinforcement, labor, tools, equipment, and incidentals necessary to complete the work.

217.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

CONCRETE ARCHES PLAIN,	C.Y.
CONCRETE ARCHES TYPE I REINFORCEMENT	C.Y.
CONCRETE ARCHES TYPE II REINFORCEMENT	C.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 218 – EMBEDMENT PLUGS

218.01 – DESCRIPTION

This section covers construction of embedment plugs, for control of groundwater flow, where called for on the plans or as directed by the Engineer. The minimum length of embedment plugs shall be ten feet (10'), and shall extend six inches (6") below the bottom and above top of pipe. Placement and materials shall be in accordance with the Standard Detail for Embedment Plugs.

218.02 – MATERIALS

Two types of embedment plugs may be used, at the Contractor's option, as follows:

Clay Plugs - The embedment and backfill material shall be select clay material separated from excavated materials and shall be approved by the Engineer prior to placement. This material shall be free of clods, clumps, debris, organic material, and stones. All clay plug material shall be compacted to a minimum of ninety percent (90%) of Standard Proctor Density (ASTM D-698) at plus or minus (±) three percent (3%) of optimum moisture content.

Flowable Fill Plugs - Flowable fill plugs shall consist of a Portland Cement grout having a minimum twenty-eight (28) day compressive strength of five hundred pounds per square inch (500 psi).

218.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

EMBEDMENT PLUGS (TYPE) EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 220 – BASES

SECTION 220 – SUBGRADE

220.01 – DESCRIPTION

This section will cover the compaction of earthwork by rolling or tamping or any combination of these methods in the construction of embankments in accordance with Section 201 or compaction of subgrade.

220.04 – CONSTRUCTION METHODS

After the subgrade material has been accepted by the Engineer it shall be compacted to a minimum density of ninety-five percent (95%) of ASTM D698-00a Standard Proctor Density and shall be maintained at ±2 percent of optimum moisture content during the compaction process. The degree of compaction shall be determined by Field Density tests taken as provided under "Testing", Section 220.05.

The Contractor is responsible for the condition of the subgrade until the pavement is in place and any portion which becomes damaged or unstable due to having become wetted or from freezing, or for any other reason, shall be corrected prior to the placing of the pavement. The finished surface shall conform to the cross sections shown on the plans and shall be smooth and unyielding.

When the moisture content of the subgrade soil does not fall within the required Moisture Range, the subgrade shall be reworked to bring the moisture content into compliance with the specifications.

220.05 – TESTING

A standard proctor test as prescribed in this Section will be made of each type of soil on samples of the subgrade after the street is rough graded. Testing to be performed by a laboratory approved by the City.

The maximum number of satisfactory tests ordered by the Engineer for a private development and the applicable method of test will be that shown on the schedule below:

TEST SCHEDULE

DESCRIPTION	METHOD OF TEST	QUANTITY OF ITEM REPRESENTED BY ONE TEST
A) Soil Classification		4800 S.Y. of Subgrade or Select Soil
1) Preparation Of Soil Mechanical Analysis	ASTM D-421	
2) Mechanical Analysis Of Soils		
3) Liquid Limit Of Soils	ASTM D-4318	
4) Plastic Limit And Plastic Index	ASTM D-4318	
5) Soil Classification	ASTM D-2487	
B) Standard Proctor Density	ASTM D-698	
C) Field Density		4800 S.Y. of Subgrade
1) Subgrade	ASTM D-1556 or	
2) Trench under Paving	ASTM D-2922	2400 S.Y. of Subgrade or Select
D) CBR 1 per Class of Soil	and D-3017	Soil or 400 L.F. of Trench or at any
	ASTM D-1883	transverse crossing.

A) **Standard Density** as determined by the Standard Proctor test shall be the density to which the Field Density is referred for comparison or percentage for each type of soil used in the work.

B) **Optimum Moisture Content** shall be the moisture content corresponding to the Maximum Density of the Standard Compaction curve.

C) **Field Density** shall be the density of the compacted subgrade determined by the Field Density test.

D) **Moisture Content** shall be the actual moisture content of the soil in the compacted embankment at the time of testing or at the time the grade is to be covered.

220.06 – METHOD OF MEASUREMENT

The quantities of compaction for which payment will be made shall be in the quantities shown on the plans provided the project is constructed to the lines and grades shown on the plans. Any allowance for additional quantities shall first be approved by the Engineer.

220.07 – BASIS OF PAYMENT

The amount of completed and accepted work shall be paid for at the contract unit prices bid per square yard.

SUBGRADE S.Y.

Payment shall be full compensation for all materials, equipment, tools, labor and incidentals necessary to complete the work.

SECTION 221 – NATURAL SOIL BASE

221.01 – DESCRIPTION

This section will cover approved soil material of the thickness shown on the plans constructed as the

subgrade to provide a foundation for the pavement. It shall be constructed in accordance with these specifications to the lines and grades shown on the plans. Natural soil base will be used only for residential streets.

221.02 – MATERIALS

The subgrade material to be used for this work shall have a Liquid Limit of thirty-five (35) or less, a Plastic Index less than twelve (12) and fifteen (15) percent to forty-nine (49%) percent by weight passing the No. 200 sieve. These soils shall have a minimum California Bearing Rating (CBR) value of fifteen (15) at 0.1 inch penetration.

221.04 – CONSTRUCTION METHODS

The subgrade shall be scarified or otherwise processed to permit uniform dispersion of moisture to the specified depth. Areas of the subgrade through rock cuts that cannot be scarified or otherwise processed shall be undercut not less than six inches (6”) and backfilled with soil meeting the requirements of Section 221.02 unless specified otherwise in accordance with Section 200.04.01.

221.06 – METHOD OF MEASUREMENT

Subgrade shall be plan quantity by the square yard in place as called for on the plans.

221.07 – BASIS OF PAYMENT

This item measured as provided for above will be paid for at the contract unit price bid per square yard for natural soil base in place and accepted:

NATURAL SOIL BASE	S.Y.

Payment shall be full compensation for all materials, equipment, tools, labor and incidentals necessary to complete the work.

SECTION 222 – SUBGRADE STABILIZATION

222.01 – DESCRIPTION.

This work shall consist of furnishing, placing and compacting one or more courses of a mixture of soil, a stabilization additive and water in accordance with these Specifications and in reasonably close conformity with the lines, grades, thickness, and typical cross sections shown on the Plans or established by the Engineer for the purpose of increasing the shear strength of subgrade soil. Stabilization additives for the purposes of this specification will be defined as cementitious additive (Portland Cement, fly ash or cement kiln dust) or lime.

222.02 – MATERIALS.

Materials shall meet the requirements specified in the following Subsections of Section 900 - Materials.

Hydrated Lime	921.02
Quick Lime	921.03
By-Product Lime	921.04
Fly Ash	922
Portland Cement	932.02
Water	932.04

Any cementitious additives shall be stored in a suitable, weather-tight building or compartment which will (1) protect it from dampness and (2) permit easy access for proper inspection and identification of each shipment. Do not mix cementitious additives from different sources in storage. Cementitious

additives shall not be used if for any reason it has become partially set or if it contains hard lumps or cakes.

The lime shall be stored in a suitable, weather-tight building or compartment, which will (1) protect it from dampness and (2) permit easy access for proper inspection and identification of each shipment. Lime shall not be used if for any reason it has become partially set or if it contains hard lumps or cakes. Do not mix limes from different sources in storage, even though they have been tested. By-product lime from residual or waste piles from approved sources may be used in lieu of hydrated or quick lime.

222.03 – EQUIPMENT.

All equipment necessary for subgrade stabilization shall meet the requirements of Subsection 301.03 and as further specified in this Section.

222.04 – CONSTRUCTION METHODS.

A) General. The primary requirement of these Specifications is to secure a completed course of stabilized material containing a uniform mixture of soil, stabilization additive, and water:

1) free from loose or segregated areas,

2) of uniform density and moisture content,

3) well bound for its full depth and

4) with a smooth surface suitable for placing subsequent courses.

5) It shall be the responsibility of the Contractor to regulate the sequence of this work, to use the prescribed amount of stabilization additive, to maintain the work, and to rework the courses as necessary to meet the above requirements.

B) Weather Limitations. Stabilization additives shall not be applied unless the air temperature is at least 40/F (4/C) and rising. The air temperature shall be taken 4 feet above the ground in the shade and away from artificial heat. Stabilization additives shall not be applied when any portion of the ground is frozen. The Contractor shall be responsible for the protection and quality of the stabilization additive and stabilized subgrade under any weather conditions.

C) Preparation of Existing Roadbed. Prior to beginning any subgrade stabilization, the roadbed shall be compacted and shaped to reasonably close conformity with the typical sections, lines, and grades as shown on the Plans or established by the Engineer. The subgrade shall be rolled in a manner approved by the Engineer, and any soft areas revealed by this rolling shall be corrected.

D) Scarifying and Loosening. Scarifying and loosening may be required prior to the application of stabilization additive to achieve the desired results as determined by the Engineer. The Contractor shall take precautions to avoid forming furrows of loosened material below the depth specified for the bottom of the stabilized subgrade. Except by special permission from the Engineer, the length of roadway scarified and loosened at any time shall not exceed the length in which the mixing with stabilization additive can be completed in two calendar days. In subgrade extents designated on the Plans or by the Engineer as having excessive rock—the dimensions or quantities of which 25 percent or more are greater than 2 ½ inches (63 mm) in size, making compliance with these Specifications impractical—the Engineer may waive certain portions of the work as described below. The Engineer may require exploratory scarifying by the Contractor before designation of extents for which full compliance of these Specifications is waived.

E) Application.

General. The type and proportion of stabilization additive indicated on the plans is approximate. The type and the final rate of application of stabilization additive ultimately used shall be based on tests

of the subgrade soil. The tests of the subgrade soils shall be performed by the Department. However, with the approval of the Engineer the Contractor has the option of having the tests performed by a laboratory approved by the Department in accordance with the Materials Division policy for soil stabilization at no additional cost to the Department. The stabilization additive shall be applied at the rate prescribed by the Engineer based on tests of the subgrade soil.

The Contractor may propose the use of a cementitious additive that was not specified on the Plans as a substitute, by submitting a proposal to the Engineer for review and approval. The proposal must include test results performed by a laboratory approved by the Department in accordance with the Materials Division policy for soil stabilization, the recommended application rates from those test results for the planned and proposed additives, and the cost comparison of the planned and proposed additives. Approval of the Engineer must be obtained prior to any substitution for the planned additive. Additives shall be used as specified in the following table.

	Soil Type – AASHTO M145						
Additive	A-1	A-2	A-3	A-4	A-5	A-6	A-7
Portland Cement	X	X	X	X	X	X	
Fly Ash		X	X	X	X	X	
Cement Kiln Dust	X	X	X	X	X		
Lime						X	X

The Contractor shall provide equipment necessary for proper control of the application rate of stabilization additive. Where tests indicate a significant change in the subgrade soil, the Department will establish a new application rate as deemed necessary for the section of road affected prior to the Contractor placing and spreading the stabilization additive.

1) Application of Cementitious Additive. Dry methods of application shall be used for placement of the cementitious additive onto the subgrade. Equipment for spreading shall be approved types which demonstrate the ability to distribute cementitious additive uniformly.

   Cementitious additive shall not be applied by the slurry method. Cementitious additive shall not be placed on wet subgrade or otherwise allowed to become wet during application prior to mixing. Cementitious additive shall not be applied when wind conditions are such that blowing cementitious additive becomes objectionable to traffic or adjacent property owners. Cementitious additive shall be placed only on that area of roadway where mixing, compaction, and finishing can be completed in the same day. During the interval of time between application and completion of the first mixing operations, cementitious additive that has been exposed to weather conditions resulting in wetting or excessive loss by blowing will not be accepted for payment, and cementitious additive unacceptable as the result of wetting shall be removed from the project.

   Specific extents of the subgrade may require modification with lime as a pretreatment to lower the plasticity index of the subgrade soils to below 20 prior to the application of a cementitious additive. The lime pretreatment shall be performed to the depth and at the rate prescribed by the Engineer based on tests of the subgrade soil. Application of lime for pretreatment shall be in accordance with the application of lime as described in Subsection 222.04.

2) Application of Lime. Lime shall not be applied when wind conditions are such that blowing lime becomes objectionable to traffic and adjacent property owners. Equipment for spreading shall be approved types which demonstrate the ability to distribute lime uniformly. When lime is applied to the soil ahead of the mixing equipment, the lime shall be placed only on that area where the first mixing operations can be completed during the same working day. During the interval of time between application and mixing, lime that has been exposed

to the open air for a period of six hours or more may not be accepted for payment; in addition, payment will not be made for lime loss due to excessive washing or blowing.

a) Dry Method.

(i) Quick Lime. When quick lime is used, the equipment for spreading lime shall be an approved type which shall demonstrate its ability to distribute the lime uniformly in controlled amounts.

(ii) Hydrated Lime. Bagged hydrated lime may be used for dry-method application only under unusual circumstances, i.e., when it would be impossible or impracticable to use other methods and only upon written approval of the Engineer and provided that all applicable Federal, State, and local laws are met. The bagged lime shall bear the manufacturer's certified weight.

b) Slurry Method. Lime shall be mixed with water into a slurry by either of the following methods.

(i) Central Plant. Mixing shall be accomplished through integral paddles, recirculating pumps, or other devices that will meet mixing requirements. The slurry distributor truck, hauling from the central plant, shall be equipped with a recirculating pump or agitator of sufficient size which will keep the lime and water in a uniform mixture until spread.

(ii) Transit Mix. The lime from the storage bin shall be metered or weighed by an approved method into the tank transit mix equipment. The tank truck shall be equipped with a recirculating pump or agitator to maintain a uniform mixing of the lime and water while in transit. The distributor truck shall be equipped with a pump, regardless of the type of mixing method used. The slurry will be applied through the spray bars under pressure to assure a uniform flow and distribution. The slurry produced by either method shall consist of a minimum mixture of approximately 1 ton of lime to each 500 gallons of water and shall not contain more than 40 percent lime. Use of compressed air for mixing will not be permitted.

c) By-product Lime. When by-product lime is used, the equipment for spreading lime shall be an approved type, which will demonstrate its ability to uniformly distribute the lime at controlled amounts.

F) Mixing.

General. Mixing of the stabilization additive with the subgrade soil shall follow application and spreading as a continuous construction operation. Work areas for mixing shall not exceed 5,000 square yards (4000 m2) unless otherwise authorized by the Engineer.

1) Single Mixing for Cementitious Additive Stabilization: The Single Mixing procedure shall be as hereinafter described for soils classified as Groups A-1 and A-3 in AASHTO M145 soil classification. The Double Mixing procedure described in Subsection 222.04(f)(2) may be allowed at the Contractor's option for these soil classifications.

a) Mixing. Unless authorized by the Engineer, the pulvermixer shall be equipped with a spray bar in the mixing chamber that is capable of injecting a sufficient quantity of water to produce a soil-cementitious additive mixture with a moisture content within the specified range in a single pass of the mixer. The quantity of water necessary for the mixing will vary with the nature of materials, normally enough water will be added to obtain a water content 2 to 5 percentage points above the optimum moisture

content for maximum density of the compacted soil-cementitious additive mixture. All clods shall be reduced in size by mixing until the soil cementitious additive mixture meets the following size requirements when tested dry by laboratory sieves:

Sieve Size	Percentage Passing
1 ½ inch	100%
¾ inch	50 minimum

Cementitious additive shall be added and the section shall be repulverized at the correct moisture content to any portion of the work area that the cementitious additive has hydrated prior to compaction at the contractor's expense, unless waived by the Engineer.

b) Additional Mixing. The specified degree of pulverization and the specified range of the moisture content of the mixture shall be achieved in the initial mixing of the cementitious additive or a second pass with a pulvermixer will be required. The pulvermixer shall be equipped to add additional water, if required. Cementitious additive shall be added and the section shall be repulverized at the correct moisture content to any portion of the work area that the cementitious additive has hydrated prior to compaction at the contractors expense, unless waived by the Engineer.

2) Double Mixing for Cementitious Additive Stabilization: The double mixing procedure shall be as hereinafter described for soils classified as Groups A-2, A-4, A-5, and A-6 in AASHTO M145 soil classification. The Single Mixing procedure described in Subsection 222.04(e)(2) may be allowed only after approval by the Engineer for these soil classifications, if the mixing can be properly performed by using special equipment or construction methods proposed by the Contractor.

a) First Mixing. The moisture content of the subgrade soil shall not exceed 80 percent of the optimum moisture as determined by AASHTO T-99 at the time of first mixing. The soil and cementitious additive shall be mixed until a uniform mixture is obtained in which all clods and non-aggregate lumps are reduced to a maximum of 2 ½ inches (63 mm) diameter size. The addition of water will not be permitted during the first mixing. First mixing operations shall begin no later than 4 hours after the application of cementitious additive. When deemed necessary by the Engineer, any portion of the area shall be rescarified and additional cementitious additive added to ensure adequate soil stabilization. The cementitious additive and soil shall be thoroughly mixed prior to the beginning of final mixing operations.

b) Final Mixing. After the soil and cementitious additive have been satisfactorily mixed, water shall be added during the final mixing operations to initiate the soilcementitious additive reaction. Water shall be sprinkled or sprayed as a mist onto the subgrade in a manner that produces a uniform coverage. The method of mixing shall be an approved procedure utilizing traveling mixing equipment that demonstrates uniform dispersion of cementitious additive and water throughout the soil. Sufficient water shall be added in the final mixing process to ensure chemical reaction between cementitious additive and soil. The quantity of water necessary for the final mixing operations will vary with the nature of the materials, normally enough water will be added to obtain a water content 2 to 5 percentage points above the optimum moisture content of the compacted soil-cementitious additive mixture. All clods shall be reduced until the soil-cementitious additive mixture meets the following size requirements when tested dry by laboratory sieves:

Sieve Size	Percentage Passing

1 ½ inch	100%
¾ inch	50 minimum

c) Double Mixing for Lime Stabilization: The mixing procedure shall be as hereinafter described.

(i) FIrst Mixing. The Contractor shall mix the soil, lime, and water until a uniform mixture is obtained in which all clods and non-aggregate lumps are reduced to a maximum of 2 ½ inches (63 mm) diameter size. The quantity of water necessary for the first mixing operation will vary with the nature of the material, normally enough water will be added to obtain a water content 2 to 5 percentage points above the optimum moisture content of the compacted stabilized soil. Sufficient water shall be added in the first mixing process to insure proper chemical reaction between the lime and soil. When proper mixing has been accomplished, the mixture shall be allowed to cure. Curing time when hydrated lime is used shall be 72 hours at ambient temperatures above 40/F (4/C). Curing time when quick lime is used shall be 48 hours at ambient temperatures above 40/F (4/C). Curing time when byproduct lime is used shall be 60 hours at ambient temperatures above 40/F (4/C).

During the curing period, the material shall be maintained in a moist condition. The surface of the stabilized area shall be sealed by light rolling to the extent that the surface will repel water and contain the moisture. When deemed necessary by the Engineer, the Contractor shall rescarify any portion of the area under stabilization for additional sprinkling to insure proper moisture for the curing.

(ii) Final Mixing. After the required curing time, the material shall be mixed uniformly by approved methods. All clods shall be reduced until the soil-lime mixture meets the following requirements when tested dry by laboratory sieves:

Nominal Sieve Sizes	**Percentage Passing**
1 ½ inch	100%
No. 4	60 minimum

(iii) Quick Lime Mixing. Within two hours after spreading quick lime and before water is added, approved means shall be used to turn under a significant portion of the quick lime to reduce harmful exposure to the heat of hydration. Sufficient water shall be added within 6 hours after spreading to permit hydration of the quick lime. CAUTION: Uncovered quick lime may be hazardous when in the presence of moisture.

d) Mixing for Lime Pretreatment: Mixing of lime for pretreatment shall be in accordance with the first mixing for lime described in Subsection 222.04(f).

e) Mixing for Depths of 8 inches or greater compacted thickness. No course stabilized shall exceed 8 inches in depth. If the depth of material to be stabilized in cut sections is more than 8 inches (200mm), that portion above the lower 8 inches shall be removed so that the bottom course can be stabilized in place. The upper portions of the cut section also shall be stabilized in courses not more than 8 inches in depth. During normal fill construction, stabilization shall be accomplished by adding and mixing the amount of stabilization additive as required on the plans to each 8 inch lift, completing the depth of fill to the typical section shown on the plans. The initial mixing shall be considered the only mixing necessary for all except the top course.

Variations to the mixing depths that may be properly performed by special equipment or methods may be used only after approved by the Engineer.

f) Mixing for Excessive Rock Areas. In areas designated by the Engineer as excessive rock areas, it is the intent that the completed course of stabilized material shall comply with the Standard Specifications as to uniformity of stabilization additive, density, moisture content, and depth insofar as practicable. Mixing and pulverization shall be accomplished in two stages and shall be sufficient to accomplish the intent of the Specifications. The particle size requirement may be waived by the Engineer.

G) Compaction. The soil-cementitious additive mixture shall be compacted immediately after mixing, so that the compaction operation is a continuation of the mixing operation. The soil-lime mixture shall be compacted during the same day as the final mixing unless approval is obtained from the Engineer to continue compaction on the following day. The target density shall be determined in the field by moisture- density tests on representative samples of the soil-stabilization additive mixture obtained from the roadway when compaction is started. The test method for the target density will be as specified in Subsection 201.04, modified to provide one compacted specimen of the soil-stabilization additive mixture as obtained from the roadway; and separate portions of the sample will be used for additional specimens with the moisture reduced or increased.

The soil-stabilization additive mixture shall be compacted immediately after mixing and before any appreciable loss of mixing moisture occurs. Mixing and compaction operations shall be performed so that the mixture will be compacted within plus or minus 2 percentage points of optimum moisture content. However, during the course of construction, changes or adjustments in the specified moisture requirements to meet field conditions may be authorized by the Engineer.

Compaction shall be continued until the entire depth of the mixture is uniformly compacted to not less than 95 percent of target density. Field density will be determined in accordance with Subsection of 201.04. The rate of operation and the number of rollers shall be sufficient to uniformly compact the section of roadway being processed as specified above for the cementitious additive and within two hours of the final mixing for the lime additive.

Depths of two or more lifts or courses shall be compacted as specified in the mixing procedure. The material shall be sprinkled or dried as necessary to provide the moisture for proper compaction. Compaction shall be continued until the entire depth of mixture is compacted to not less than 95 percent of the target density established in accordance with the paragraph above.

The material shall be sprinkled and rolled. All irregularities, depressions, or weak spots which develop shall be immediately corrected by scarifying the areas affected, adding or removing material as required, and reshaping and recompacting by sprinkling and rolling.

In addition to complying with the requirements specified for density, the full depth of the material shown on the Plans shall be uniformly compacted to the extent necessary for it to remain firm and stable under construction equipment. After each section is completed, density tests as necessary, will be made by the Engineer for acceptance. Throughout this entire operation the shape of the course shall be maintained and the surface upon completion shall be smooth and in conformity with the typical section shown on the Plans and to the established lines and grades. Should the material, due to any reason or cause, lose the required stability, density, or finish before the next course is placed or the work is accepted, it shall be replaced and refinished at the sole expense of the Contractor.

In areas designated by the Engineer as excessive rock areas, it is the intent that compaction be in substantial compliance with these Specifications. However, it is recognized that the soil-stabilization additive mixture may not be uniform and some variation is to be expected in both the target density and optimum moisture, depending on the stabilization additive content of a given

sample. In the event the in-place density tests are not practical because of rock in the soil-stabilization additive mixture, the Engineer may waive the density and moisture content requirements and approve compacting by visual observation in lieu of such tests.

H) Finishing and Curing. After the final layer of the stabilized subgrade has been compacted, it shall be brought within reasonable compliance to the lines, grades, and typical sections. The completed section shall then be finished with a suitable roller sufficiently light to prevent hair cracking. The stabilized subgrade shall be maintained at a moisture content satisfactory for proper curing by sprinkling until a prime, seal, or succeeding course is placed, whichever occurs first.

I) Tolerance. The finished surface tolerance shall be in conformity with the Plans.

222.06 – METHOD OF MEASUREMENT.

Fly ash will be measured by the ton. Cement kiln dust will be measured by the ton. Portland Cement will be measured by the ton. Cementitious stabilized subgrade will be measured by the square yards of subgrade stabilization completed in place. Lime will be measured by the ton. Lime stabilized subgrade will be measured by the square yard of subgrade stabilization completed in place. Lime Pretreatment will be measured by the square yard of subgrade pretreatment completed in place. Water and rolling will not be measured for payment.

222.07 – BASIS OF PAYMENT.

Accepted quantities for stabilized subgrade, measured as provided above, will be paid for at the contract unit price as follows:

FLY ASH	TON
LIME	TON
CEMENT KILN DUST	TON
PORTLAND CEMENT	TON
CEMENTITIOUS STABILIZED SUBGRADE	SY
LIME STABILIZED SUBGRADE	SY
LIME PRETREATMENT	SY

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.

Payment for quick lime shall be based upon a 90 percent available lime index by rapid sugar method, calculated as percent CaO by weight.

Payment for hydrated lime shall be based upon a 90 percent available lime index by rapid sugar method, calculated as percent Ca(OH)2 by weight.

Payment for by-product lime shall be based on a substitution ratio calculated on a 90 percent available lime index by rapid sugar method. When the available lime index percentage falls below 90 percent, payment will be made at an adjusted price—which shall be reduced at the rate of one percent of the Contract unit bid price for lime for each percent, or fraction thereof, from 90.0 percent down to—and including—an available lime index of 80.0 percent. When the available lime index falls below 80.0 percent for the type of lime used, add a sufficient quantity of additional lime of the same type to bring the total amount to the required 90.0 percent of available lime index at no additional cost to the City.

SECTION 225 – AGGREGATE BASE

225.01 – DESCRIPTION

This work shall consist of furnishing and placing one or more courses of aggregates and additives, if specified, on a prepared subgrade or subbase in accordance with these specifications and in

reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the Plans or established by the Engineer.

Aggregate base may be mixed off the roadbed and may be blended by plant mixing or other approved methods.

Aggregate base may be mixed on the roadbed with approved methods that will produce a uniformly blended material. Aggregate base shall not be mixed on any completed base or surface course.

225.02 – MATERIALS

Materials shall conform to the requirements specified in the following Section of Section 923 - Materials, for the type gradation specified.

Aggregate Base

The gradation may be either Type A or Type B unless otherwise specified on the Plans or in the Special Provisions. After work starts the same gradation type and source as specified or selected shall be used throughout the project unless otherwise permitted in writing by the Engineer, except as follows:

The gradation shall be type A in the top 3 inches on any base course except when the specified thickness is 6 inches or less where it shall be for the total thickness.

225.04 – CONSTRUCTION METHODS

A) Preparation of Subgrade - Prior to placing any new base material or subbase and base course material on the roadbed, the subgrade shall be completed according to the requirements of Section 220, Subgrade, of these Specifications or the method specified on the Plans or in the Special Provisions.

B) If there is an existing aggregate course in place, it shall be prepared in accordance with the requirements of the method of Section 226, Processing Existing Base and Surface, of these Specifications as indicated on the Plans and in the Special Provisions.

C) Mixing Aggregate Base

1) Offsite Mixing. When mixing or blending of materials for aggregate base is done at an approved location off the roadbed one of the following procedures shall be used.

a) Stationary Plant - Mixing Method. The aggregate and water shall be mixed in an approved central mixing plant of the pugmill type, rotary drum type or in a continuous type of mixer.

b) Water shall be added during the mixing operation in the amount necessary to provide the proper moisture content for satisfactory compaction.

c) If a pugmill type or rotary drum type of mixer is used, the materials shall be proportioned by batch weights, and if a continuous type of mixer is used, the materials may be proportioned by volume or by weight.

d) Should the Contractor elect to proportion the materials by volumetric methods and perform the mixing in a continuous type mixer, the completed mixture shall be uniform in character and of the same consistency with respect to aggregates and water as that obtained by weight proportioning and batch mixing.

e) If a continuous type mixer is used, the correct proportions of each aggregate size introduced into the mixer shall be drawn from storage by an approved type of continuous feeder through adjustable calibrated gates, which shall supply the correct amount of coarse aggregate and fine aggregate required to meet the specified

gradation, and so arrange that the proportion of each aggregate size can be separately adjusted. The storage of materials shall be sufficient to supply the mixer when it is in operation at full capacity.

f) The weight of charge in a batch mixer or the rate of feet to a continuous type mixer shall not exceed that which will permit complete mixing of the material.

g) Mixing of materials shall be continued until a uniform mixture is obtained.

2) Onsite Mixing. When the materials required to produce the specified mixture are to be combined and blended on the roadbed, the weighed material shall be delivered and placed in measured windrows, each in the proper proportions before blending. Fine aggregate to be added to the mixture shall be pulverized to 100 percent passing the one inch sieve and not less than 80 percent passing the No. 4 sieve.

a) The total quantities for blending at one operation shall not be in excess of the amount that can be readily handled and thoroughly and uniformly mixed and blended to these requirements.

b) During the latter stages of the mixing and before the final mixing is completed, the mixture shall be moistened as deemed necessary to provide a suitable working condition during the final stages of mixing. Such application of water shall be accurate and uniform throughout the length of the section being treated so that no excess wet or dry spots will be evidenced in the finished blend. Application of excess water should be avoided, either during mixing or during compaction, in order that undue softening of the subgrade will not develop.

D) Spreading - Aggregate base materials mixed at locations off the roadbed shall be transported to the roadbed by means of suitable vehicles and deposited by means of approved spreading equipment. The layers shall be placed so that when compacted they will be true to the grades or levels required with the least possible surface disturbance. The Contractor shall make such adjustments in placing procedures or equipment as may be required to obtain true grades, to minimize segregation and degradation, to reduce or accelerate loss or accretion of water, and to assure an acceptable base.

1) The aggregate base material shall be spread and compacted to the required density in one or more layers, as specified below, and of such width and thickness that after compacting, the finished base will conform to the required grade and cross section. The aggregate base material for each separate course shall be spread for the full width of the roadbed before the placing of the succeeding courses.

2) Longitudinal and transverse joints shall be staggered a minimum of 12 inches in each succeeding course.

3) Aggregate base material shall be laid in courses of a minimum of 3 inches compacted thickness and shall not exceed a maximum of 6 inches compacted thickness, except when shoulders are shown on a typical section to be constructed as a separate operation, then they may be constructed in one course providing they do not exceed 8 inches in thickness, and in two approximately equal courses where they exceed 8 inches. In either case, the compacted shoulders shall meet specified density requirements.

4) After the blended and flattened windrow of aggregate base material mixed on the roadbed has been tested and approved by the Engineer, it shall be spread uniformly as specified above over the full length and width of the section to be compacted. This spreading shall be done in such a manner as to prevent segregation of the mixture.

E) Shaping and Compaction - Compaction of each layer shall continue until a density of not less than

100 percent of modified proctor density, as determined by AASHTO T-180, method D, has been achieved. Provided, that aggregate base outside the pavement edge for new construction, or outside the old pavement edge for widening, shall have a minimum density of 95 percent of standard density, AASHTO T-180, method D. The surface of each layer shall be maintained during the compaction operations in such a manner that a uniform texture is produced and aggregates firmly keyed. Water shall be uniformly applied over the base materials during compaction in the amount necessary for proper consolidation.

F) Tolerances - Tolerances for surface, width and thickness shall be in conformity with Plans and Specifications.

225.06 – METHOD OF MEASUREMENT

Aggregate base will be measured by the cubic yard, compacted in place to the specified density. Measurement will be based on the actual length multiplied by the theoretical cross section shown on the Plans. Rolling and water as required to obtain a specified density will not be a separate pay item, but the cost of same shall be included in the price of other bid items.

225.07 – BASIS OF PAYMENT

Accepted aggregate base, measured as provided above, will be paid for at the contract unit price for:

AGGREGATE BASE C.Y.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

SECTION 226 – PROCESSING EXISTING BASE AND SURFACE

226.01 – DESCRIPTION

This work shall consist of the removal, processing, reuse or disposal of existing aggregate surface course or base course and asphalt surface.

This work shall be done in accordance with one of the following methods as specified herein and shown on the Plans or as indicated by a pay item on the Plans and in the Proposal.

226.04 – CONSTRUCTION METHODS

General. The aggregate or other materials in place shall be loosened by scarifying or the use of other suitable methods to its full depth and width. All loosened aggregate or asphalt shall be processed and broken into pieces which will pass a 3 inch sieve. The materials shall be windrowed on the subgrade or shoulder as the case may require. Care shall be exercised in loosening, removing, processing and storage of aggregate to avoid the addition of excess amounts of soil or other foreign material which would render it unsuitable for the use hereafter specified. Damaged material resulting from improper workmanship of the Contractor will not be measured for payment.

Method A - For Salvage and Stockpiling. The processed materials shall not contain detrimental amounts of subgrade or soil or other foreign material. The processed material shall be loaded and hauled to storage locations indicated. All materials shall be stored in a neat and workmanlike manner. All grass, weeds and other rubbish shall be removed from the storage area prior to stockpiling material.

Method B - For Use in Subgrade. The processed materials shall be windrowed on the shoulders during the shaping and conditioning of the subgrade. The materials shall then be spread uniformly over the full width of the section and compacted and completed with the subgrade in accordance with the method specified.

Method C - For Use as Subbase. The processed materials shall be spread evenly on the previously

completed and compacted subgrade and then compacted to the requirements specified for the method of subgrade preparation.

Method D - For Use in New Base Courses, Shoulders, or Ramps. The processed materials may be placed on the completed subgrade as a base course, shoulders or ramps, or it may be blended uniformly with new material for any course. The suitability of the removed materials shall be determined by the Engineer and materials used as authorized.

These materials shall be compacted to not less than 95 percent of standard density for shoulders, ramps and base courses.

226.06 – METHOD OF MEASUREMENT

Processing existing base and surface will be measured by the station of 100 feet or fraction thereof measured along the center line of the roadbed.

226.07 – BASIS OF PAYMENT

Accepted quantities for processing existing base and surface, measured as provided above, will be paid for at the contract unit price for:

PROCESSING EXISTING BASE AND SURFACE, METHOD A	STA.
PROCESSING EXISTING BASE AND SURFACE, METHOD B	STA.
PROCESSING EXISTING BASE AND SURFACE, METHOD C	STA.
PROCESSING EXISTING BASE AND SURFACE, METHOD D	STA.

which shall be full compensation for furnishing all equipment, tools, labor and incidentals necessary to complete the work as specified.

SECTION 250 – TRENCHLESS CONSTRUCTION

SECTION 251 - JACKING

251.01 - DESCRIPTION

This section covers furnishing and installation of pipe by trenchless method of Jacking as shown on the plans and in conformity with these specifications. In general, a boring head begins the tunnel excavation from an access pit and is pushed along by a hydraulic pump unit that remains in the pit. The link to the boring head is maintained by adding jacking pipe between the pushing unit and the head. By this procedure, the pipe is laid as the tunnel is bored.

251.02 – MATERIALS

251.02.01 - SUBMITTALS

Submittals shall be provided in accordance with the requirements specified in Section 615.02.

251.02.02 – PIPE MATERIALS

Acceptable pipe materials and fittings shall meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Rigid	Reinforced Concrete Pipe (RCP)	647
	Vitrified Clay Pipe (VCP)	649
Flexible	Polyvinyl Chloride (PVC)	652
	Reinforced Fiberglass Pipe (RFP)	653

251.03 - CONSTRUCTION METHODS

All construction requirements specified in Section 615.04 shall apply. The excavation and backfill for pits and installation of shoring shall be as outlined in Section 212.04(b).

Heavy-duty jacks suitable for forcing the pipe through the embankment or earth shall be provided. In operating jacks, even pressure shall be applied to all jacks used. A suitable jacking head, usually of timber, and suitable bracing between jacks and jacking head shall be provided so that pressure will be applied to the pipe uniformly around the ring of the pipe. A suitable jacking frame or backstop shall be provided. The pipe to be jacked shall be set on guides properly braced together to support the section of the pipe and to direct it in the proper line and grade. The whole jacking assembly shall be placed so as to line up with the direction and grade of the pipe. In general, soil shall be excavated or augured just ahead of the pipe and material removed through the pipe, and the pipe forced through the embankment with jacks into the space thus provided. The excavation for the underside of the pipe for at least one-third (1/3) of the circumference of the pipe shall conform to the contour and grade of the pipe. The excavation for the top half of the pipe shall conform closely to the outside diameter of the pipe, and a clearance greater than two inches (2”) will not be permitted.

The pipe preferably shall be jacked from the low or downstream end. Lateral or vertical variation in the final position of the pipe from the line and grade established by the Engineer will be permitted only to the extent of one inch (1”) in ten (10) , provided that such variation shall be regular and only in one direction and that the final grade of flow line shall be in the direction indicated on the plans.

Nothing contained herein shall be construed as relieving the Contractor from his responsibility for the safety of the work and for all damages to persons or property.

251.03.01 – SEWER SERVICE CONNECTIONS

All sewer service connections shall be accomplished and paid for in accordance with Section 611.

251.06 – BASIS OF PAYMENT

"Jacking" shall be measured by the lineal foot of pipe completed. Payment for "Jacking" shall be made at the unit price bid per lineal foot for each size. The price established shall be full compensation for furnishing and placing all materials, including pipe, excavation and backfill, sheeting, shoring, bracing and drainage, disposal of all surplus materials, labor, tools, equipment, and incidentals necessary to complete this item of work.

251.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

KING (SIZE)	L.F.
KING – (PIPE SIZE)	L.F.
KING – CASING (SIZE)	L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and

incidentals, and for performing the work in accordance with these specifications.

SECTION 252 – BORING

252.01 – DESCRIPTION

This section covers furnishing and installation of pipe by trenchless method of boring as shown on the plans or specified.

Boring consists of the initial installation of a steel casing pipe, installed mechanically, and with a suitable assembly designed to produce a smooth, straight shaft at the established line and grade. The pipe is then installed inside the casing pipe pursuant to the Standard Detail for Boring.

252.02 – MATERIALS

Acceptable pipe materials and fittings shall meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Rigid	Reinforced Concrete Pipe (RCP)	647
	Vitrified Clay Pipe (VCP)	649
Flexible	Ductile Iron Pipe (DIP)	650
	High Density Polyethylene Pipe (HDPE)	651
	Polyvinyl Chloride (PVC)	652
	Reinforced Fiberglass Pipe (RFP)	653

252.02.01 – SUBMITTALS

The Contractor shall furnish for the Engineer's approval, a plan showing his proposed method of handling, including the design for the equipment, equipment support of backstop, arrangement and position of jacks, pipe guides, etc., complete in assembled position. The approval of this plan by the Engineer will not relieve the Contractor from his responsibility to obtain the specified results.

252.02.02 – CASING PIPE MATERIALS

Acceptable casing pipe materials shall meet the requirements of the appropriate sections listed below:

Casing Pipe Material	Section
Steel Casing Pipe (Water)	528
Steel Casing Pipe (Sanitary Sewer)	654

252.04 - CONSTRUCTION METHODS

A) General – Where pipe is required to be installed under railroad embankments or under highways, streets, or other facilities by trenchless methods, construction shall be made in such a manner that will not interfere with the operation of the railroad, street, highway, or other facility, and shall not weaken or damage any embankment or structure. During construction operations, barricades and lights to safeguard traffic and pedestrians shall be furnished and maintained, as directed by the Engineer, until such time as the backfill has been completed and then shall be removed from the site.

The Contractor shall take proper precautions to avoid excavating earth or rock or shattering rock beyond the limits of excavation shown on the plans. All damages caused by excavating or blasting, either to surface or subsurface structures, shall be repaired or replaced by the Contractor

at his own cost and expense.

Suitable pit shafts, or trenches shall be excavated for the purpose of conducting the trenchless operations and for placing end joints of the pipe. Wherever end trenches are cut in the sides of the embankment or beyond it, such work shall be sheeted securely and braced in a manner satisfactory to the Engineer to prevent earth caving.

The removal of any obstruction that may be found to conflict with the placing of the pipe shall not be measured for payment nor paid for as a separate contract pay item. The removal of any such obstruction shall be included in the cost of other items.

Once the pipe installation has commenced it shall be continued uninterrupted around the clock until the pipe has been installed between the specified limits.

Any pipe damaged during operations shall be removed and replaced by the contractor at his expense.

The pits or trenches excavated to facilitate the operations shall be backfilled immediately after the pipe has been installed.

B) Boring Requirements - Work shall comply with the Standard Detail for Boring. The excavation and backfill for pits and installation of shoring shall be as outlined in Section 212.

Boring without the concurrent installation of a casing pipe shall not be permitted, unless shown on plans or directed by the Engineer. All joints in casing pipe shall be welded. Casing pipe shall extend through the entire fill and be installed in a manner that shall not disrupt traffic nor damage roadway grade and surface. The introduction of water into the excavation shall be prohibited.

The size of the bored hole shall not exceed the outside diameter of the pipe bell or casing pipe more than one inch (1”). The use of water or other fluids in connection with the boring operation shall only be permitted when approved by the Engineer.

Nothing contained herein shall be construed as relieving the Contractor from his responsibility for the safety of the work and for all damage to persons and property.

C) Skid Supports

a. Wood Skid Supports – Wood skid supports, from bell to spigot, shall be used and fastened securely to pipe with steel strapping, cables or clamps. Use of petroleum products shall not be allowed as a lubricant to ease installation. When wood skids are used, they shall be pressure treated with creosote pentachlorophenol, or salt type preservative in accordance with APWA C-2. Cut surfaces shall be given two (2) heavy brush coats of the same preservative. Skid support spacing and position shall be in accordance with the Standard Detail for Boring.

b. Casing Spacers – Casing spacers shall be PVC with stainless steel bands as manufactured by Advance Products & Systems, Inc. of Lafayette, Louisiana or approved equal. Use and positioning of spacers shall be in accordance with the manufacturer's recommendations.

D) Plugging Pipe Ends - Both ends of the casing pipe shall be plugged with a grout or concrete having a minimum compressive strength of twenty-five hundred pounds per square inch (2,500 psi) or grouted masonry and shall conform to the applicable requirements of Section 900. Each plug shall be a minimum length of eighteen inch (18”) The grouting pressure shall be in accordance with the pipe manufacturer's recommendations.

E) Filling Annular Space - The annular space between the waterline pipe and the steel casing pipe shall not be filled.

252.06 – METHOD OF MEASUREMENT

"Boring" shall be measured by the lineal foot of pipe bored. Payment for "Boring" shall be made at the unit price bid per lineal foot for each size. The price established shall be full compensation for furnishing and placing all materials including steel casing pipe, carrier pipe, grout or concrete, excavation and backfill, sheeting, shoring, bracing and drainage, disposal of all surplus materials, labor, tools, equipment, and incidentals necessary to complete this item of work. For water construction, "Boring – Pipe or Boring – Casing" shall be measured by the lineal foot bored. Payment for " Boring – Pipe or Boring – Casing " shall be made at the unit price bid per lineal foot for each size. The price established shall be full compensation for furnishing and placing all materials including pipe or casing, excavation and backfill, sheeting, shoring, bracing and drainage, disposal of all surplus materials, labor, tools, equipment, and incidentals necessary to complete this item of work.

252.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

BORING (SIZE)	L.F.
BORING – (PIPE SIZE)	L.F.
BORING – CASING (SIZE)	L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 253 – TUNNELING

253.01 – DESCRIPTION

This section covers furnishing and installation of pipe by trenchless method of tunneling using steel plate liners. Tunneling may be accomplished by open-face mining with or without shields. Compressed air may also be required to control the entry of water into the tunnel.

253.02 – MATERIALS

253.02.01 – SUBMITTALS

Submittals shall be provided in accordance with the requirements specified in Section 252.

253.02.02 – PIPE MATERIALS

Acceptable pipe materials and fittings shall meet the requirements of Section 252.02.

253.02.03 – TUNNEL LINER STEEL PLATES

Tunnel liner steel plates shall conform to the requirements of Section 528 and 654. The minimum wall thickness shall be United States Gauge 12 (0.2046 inches).

253.05 – CONSTRUCTION METHODS

All construction requirements specified in Section 528 and 654 shall apply. The excavation and backfill for pits and installation of shoring shall be as outlined in Section 212.

The tunnel shall be excavated in such a manner and to such dimensions that will permit placing of the proper supports necessary to protect the excavation. The Contractor shall take the proper precautions to avoid excavating earth or rack or shattering rock beyond the limits of excavation shown on the plans. All damages by excavation and blasting, either to surface or subsurface structures, shall be repaired or replaced by the Contractor at his own cost and expense.

Adequate provisions shall be provided for safety and health of the workmen. All equipment operated in the tunnel shall be powered by either air or electricity. No equipment shall be permitted in the tunnel that uses a petroleum product for fuel. Electric lights shall be used for illumination of the tunnel construction, for illumination of completed portions of the tunnel used for passage, and wherever lighting is needed for inspection of the work. Sufficient number of lamps shall be used to properly illuminate the work and all wiring for electric power and lights shall be installed and maintained in a safe and secure manner. The Contractor shall maintain the tunnel air in a condition suitable for the health of the workmen and sufficiently clear for surveying operations. A sufficient supply of fresh air shall be provided and maintained at all times in all underground places and provisions shall be made for the quick and complete removal of gases and dust resulting from blasting or other tunnel operations. Except when unnecessary due to natural ventilation, artificial ventilation shall be maintained in the tunnel by ventilating plants of ample capacity operated when needed to meet the preceding requirements.

Suitable steel or timber sheeting, shoring, and bracing shall be used to support the sides and roof of the excavation. Supports may be left in place provided that they clear the minimum thickness of the concrete backfill around the pipe. No separate payment will be made for supports left in place. The space between the liner plate and the limits of excavation shall be pressure grouted or mud jacked. Tolerance in line and grade shall be as specified in "Jacking".

Nothing contained herein shall be construed as relieving the Contractor from his full responsibility for the safety of the work and for all damages to persons and property.

253.06 – METHOD OF MEASUREMENT

"Tunneling" shall be measured by the lineal foot of pipe tunneled. Payment for "Tunneling" shall be made at the unit price bid per lineal foot for each size. The price established shall be full compensation for furnishing and placing all materials, including steel liner plate, waterline pipe, grout or cement, backfill, sheeting, shoring, bracing and drainage, disposal of all surplus materials, labor, tools, equipment, and incidentals necessary to complete this item of work.

253.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

TUNNELING (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 254 – MICRO AND SMALL DIAMETER TUNNELING

254.01 – DESCRIPTION

This section covers furnishing and installation of pipe by trenchless method of micro and small diameter tunneling. Micro and small diameter tunneling is the installation of pipe by Jacking the pipe behind a remotely controlled steerable, laser guided, articulated tunnel shield.

The size range of microtunneling shall be as follows:

Microtunneling - Tunneling in diameters that are too small for man entry, i.e., thirty-six inches (36”) or smaller in internal diameter.

Small Diameter Tunneling - Tunnels with an internal diameter greater than thirty-six inches (36”) and smaller than sixteen feet (16') in internal diameter.

254.02 – PIPE MATERIALS

Acceptable pipe materials and fittings shall meet the requirements of the appropriate sections listed

below:

Pipe Type	Pipe Material	Section
Rigid	Reinforced Concrete Pipe (RCP)	647
	Vitrified Clay Pipe (VCP)	649
Flexible	Polyvinyl Chloride (PVC)	652
	Reinforced Fiberglass Pipe (RFP)	653

Acceptable casing pipe materials shall meet the requirements of the appropriate sections listed below:

Casing Pipe Material	Section
Steel Casing Pipe (Water)	528
Steel Casing Pipe (Sanitary Sewer)	654

254.03 – EQUIPMENT

The Microtunnel boring machine shall be operated remotely. The Small Diameter tunnel-boring machine shall be given to a system capable of being remotely operated from outside the tunnel unless otherwise specified or approved by the Engineer.

The Tunnel Shield shall have a full face with an enclosed plenum chamber containing slurry under pressure. The shield must be equipped with a valve system that enables the plenum chamber to be isolated from the tunnel. The machine may, if required, be capable of conversion to mechanical earth pressure balanced, screw auger shield type.

The Tunnel Shield shall be capable of fully supporting the face both during excavation and during shutdown, and shall have the capability of presetting a calculated earth balancing pressure and positively measuring the earth pressure at the face.

In soil conditions of very low strength and high water table, the tunnel shield may, if required by the Engineer, be equipped with a sliding cutter head. The pressure exerted by the cutter head over the excavated face shall remain constant, regardless of variations in the excavation rate. The rate of excavation must be able to be varied independent of the jacking speed and be set to zero, if necessary.

The system shall be laser-guided and monitored continuously with a closed circuit television or other approved control system. All functions of the system shall be monitored and transmitted to the operation console. The microtunneling system shall be capable of being remotely controlled from the surface. The minimum information to be available to the operator on the control console includes rate of advance, length of conduit installed, thrust force, deviation from line and grade, role, inclination, and valve positions.

The soil transportation method shall be capable of handling and removing material of high water content from the face. The system shall be capable of any adjustment required to balance the ground water pressure to a level of plus three (3') and an accuracy of plus or minus (±) one foot (1').

The jacking system, including any intermediate jacks used, shall be capable of continuously monitoring the jacking pressure, the rate of advancement, and the distance jacked.

When soil conditions dictate, the tunnel shield must be capable of crushing cobbles and boulders. The excavation system shall be fully capable of excavating all materials that it will encounter.

The tunnel shield must be articulated and maneuvered by trunion mounted steering jacks or other approved method to enable accurate control of line and level.

The jacking system shall develop a uniform distribution of jacking forces on the end of the pipe.

Intermediate jacking stations shall be provided when the calculation of the total jacking pressure, needed to complete the installation, exceeds the maximum designed working compressive loads allowed for the pipe provided by the Contractor and approved by the Engineer.

A lubrication system shall be provided that injects an approved lubricant at the rear of the tunneling shield (if necessary, through the pipe wall in man entry sized tunnels) to lower the friction developed on the sides of the pipe during jacking.

A separation plant shall be provided when using the slurry balance system. The plant shall clean the excavated soil from the water for disposal and return the water back to the cutting face for reuse.

The over cut on the tunneling shield shall not exceed one inch (1") without the approval of the Engineer. The annular space created by the over cut must be filled with bentonite or approved lubricant suitable for the particular soil condition to be tunneled.

The tunneling system shall be capable of maintaining grade to within plus or minus (±) one and one half inches (1 ½ ") over the total distance between the jacking and reception shaft.

All groundwater encountered during the excavation of the tunnel shall be balanced by the tunneling machine. No loss of ground water shall be permitted.

Slurry tunneling systems shall use a minimum volume of water in the slurry system.

The tunneling shield must be capable of bi-directional drive on the cutter head wheel to minimize drift and rotation or roll of the conduit during installation.

254.04 – CONSTRUCTION METHODS

254.04.01 – DESCRIPTION

The Contractor shall have discretion to select the method of microtunneled pipe installation, subject to approval by the Engineer.

The tunneling shield connected to and followed by the pipe being installed, shall ensure that the soils being excavated through are fully supported at all times. This shall be accomplished without the use of any ground stabilization, de-watering, or other support techniques.

The minimum depth of cover for the micro-small diameter tunnel is normally six feet (6') or one and one half (1 ½) times the outer diameter of the conduit being installed, whichever is the greater.

254.04.02 – TUNNELING SHIELD

The tunnel shields shall be powered by electric or hydraulic motors. The shield shall be articulated to enable steering of the system. Steering rams and valves shall be controlled by a low-pressure power pack located in the shield or other approved means.

Line and grade shall be controlled by a laser beam transmitted from the drive shaft along the centerline of the pipe to a target mounted in the shield. The position of the laser on the target shall be transmitted back to the operator by closed circuit television, together with other information such as face pressure, roll, pitch, steering attitude, and valves open or closed.

254.04.03 – SOIL TRANSPORT SYSTEMS

A) Slurry System - Slurry system may be used to match soil excavation speed to the excavation rate and achieve a minimum velocity to prevent settlement of solids in the slurry lines, and to balance the groundwater pressure.

This shall be achieved by the use of variable speed pumps, pressure control valves, and a flow meter. A slurry by-pass unit shall be included in the system to allow the direction of flow to be changed and isolated as necessary. The slurry system shall have separation equipment that will remove the soil from the water. This may be accomplished by simple lagoons or tanks as approved by the Engineer. With larger shields, hydro-cyclones and vibrating screens may also be used.

B) Auger System - May be used to remove the excavated soil by auger to the jacking shaft, where it may be removed by conventional means.

C) Jacking System - The main jacks shall successively push the machine together with a string of connected pipes. The capacity of the jacks and the extension rate shall be synchronized with the excavation rate of the shield. Intermediate jacking stations shall be used when the calculation of the total jacking force needed to complete the installation exceeds the maximum design working compressive loads allowed for the pipe.

D) Controls - A control equipment shall be required to integrate the system of excavation and removal of soil and simultaneous replacement by pipe.

254.04.04 – SUBMITTALS

Submit for review complete working drawings showing details of the proposed method of construction and the sequence of operations to be performed during construction. Show the method of microtunneling, including the microtunneling system to be used, location of working shafts, including method of excavation, shoring and bracing, and de-watering techniques that are proposed to be used. The following is not intended to limit, but to provide the minimum of, details which must be included.

A) Manufacturer's literature describing in detail the microtunneling system to be used. Detailed description of projects on which the system has been successfully used, including the names, addresses, and telephone numbers of owner's representatives and engineers for these projects.

B) Method of muck disposal.

C) Method(s) of controlling groundwater.

D) Shaft dimensions, locations, surface construction, profile, depth, method of excavation, and shoring and bracing.

E) Design calculations for the proposed pipe to be used. The design calculations shall take into account maximum ground and hydrostatic loads, jacking thrusts, slurry and grout pressures, external loads such as railroads and highway traffic, and any other loads that may be reasonably anticipated. All loads shall be shown and described.

F) When used, structural details of reinforced concrete pipe, including reinforcing at the joints.

All Contractor submittals requiring structural design shall be signed and sealed by a Professional Engineer, registered to practice engineering in the state of Oklahoma.

The Engineer shall base the review of submitted details and data with consideration of requirements for the completed work, utilities, and the possibility of unnecessary delays in the execution of the work to be constructed. Review and acceptance of the Contractor submittals by the Engineer shall not be construed in any way as relieving the Contractor of his responsibilities.

254.04.06 – DRIVE AND RECEPTION SHAFTS

Shafts shall be of the minimum size possible commensurate with safe working practices and located as shown on the plans. Where no such locations are given, the Contractor shall determine such locations. Shaft locations shall, where possible, be kept clear of intersections and within a single traffic lane in order

to minimize disruption to the flow of traffic. The contractor shall furnish, install, and operate pumps, pipes, appliances, and equipment to keep the jacking shaft free from water. The design of the shafts shall ensure safe exit from the driving shaft and entry into the receiving shaft of the tunneling shield and provide sufficient backstop capacity to resist the forces developed by the thrust jacks.

254.04.07 – EXECUTION

Methods of construction for the shafts, jacking pits, or other components of the construction shall be such as to ensure the safety of the work, Contractor's employees, the public, and adjacent property, whether public or private.

All shafts and jacking pits shall conform with applicable Trench Safety Standards and OSHA excavation, trenching, and shoring standards which are contained in the Code of Federal Regulations 25 (CFE) 1925.650 - 1925.653.

Shafts and jacking pits shall be adequately ventilated. Air monitoring of the shafts or pits shall be conducted on a continuous basis. Threshold limits of the gas concentrations monitored shall be:

Gas Type	Concentration Threshold Limit
Carbon Monoxide	? 0.005%
Methane	? 0.25%
Hydrogen Sulfide	? 0.001%
Oxygen	? 20.0%

All work of excavating, shoring, and bracing and tunneling shall be so executed that settlement is minimized.

Before beginning construction at any location, the contractor must adequately protect existing structures, utilities, trees, shrubs, and other permanent objects. The repair of or compensation for damage to permanent facilities due to negligence or lack of adequate protection on the part of the Contractor shall be at no cost to the City.

Excavation face pressure on the tunnel shield shall be maintained at all times between the measured active earth pressure and fifty percent (50%) of the computed passive earth pressure. Fluid pressure applied at the face to balance the ground water shall be maintained at a level slightly in excess of normal hydrostatic pressure and shall be monitored continuously.

The machine shall be operated so as to prevent either surface heave or loss of ground during tunneling, and shall be steerable to maintain line and grade within the tolerances specified. This shall be achieved by continuously monitoring line, level inclination, and steering attitude during the operation. When the earth pressure slurry balance system is used, the composition of the slurry must be carefully monitored for specific gravity and viscosity, particularly with sizes in excess of twenty-four inches (24”) in internal diameter.

The thrust reaction backstop shall be properly designed and constructed. The backstop shall be normal to the proposed pipe alignment. The thrust wall shall be designed to support the maximum obtainable jacking pressure developed by the main jacking system. Special care shall be taken when setting the pipe guide rails in the starter shaft to ensure correctness of the alignment, grade, and stability. The shield is not to be jacked until the concrete thrust block (if selected) and the treated soil zone (if required) in the driving shaft have attained their required strength.

The pipe shall be jacked in place without damaging the pipe joints or completed pipe section. Any pipe that has been damaged during installation shall be replaced by the Contractor. The cost of replacement or installation of a new pipe shall be at no additional cost to the City.

All excavated material from tunnel and shaft construction shall be disposed of. No stockpiling shall be permitted on the construction site. Material shall be removed at regular intervals not exceeding forty-eight (48) hours.

All excavation and backfilling shall be accomplished in accordance with the requirements established in Section 212.

The Contractor shall monitor ground movements associated with the work and maintain these within permissible tolerances. Surface settlement and heave monitoring points shall be located along the line of the tunnel. The contractor shall install instrumentation, take readings, and provide the Engineer with copies, all in accordance with these specifications. These actions are meant to supplement the Contractor's monitoring system and do not relieve the Contractor of his responsibility, nor place on the Engineer, responsibility for control of ground movement and protection of the work and adjacent structures.

254.06 – METHOD OF MEASUREMENT

"Microtunneling" or "Small-Diameter Tunneling" shall be measured by the lineal foot of pipe completed. Payment for "Microtunneling" or "Small-Diameter Tunneling" shall be made at the unit price bid per lineal foot for each size, complete in place, as provided in the Proposals. The price established shall be full compensation for dewatering shafts, sheeting shoring and bracing, drainage, providing access shafts or portals, disposal of surplus excavated materials, including excavation and backfill and replacement of surface, or other improvements, furnishing all labor, tools, equipment, and incidentals, furnishing and installing the waterline pipe, steel casing pipe and performing all that is required to construct the tunnel as shown on the plans and called for in these specifications.

254.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MICRO-TUNNELING (SIZE)	L.F.
SMALL DIAMETER TUNNELING (SIZE)	L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 290 – EARTHWORK CONSTRUCTION STANDARD BID ITEMS

290.01 – DESCRIPTION

This section covers Standard Bid Items used in the contract documents for the construction of earthwork. Additional bid items may be called out in the Special Provisions, other sections of the Standard Specifications, or as directed by the Engineer for additional work covered and change orders.

SECTION	CODE	DESCRIPTION	UNIT
200	200-00	UNCLASSIFIED EXCAVATION	C.Y.
200	200-01	UNSUITABLE MATERIAL EXCAVATION	C.Y.
200	200-02	EXCESS EXCAVATION	C.Y.
201	201-00	EMBANKMENT	C.Y.
202	202-00	BORROW	C.Y.
211	211-00	DEWATERING	L.F.
212	212-01	TRENCH EXCAVATION AND BACKFILL - ZERO (0') FT TO TEN (10') FT	L.F.
212	212-02	TRENCH EXCAVATION AND BACKFILL - ZERO (0') FT TO FIFTEEN (15') FT	L.F.
212	212-03	TRENCH EXCAVATION AND BACKFILL - ZERO (0') FT TO TWENTY (20') FT	L.F.
212	212-04	TRENCH EXCAVATION AND BACKFILL - ZERO (0') FT TO TWENTY-FIVE (25') FT	L.F.
212	212-05	TRENCH EXCAVATION AND BACKFILL - ZERO (0') FT TO THIRTY (30') FT	L.F.
212	212-06	TRENCH LINEAL MEASUREMENT	L.F.
212	212-07	STRUCTURAL EXCAVATION	C.Y.
213	213-01	CRUSHED ROCK FOUNDATION	C.Y.
213	213-02	CRUSHED ROCK FOUNDATION	TON
214	214-00	LEAN MIX CONCRETE FOUNDATION	C.Y.
215	215-01	EMBEDMENT MATERIAL	C.Y.
215	215-02	EMBEDMENT MATERIAL	TON
216	216-01	CONCRETE CRADLE PLAIN	C.Y.
216	216-02	CONCRETE CRADLE TYPE I REINFORCEMENT	C.Y.
216	216-03	CONCRETE CRADLE TYPE II REINFORCEMENT	C.Y.
217	217-01	CONCRETE ARCHES PLAIN,	C.Y.
217	217-02	CONCRETE ARCHES TYPE I REINFORCEMENT	C.Y.
217	217-02	CONCRETE ARCHES TYPE II REINFORCEMENT	C.Y.
218	218-00	EMBEDMENT PLUGS (TYPE)	EA.
220	220-00	SUBGRADE	S.Y.
221	221-00	NATURAL SOIL BASE	S.Y.
222	222-01	FLY ASH	TON
222	222-02	LIME	TON
222	222-03	CEMENT KILN DUST	TON
222	222-04	PORTLAND CEMENT	TON
222	222-05	CEMENTITIOUS STABILIZED SUBGRADE	S.Y.
222	222-06	LIME STABILIZED SUBGRADE	S.Y.

SECTION	CODE	DESCRIPTION	UNIT
222	222-07	LIME PRETREATMENT	S.Y.
225	225-00	AGGREGATE BASE	C.Y.
226	226-01	PROCESSING EXISTING BASE AND SURFACE, METHOD A	STA.
226	226-02	PROCESSING EXISTING BASE AND SURFACE, METHOD B	STA.
226	226-03	PROCESSING EXISTING BASE AND SURFACE, METHOD C	STA.
226	226-04	PROCESSING EXISTING BASE AND SURFACE, METHOD D	STA.
251	251-01	JACKING (SIZE)	L.F.
251	251-02	JACKING - (PIPE SIZE)	L.F.
251	251-03	JACKING - CASING (SIZE)	L.F.
252	252-01	BORING (SIZE)	L.F.
252	252-02	BORING (PIPE SIZE)	L.F.
252	252-03	BORING - CASING (SIZE)	L.F.
253	253-00	TUNNELING (SIZE)	L.F.
254	254-01	MICRO-TUNNELING (SIZE)	L.F.
254	254-02	SMALL DIAMETER TUNNELING (SIZE)	L.F.

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SECTION 300 – PAVEMENT AND SURFACE COURSES

SECTION 301 – PLANT-MIX ASPHALTIC CONCRETE

301.01 – DESCRIPTION

This section covers base course, level course, surface course or any combination of these courses as shown on the plans. The mixture shall be composed of a mineral aggregate uniformly coated with an approved asphaltic cement and shall be laid upon an approved base course or old pavement in accordance with these specifications and in conformity with the line, grade and typical cross sections shown on the plans.

301.02 – MATERIALS

Materials shall meet the requirements of Section 931. The Contractor shall have ample material in the stockpiles at the plant site at the beginning of each day's operation to supply and be used for that day's operation.

301.02.01 – WEATHER AND TEMPERATURE LIMITATIONS

No asphaltic concrete shall be laid when there is frost in the course on which it is being laid. Unless specified otherwise by the Engineer, asphaltic concrete surface courses shall be laid only when one (1) of the following conditions of temperature and wind velocity prevail:

TABLE 301.02.01 – WEATHER AND TEMPERATURE LIMITATIONS

Temperature (ºF)	Wind Velocity MPH Maximum
60 or Above	40
50-60	15
45-50	5

Asphaltic concrete surface course shall not be laid when temperature is less than forty-five degrees F (45°F), except in unusual circumstances when the wind is virtually still and the surface on which the course is being laid is warmer than forty-five degrees F (45°F) In no case shall surface course be laid when the temperature is less than forty degrees F (40°F).

301.03 – EQUIPMENT

A) General - All plants used by the Contractor for the preparation of asphaltic concrete mixture shall have both capacity and controls sufficient to produce the asphalt mixture at the rate required for the satisfactory prosecution of the job within the specified time, and to produce asphalt mixture meeting the requirements of Section 931.

Batch mixing plants shall conform to the special requirements of Section 301.03(C).

Drum mixing plants shall conform to the special requirements of Section 301.03(D).

B) Requirements for all Plants - Mixing plants shall be of sufficient capacity and coordinated to adequately handle the proposed bituminous construction.

1) Equipment for Preparation of Bituminous Material - Tanks for storage of the bituminous material shall be equipped to heat and hold the material at the required temperatures. The heating shall be accomplished by steam coils, electricity, or other approved means so that no flame shall come in contact with the tank. The circulating system for the bituminous material shall be designed to assure proper and continuous circulation during the operating

period. Provision shall be made for measuring and sampling materials in storage tanks.

2) Cold Aggregate Feed - The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the dryer so that uniform production and uniform temperature will be obtained.

Dryer - A dryer of satisfactory design for drying and heating the mineral aggregate shall be provided. The dryer shall be capable of drying and uniformly heating the mineral aggregate to the temperature requirements set forth in these specifications without burning or overheating any portion.

Bituminous Control Unit - Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bituminous material in the mix within the tolerance specified. Means shall be provided for checking the quantity or rate of flow of bituminous material into the mixer.

Suitable means shall be provided, either by steam jacketing or other insulating for maintaining the specified temperature of the bituminous material in the pipe lines, meters, weight buckets, spray bars, and other containers or flow lines.

3) Thermometric Equipment - An armored continuous recording thermometer of adequate range in temperature reading shall be fixed in the bituminous line at a suitable location near the charging valve at the mixer unit.

The plant shall also be equipped with either an approved dial scale mercury actuated thermometer, and electric pyrometer, or other approved thermometric instruments so placed at the discharge chute of the dryer as to register automatically or indicate the temperature of the heated aggregates or mixture.

The Engineer may require replacement of any thermometer by an approved temperature recording apparatus for better regulation of the temperature of aggregates.

4) Dust Collector - The plant shall be equipped with a dust collector constructed to waste or return uniformly all or any part of the material collected as directed.

5) Truck Scales - The bituminous mixture shall be weighed on approved scales furnished by the Contractor or on public scales at the Contractor's expense. Such scales shall be inspected and sealed as often as the Engineer deems necessary to assure their accuracy, but not less than once every six (6) months.

6) Safety Requirements - Adequate and safe stairways to the mixer platform and sampling points shall be provided and guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required. Accessibility to the top of truck bodies shall be provided at the plant site by a platform or other suitable device to enable the Engineer to obtain sampling and mixture temperature data. A hoist or pulley system shall be provided to raise scale calibration equipment, sampling equipment and other similar equipment from the ground to the mixer platform and return. All gears, pulleys, chains, sprockets and other dangerous moving parts shall be thoroughly guarded and protected. Ample and unobstructed space shall be provided on the mixing platform. A clean and unobstructed passage shall be maintained at all times in and around the truck loading area. This area shall be kept free from drippings from the mixing platform.

7) Asphalt Quality - The asphalt manufacturer is responsible for the quality of the produced asphalt. From time to time, the Engineer may require the QC test result on the asphalt. It shall be the responsibility of the Contractor to provide the information.

8) Asphalt Source - The Contractor shall not change the asphalt source without written approval from the Engineer.

C) Additional Requirements for Batching Plants

1) Plant Scales - Scales shall be accurate to 0.5% of the maximum load that may be required. Poises shall be designed to be locked in any position to prevent unauthorized change of position. The Contractor may provide an approved automatic printer system which will print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching and mixing control system. Such weights shall be evidenced by a weigh ticket for each load. Scales shall be inspected and sealed as often as the Engineer may deem necessary to assure their continued accuracy, but not less than once every six (6) months.

2) Screens - Plant screens, capable of screening all aggregates to the specified sizes and proportions and having normal capacities in excess of the full capacity of the mixer, shall be provided. All screens shall be kept unclogged and free from rips and tears.

3) Hot Aggregate Bins - The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to assure separate and adequate storage of appropriate fractions of the heated mineral aggregates. Separate dry storage shall be provided for mineral filler when used and the plant shall be equipped to control the feed of such material into the mixer. Each bin shall be provided with overflow pipes of such size and at such location as to prevent backing up of material into other compartments or bins. Each compartment shall be provided with its individual outlet gate, constructed so that when closed there shall be no leakage. The gates shall cut off quickly and completely. Bins shall be so constructed that samples can be readily obtained.

4) Weight Box or Hopper - The equipment shall include a means for accurately weighing each size of aggregate in a weight box or hopper suspended on scales and of ample size to hold a full batch without hand raking or running over. The gate shall close tightly so that no material is allowed to leak into the mixer while a batch is being weighed.

5) Bituminous Control - The equipment used to measure the bituminous material shall be accurate to plus or minus (±)0.5%. The bituminous material bucket shall be a non-tilting type with a suitable cover. The length of the discharge opening or spray bar shall be not less than three-fourths (3/4) the length of the mixer and it shall discharge directly into the mixer. The bituminous material bucket, its discharge valve or valves and spray bar shall be adequately heated. Steam jackets, if used, shall be efficiently drained and all connections shall be so constructed that they will not interfere with the efficient operation of the bituminous scales. The capacity of the bituminous material bucket shall be at least fifteen percent (15%) in excess of the weight of bituminous material required in any batch. The plant shall have an adequately heated quick-acting, non-drip, charging valve located directly over the bituminous material bucket.

   The indicator dial shall have a capacity of at least fifteen percent (15%) in excess of the quantity of bituminous material used in a batch. The controls shall be constructed so that they may be fixed at any dial setting and will automatically reset to that reading after the addition of bituminous material to each batch. The dial shall be in full view of the mixer operator. The flow of bituminous material shall be automatically controlled so that it will begin when the dry mixing period is over. All of the bituminous material required for one batch shall be discharged in not more than fifteen (15) seconds after the flow has started. The size and spacing of the spray bar openings shall provide a uniform application of bituminous material the full length of the mixer. The section of the bituminous line between the charging valve and the spray bar shall be provided with a valve and outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

6) Mixer - The batch mixer shall be an approved type capable of producing a uniform mixture within the job mix tolerances. If not enclosed, the mixer box shall be equipped with a dust hood to prevent loss of dust.

   The clearance of the blades from all fixed and moving parts shall not exceed one inch (1”) unless the maximum diameter of aggregate in the mix exceeds one and one-fourth inches (1

¼"), in which case the clearance shall not exceed one and one-half inches (1 ½").

7) Control of Mixing Time - The mixer shall be equipped with an accurate time lock to control the operations of a complete mixing cycle. It shall lock the weight box gate after the charging of the mixer until the closing of the mixer gate at the completion of the cycle. It shall lock the bituminous material bucket throughout the dry mixing periods. The dry mixing period is defined as the interval of time between the opening of the weight box gate and the start of introduction of bituminous material. The wet mixing period is the interval of time between the start of introduction of bituminous material and the opening of the mixer gate.

   The control of the timing shall be flexible and capable of being set at intervals of five (5) seconds or less throughout a total cycle of up to three (3) minutes. A mechanical batch counter shall be installed as a part of the timing device and shall be so designed as to register only completely mixed batches.

   The setting of time intervals shall be performed in the presence of and at the direction of the Engineer.

D) Additional Requirements for Dryer Drum Mixing Plants

1) General - The basic requirements of this method of operation is to provide positive control of the bituminous material flow automatically coupled with the aggregate feed flow to maintain the required proportions to deliver a well-coated homogeneous mixture of asphaltic concrete at the prescribed temperature, gradation and asphalt content.

2) Aggregate Handling and Proportioning - The aggregate feeding system shall provide a means for accurately calibrating the material feed for each individual aggregate. A screening unit shall be placed between the aggregate cold feed bins and the drum mixer to remove oversized aggregate and roots, clay balls, etc.

   Moisture adjustments of the cold aggregate will be taken into consideration before the aggregate is weighed. The cold aggregate shall be weighed by use of a belt scale or other device, which will automatically regulate the bituminous feed and permit instant correction of variations in the load. A method and facilities shall be provided for obtaining representative samples of the combined mix of aggregate from the belt at any time during production operations.

3) Bituminous Control - The bituminous material shall be introduced through an indicating meter, which will accurately measure only the flow of that material. The asphalt pump shall be operated within the rated capacity of the manufacturer's recommendation.

   A pressure gauge shall be installed between the pump and the meter.

4) Interlocking Control - The aggregate feeding system shall be interlocked with the asphalt pump and shall be quick adjusting and shall maintain a constant and uniform flow throughout the range of its calibration.

   The interlocking control shall indicate a visual and/or an audible signal when the level of material on any one feeder approaches the strike off capacity of the feed gate or otherwise fails to feed the proper proportion of aggregate, or the pressure falls on the bituminous supply lines.

5) Drum Dryer Mixer - The drum dryer mixer shall be equipped with automatic burner controls and temperature sensing of the mixture at discharge.

6) Surge or Storage Bins - The drum mix plant shall be equipped with a surge bin or storage bin. If storage of the hot mix asphalt is required, the surge or storage bin shall be designed so that the characteristics of the mixture being stored or surged shall not be changed. All mixture delivered from a surge or storage bin shall meet the specifications for the mix being delivered.

E) Bituminous Pavers - Bituminous pavers shall be self-contained, power propelled machines,

provided with an activated, heated screed, with an approved automatic control device for laying the mix to the specified slope, grade, and crown. The screed shall effectively produce a finished surface of the required evenness and uniform texture without tearing, shoving, or gouging the mixture uniformly in front of the screed.

Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of asphalt mixture in widths shown on the plans.

Motor graders equipped with a blade of not less than twelve (12) feet, and a wheelbase of not less than sixteen (16) feet, tight and in good operating condition may be used for spreading leveling courses.

F) Compacting Equipment - Compacting equipment shall be designed to produce the pavement density and surface smoothness herein specified, and shall be maintained in first-class operating condition.

301.04 – CONSTRUCTION METHODS

A) Preparation of Asphaltic Cement - The asphaltic cement shall be heated at the paving plant to a temperature of three hundred degrees F (300°F) to three hundred fifty degrees F (350°F).

B) Preparation of Mineral Aggregates - The mineral aggregates shall be dried and heated at the paving plant so that when delivered to the mixer they shall be at as low a temperature as is consistent with proper mixing and laying, and in no case to exceed three hundred twenty-five degrees F (325°F). Aggregates may be fed simultaneously into the same drier but in such case, immediately after heating, they shall be screened into the bin sizes specified. Oversize material, crushed after passing through the drier shall not be incorporated into the mixer without again being heated and dried.

C) Preparation of Bituminous Mixture - The hot aggregate prepared as prescribed above shall be accurately measured and conveyed into a mixer in the proportionate amounts of each aggregate required to meet the specified grading.

The mixture shall be made by first charging the mixer with the mineral aggregate and filler and mixing these dry for a period of from five (5) to twenty (20) seconds after which the asphaltic cement shall be added and the mixing continued for a period of not less than thirty (30) seconds, or longer, if necessary to produce a homogeneous mixture in which all particles of the mineral aggregate are uniformly coated.

D) Loading and Transportation of Mixture - The mixture shall be transported from the mixing plant to the work in tight vehicles with metal bottom previously cleaned of all foreign materials. When directed by the Engineer the vehicles shall be suitably insulated and each load shall be covered with canvas or other suitable material of sufficient size to protect it from weather conditions. The inside surface of all vehicles used for hauling mixtures may be lightly lubricated with a truck bed release agent just before loading, but excess of lubricant will not be permitted. No loads shall be sent out so late in the day as to interfere with spreading and compacting the mixture during daylight unless artificial light satisfactory to the Engineer is provided.

E) Tack Coat - Before the asphaltic mixture is laid, the surface upon which it is to be placed shall be cleaned thoroughly to the satisfaction of the Engineer, and if indicated on the plans, shall be given a uniform tack coat application with asphalt of the type shown herein. This tack coat shall be applied, as directed by the Engineer, with an approved sprayer at the rate of not to exceed 0.10 gallon per square yard of surface. All contact surfaces of curbs and gutters, manholes and other structures shall be painted with a thin uniform coat of asphaltic material used for the tack coat or in case no tack coat is shown on the plans, curbs and other structures shall be painted with a thin uniform coating of emulsified asphalt.

F) Placing Asphaltic Mixture - The asphaltic mixture shall be laid at a temperature from two hundred sixty degrees F (260°F) to three hundred degrees F (300°F) and only upon an approved base which

is dry. The mixture shall be delivered on the job at a minimum workable temperature which will produce the density herein specified after final compaction.

When existing paving is to be resurfaced to a crown section not conforming to that of the original paving, the asphaltic concrete leveling course shall be placed in lifts beginning at the point on the existing slab requiring the greatest addition of material and by the addition of successive lifts of material, gradually shaping the crown to conform to that required in the finished slab. The last increment of material shall consist of a uniform thickness of an asphaltic concrete wearing surface.

When the asphaltic mixture is placed in a narrow strip along the edge of an existing pavement, or used to level up small areas of an existing pavement, or placed in small irregular areas where the use of a finishing machine is not practical, the finishing machine may be eliminated, when authorized by the Engineer, provided a satisfactory surface can be obtained by other approved methods.

Immediately after any course is screeded, and before compaction is started, the surface shall be checked, and any inequalities adjusted, all fat sandy accumulation from the screen removed by a lute, and all fat spots in any course removed and replaced with satisfactory material. Irregularities in alignment and grade along the outside edge shall also be corrected by the addition or removal of mixture before the edge is compacted.

The mixture shall be distributed into place by means of shovel and lute in a loose layer of uniform density and correct depth. Shovelers and rakers shall work skillfully together so that the finished product will require a minimum amount of rework after the first compactive effort.

Placing of mixture shall be as continuous as possible and the roller shall pass over the unprotected edge of the fresh laid mixture only when the laying of this course is to be discontinued for such length of time as to permit the mixture to become chilled.

Thickness of compacted course shall be as specified in the plans, not greater than six inches (6”) in depth. Thickness will be reduced by the Engineer, if the required densities cannot be obtained.

Forms will not be required when the finishing machine is of such type as not to require forms for grade control. When forms are required they shall have a thickness equal to the compacted surface course and shall remain in place until final surface finishing, other than rolling, has been completed.

In placing a level-up course with the spreading and finishing machine, the forms, binder twine or cord, shall be set to line and grade established by the Engineer. When directed by the Engineer, level-up shall be spread with an approved motor patrol grader.

Fillets, spandrels and other large areas which cannot be laid with a machine shall be placed in accordance with Section W-IV, "Fillets, Spandrels and other Large Hand Worked Areas", in the Asphaltic Concrete Paving Manual.

G) Joints - Longitudinal and transverse joints shall be made in such a manner that a smooth, strong, neat union is obtained, between the respective lanes or lane ends. They shall be made by the methods and procedures outlined in Section W-III, "Joints" of the Asphalt Paving Manual or some other method acceptable to the Engineer. Longitudinal joints shall conform to the tolerances defined in Section W-III 1-a (3) or Section W-III b (3) "Alignment", of the manual.

Transverse or longitudinal joints accumulating mud, dust, or foreign matter shall be trimmed back to the satisfaction of the Engineer so that a proper bond of asphaltic concrete will be obtained. Longitudinal joints with an undue dust film shall be tacked with an approved tack coat before the adjoining lane is placed.

Joints with PC Concrete such as curbs, gutters, and pavements shall be made to conform to Section W-III, "Asphaltic Concrete to Portland Cement Joints" in the Asphaltic Concrete Paving Manual. Joints with manholes, valve boxes and inlet grates shall be made to conform to sections

as shown on the sheet of details.

H) Compaction - Rolling shall be done in such a manner that a surface will be obtained meeting the tolerance for smoothness and density requirements specified and all roller marks shall be eliminated.

The target density for compaction shall be 94 percent of the maximum theoretical density shown on the latest laboratory mix design report for the percent asphalt content recommended except in situations as described below. Tests to establish the maximum theoretical density of the plant mixture shall be performed as often as necessary to ensure an accurate value is used in the calculation of roadway density.

The average roadway density shall be not less than the target density. Individual roadway densities more than two percent (2%) below the target densities will not be accepted. It is the intent that the contractor achieve uniform compaction at or above the target density. The difference from the high to low percent density tested shall not exceed four percent (4%).

When Type B, M or D asphalt concrete is placed on an existing surface that has not received full-width milling, in a plan thickness of 2" or less, the average target density shall be ninety-three percent (93%) of maximum theoretical density.

When the existing surface has been milled full-width, or if a leveling course has been placed prior to the overlay, the average target density shall be ninety-four (94) percent of maximum theoretical density, (Type B, M or D).

In the interest of appearance and practicality, non-destructive tests on the pavement may be required by the Engineer for resurface courses.

In order to aid the Contractor in achieving the foregoing requirements for compaction, Section W-V, "General Rolling Operations" has been included in the Asphaltic Concrete Paving Manual, J. Rogers Martin being the author.

A self-propelled pneumatic roller may be required by the Engineer to obtain the specified density and surface texture.

I) Testing and Correcting Surface - The riding qualities of the finished surface shall be satisfactory to the Engineer. In case of dispute, the remaining provisions of the standard specifications shall apply.

For the purpose of testing the finished surface, a ten (10) foot straightedge shall be available on the work. Depressions which may develop after the first rolling shall be remedied by loosening the surface depressions not being noticeable until the final compaction has been made, the surface course shall be removed and sufficient new material laid to form a true even surface.

The finished pavement surface shall show no deviation from the general surface in excess of one-sixteenth inch (1/16”) per foot as measured in the following manner:

A ten (10) foot straightedge shall be placed parallel to the centerline of the roadway so as to bridge any depressions.

Ordinates measured from the face of the straightedge to the surface of the pavement shall not exceed one-sixteenth inch (1/16”) for each foot in distance from the nearest point of contact with a maximum permissible variation of three-sixteenths inch (3/16”).

Such portions of the completed pavement as are defective in finish, density, or composition, or that do not comply in all respects with the requirements of these specifications shall be taken up, removed and replaced with suitable material properly laid in accordance with these specifications.

Prior to the acceptance of the pavement, the pavement shall be flooded with a sufficient quantity of water to show if areas of ponding exist. All areas of ponding in excess of one-fourth inch (1/4”) in depth and any length of curb and gutter that ponds in excess of one-fourth inch (1/4”) in depth, shall

be removed and replaced by the Contractor and at the Contractor's expense.

The water may be applied by tank truck or with fire hose if a fire hydrant is available. The water shall be applied as directed by the Engineer and all expenses borne by the Contractor.

When it is necessary to remove and replace a section of curb and gutter any remaining portion of the curb and gutter adjacent to joints that is less than ten (10) feet in length shall also be removed and replaced by the Contractor and at the Contractor's expense.

J) Opening to Traffic - No traffic shall be permitted on the asphaltic concrete pavement until it has received its final rolling and cooled to a temperature of one-hundred fifty (150) degrees.

K) Returns, Driveways and Other Extremities - These areas shall be placed in accordance with Section W-VII, "Resurfacing at Returns, Driveways and other Extremities", of the Asphaltic Concrete Paving Manual.

301.05 – TESTING

301.05.01 – DESCRIPTION

It is the intent of these specifications that the pavement shall be constructed strictly in accordance with the thickness shown on the plans.

Where any pavement is found not so constructed, the following rules relative to core drilling pavement, replacement of the faulty pavement and adjustment of payment shall govern. All pavements shall be cored and measured for thickness before being accepted by the City as hereinafter provided.

All hot mix asphaltic pavements that will be maintained by the City will be tested according to the following section:

A) General: The asphaltic pavement base and surface coarse will be accepted by the engineer on a "Lot" by "Lot" base. A "Lot" is considered to be 2,000 tons or part thereof or one (1) day of plant production.

B) Acceptance Testing: The acceptance testing of a "Lot" will be performed by a qualified testing laboratory approved by the City.

C) Tests results reports: Tests reports will be mailed on a daily basis in duplicate to the following address:

Field Engineer
City of Oklahoma City
420 West Main, Suite 700
Oklahoma City, OK 73102

D) Asphaltic Concrete Mix Design: Asphaltic concrete mix design and initial job-mix formula are the responsibility of the contractor and shall be submitted to the City for approval by the engineer.

The mix design shall be prepared in a City approved laboratory. The mix design and the initial job-mix formula for the contractor should be within the limits of the City's specifications. A new mix design is required should the material source change or results with the job-mix formula prove unsatisfactory.

E) Sampling and Testing: Sampling and testing of the asphaltic concrete at the job site shall be in accordance with Table 301.05.01. In all cases, it is the responsibility of the contractor to notify the testing laboratory one (1) day in advance of the work that is to be performed. It is the responsibility of the contractor to prove the acceptability of a "Lot" that does not have the required testing. The City reserves the right to request the removal of "Lots" that do not have the required testing.

F) Acceptance: Acceptance of all asphaltic concrete lifts (new construction and overlays) 1 1/2 inches or greater in thickness will be based on density as specified in Section 301.05 F) 1). All lifts less

than 1 1/2 inches in thickness will be accepted on the basis of Section 301.01 4) 2).

1) All asphaltic concrete lifts 1 1/2 inches or greater thickness. The target density of each lot shall be 94 percent (unless specified otherwise by the Engineer) of the maximum Theoretical Specific Gravity at the Job Mix Formula asphalt content determined by the most recent specific gravity of the bituminous paving mixture in accordance with the AASHTO T 209. The roadway density of each lot will be the average of tests on three (3) separate specimens taken within the limits of the area represented by the lot. The locations and times of the test specimens collection shall be established by the engineer or his/her representative.

   The City appointed testing laboratory shall cut test specimens for each lot from the pavement by sawing or coring a specimen having a minimum size of four inches (4") on the cut side or diameter, not more than five (5) feet from the edge of travel way. The cost of cutting specimens and satisfactorily repairing the specimens area shall be paid by the City or the contractor depending on the type of contract as specified in sub-section (g). Repairing the specimen area with asphalt will be the responsibility of the contractor. Density may be on the specimens or through use of nuclear density gauges. The use of a nuclear density gauge or testing on the specimens shall be at the discretion of the engineer.

   Acceptance and payment will be based on tests by the approved testing laboratory and the decision of the engineer. The minimum density of 92 percent and maximum density of 96 percent are the acceptable levels of density (unless otherwise specified by the Engineer).

2) All lifts less than 1 ½ inches in thickness. The acceptance of asphaltic concrete lifts that are less than 1 ½ inches will be at the discretion of the engineer.

G) Payment: The City will appoint an approved testing laboratory and will compensate the laboratory for the services rendered directly for projects that are contracted and paid for by the City. Compensation for the services rendered will be in accordance with the agreement between the City and the testing laboratory.

   The contractor shall retain the services of an approved testing laboratory and will compensate the testing laboratory directly for its services for projects that are not contracted and paid for by the City. Compensation for the services rendered will be based on the agreement between the contractor and the testing laboratory. However, the testing services rendered should meet the specifications and provision of the City.

TABLE 301.05.01
SCHEDULE OF TESTS FOR ACCEPTANCE OF PLANT MIX ASPHALT CONCRETE PAVEMENT

Asphalt Extraction And Gradation	1000 tons Asphalt Pavement
Roadway Density Of Asphalt Mix	4 Per 2000 Tons Asphalt Pavement or as directed by the City Engineer
Hveem Stability Test And Density Of Molded Specimen	1 Per 2000 Tons Asphalt Pavement
Maximum Theoretical Specific Gravity Of Asphalt Mix	1 Per 2000 Tons Asphalt Pavement

301.05.02 – CORE DRILLING PAVEMENT

All pavements shall be cored and measured for thickness at (minimum of three) such points as the Engineer may select in each lot of paving.

TABLE 301.05.02 – TOLERANCE IN PAVEMENT THICKNESS

GROUP	DEFICIENCY IN THICKNESS (PERCENT)	PENALTY IN PERCENT REDUCTION IN UNIT PRICE
A	0-5%	NONE
B	5-6%	5%
	6-7%	10%
	7-8%	15%

	8-9%	20%
	9-10%	25%
C	10-12.5%	50%
	12.5-15%	75%
D	>15%	NO PAYMENT

Should any core show a deficiency of more than 0.25 inches check cores shall be taken each way in the lane so deficient, as directed by the Engineer, until the thickness of the pavement is not more than 0.25 inch deficient. The average thickness of the deficient cores shall determine the percent of penalty that shall be used to calculate the reduction in unit price for each square yard so deficient.

All costs in connection with core drilling the pavement and refilling the core holes shall be borne by the Contractor. Core holes shall be filled in an acceptable manner with material matching the pavement from which the cores were cut. The coring of the pavement shall be performed by a City approved testing lab.

For pavement slab, the average thickness of which, determined as hereinafter provided, is within 0.25 inch, of the thickness required on the plans, the contract unit price offered shall be used in payment.

For pavement slab, the average thickness of which determined as hereinafter provided, is less than the thickness shown on the plans by more than 0.25 inch, but less than 0.75 inch, an adjusted unit price shown in Table 301.05.02 will be used in payment.

No additional payment over the contract unit price will be made for any slab the average thickness of which, determined as hereinafter provided, exceeds the thickness shown on the plans.

The thickness of the slab will be determined by average of 9-point gage jig measurement of the thickness of adjacent cores, and the average thickness determined from each pair of adjacent cores shall apply to the length of lane between those cores. The last deficient core and the first core of satisfactory thickness shall be averaged to determine what deduction in payment will be made from the length of lane laying between them. In calculating the average thickness of the slab, the Engineer shall make a decision on the pavement measurements that are in excess of the thickness specified on the plans.

If, in the opinion of the Engineer, a deficiency in slab thickness of 0.75" or more is sufficient to impair seriously the service expected from the pavement, the Contractor will be required to remove the deficient area and to replace it with slab of a satisfactory quality and thickness. The Contractor will receive no compensation for materials or labor involved in the removal and replacement of the defective slab. If, on the other hand, in the opinion of the Engineer, there is no probability of immediate failure, he may allow the Contractor the choice of leaving the defective slab in place and receiving no compensation or payment for same, or of removing and replacing the pavement as provided.

If the Contractor believes that the cores and measurements taken are not sufficient to indicate fairly the actual thickness of pavement, he may request that additional cores and measurements be taken. The cost of additional cores and measurements will be paid by the Contractor. Cores will not be spaced closer than ten (10) feet.

Deductions for deficient thickness may be entered on any estimate after the information becomes available. No pavement shall be accepted for payment until it has been cored and provisions of Section 301 have been adhered to.

301.06 – METHOD OF MEASUREMENT

Asphaltic concrete may be measured by the square yard of surface area of specified thickness or by the ton (2000 lbs.) of mixture accepted in place. Asphaltic concrete leveling course shall be measured by the ton (2000 lbs.) of material accepted in place. Tack coat will be measured by the gallon at the temperature applied.

301.07 – BASIS OF PAYMENT

The various items measured as provided above will be paid for at the contract unit price bid:

ASPHALTIC CONCRETE TYPE (A – E) (X INCHES)	S.Y.
ASPHALTIC CONCRETE TYPE (A – E)	TON
ASPHALT CONCRETE, TYPE (A – E) (POL. MOD.)	TON
ASPHALTIC CONCRETE LEVELING COURSE	TON

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 302 – RECYCLED HOT-MIX ASPHALT CONCRETE (RHM – ASPHALT CONCRETE)

302.01 – DESCRIPTION

This section covers the construction of asphaltic concrete using a combination of salvaged bituminous material and virgin material.

302.02 – MATERIALS

The bituminous mixture shall comply with the requirements of Section 931.

Salvaged materials shall be sized to pass a two inch (2") sieve.

Liquid asphalt will meet the requirements of Section 931 with the Viscosity Grade to be established by the mix design. Commercial softening agents must be approved by the Engineer and only after they have been tested for premature hardening with the salvaged and virgin materials to be used on this project.

All virgin aggregates shall meet the requirements of Section 931.

A maximum of 25 percent salvaged bituminous material by weight may be used in all bituminous mixtures. All salvaged bituminous material shall be assumed to contain 30 percent natural sand for mix design purposes.

302.03 – EQUIPMENT

Mixing shall be performed in either a batch plant or a dryer drum plant in accordance with Section 301.05, modified as required to facilitate recycling operations in conformance with current air pollution standards. Mixing shall continue until homogeneity and a uniform coating can be achieved.

302.04 – CONSTRUCTION METHODS

A) Preparation of Asphaltic Cement - The asphaltic cement shall be heated at the paving plant to a temperature of two hundred seventy-five degrees F (275°F) to three hundred twenty-five degrees F (325°F).

B) Preparation of Mineral Aggregates - The mineral aggregates shall be dried and heated at the paving plant so that when delivered to the mixer they shall be at as low a temperature as is consistent with proper mixing and laying, and in no case to exceed three hundred twenty-five degrees F (325°F). Aggregates may be fed simultaneously into the same drier but in such case, immediately after heating, they shall be screened into the bin sizes specified. Oversize material, crushed after passing through the drier shall not be incorporated into the mixer without again being heated and dried.

L) Preparation of Bituminous Mixture - The hot aggregate prepared as prescribed above shall be accurately measured and conveyed into a mixer in the proportionate amounts of each aggregate required to meet the specified grading.

The mixture shall be made by first charging the mixer with the mineral aggregate and filler and mixing these dry for a period of from five (5) to twenty (20) seconds after which the asphaltic

cement shall be added and the mixing continued for a period of not less than thirty (30) seconds, or longer, if necessary to produce a homogeneous mixture in which all particles of the mineral aggregate are uniformly coated.

M) Loading and Transportation of Mixture - The mixture shall be transported from the paving plant to the work in tight vehicles with metal bottom previously cleaned of all foreign materials. When directed by the Engineer the vehicles shall be suitably insulated and each load shall be covered with canvas or other suitable material of sufficient size to protect it from weather conditions. The inside surface of all vehicles used for hauling mixtures may be lightly lubricated with a thin oil or soap solution just before loading, but excess of lubricant will not be permitted. No loads shall be sent out so late in the day as to interfere with spreading and compacting the mixture during daylight unless artificial light satisfactory to the Engineer is provided.

N) Tack Coat - Before the asphaltic mixture is laid, the surface upon which it is to be placed shall be cleaned thoroughly to the satisfaction of the Engineer, and if indicated on the plans, shall be given a uniform tack coat application with asphalt of the type shown herein. This tack coat shall be applied, as directed by the Engineer, with an approved sprayer at the rate of not to exceed 0.10 gallon per square yard of surface. All contact surfaces of curbs and gutters, manholes and other structures shall be painted with a thin uniform coat of asphaltic material used for the tack coat or in case no tack coat is shown on the plans, curbs and other structures shall be painted with a thin uniform coating of emulsified asphalt.

O) Placing Asphaltic Mixture - The asphaltic mixture shall be laid at a temperature from two hundred twenty-five degrees F (225°F) to three hundred degrees F (300°F) and only upon an approved base which is dry. The mixture shall be delivered on the job at a minimum workable temperature that will produce the density herein specified after final compaction.

When existing paving is to be resurfaced to a crown section not conforming to that of the original paving, the asphaltic concrete leveling course shall be placed in lifts beginning at the point on the existing slab requiring the greatest addition of material and by the addition of successive lifts of material, gradually shaping the crown to conform to that required in the finished slab. The last increment of material shall consist of a uniform thickness of an asphaltic concrete wearing surface.

When the asphaltic mixture is placed in a narrow strip along the edge of an existing pavement, or used to level up small areas of an existing pavement, or placed in small irregular areas where the use of a finishing machine is not practical, the finishing machine may be eliminated, when authorized by the Engineer, provided a satisfactory surface can be obtained by other approved methods.

Immediately after any course is screeded, and before compaction is started, the surface shall be checked, and any inequalities adjusted, all fat sandy accumulation from the screen removed by a lute, and all fat spots in any course removed and replaced with satisfactory material. Irregularities in alignment and grade along the outside edge shall also be corrected by the addition or removal of mixture before the edge is compacted.

The mixture shall be distributed into place by means of shovel and lute in a loose layer of uniform density and correct depth. Shovelers and rakers shall work skillfully together so that the finished product will require a minimum amount of rework after the first compactive effort.

Placing of mixture shall be as continuous as possible and the roller shall pass over the unprotected edge of the fresh laid mixture only when the laying of this course is to be discontinued for such length of time as to permit the mixture to become chilled.

Thickness of compacted course shall be not more than eight inches (8”) in depth. Thickness will be reduced by the Engineer, if the required densities cannot be obtained.

Forms will not be required when the finishing machine is of such type as not to require forms for grade control. When forms are required they shall have a thickness equal to the compacted

surface course and shall remain in place until final surface finishing, other than rolling, has been completed.

In placing a level-up course with the spreading and finishing machine, the forms, binder twine or cord, shall be set to line and grade established by the Engineer. When directed by the Engineer, level-up shall be spread with an approved motor patrol grader.

Fillets, spandrels and other large areas which cannot be laid with a machine shall be placed in accordance with Section W-IV, "Fillets, Spandrels and other Large Handworked Areas", in the Asphaltic Concrete Paving Manual.

P) Joints - Longitudinal and transverse joints shall be made in such a manner that a smooth, strong, neat union is obtained, between the respective lanes or lane ends. They shall be made by the methods and procedures outlined in Section W-III, "Joints" of the Asphalt Paving Manual or some other method acceptable to the Engineer. Longitudinal joints shall conform to the tolerances defined in Section W-III 1-a (3) or Section W-III b (3) "Alignment", of the manual.

Transverse or longitudinal joints accumulating mud, dust, or foreign matter shall be trimmed back to the satisfaction of the Engineer so that a proper bond of asphaltic concrete will be obtained. Longitudinal joints with an undue dust film shall be tacked with an approved tack coat before the adjoining lane is placed.

Joints with PC Concrete such as curbs, gutters, and pavements shall be made to conform to Section W-III, "Asphaltic Concrete to Portland Cement Joints" in the Asphaltic Concrete Paving Manual. Joints with manholes, valve boxes and inlet grates shall be made to conform to sections as shown on the sheet of details.

Q) Compaction - Rolling shall be done in such a manner that a surface will be obtained meeting the tolerance for smoothness and density requirements specified and all roller marks shall be eliminated.

The target density for compaction shall be 94 percent of the maximum theoretical density shown on the latest laboratory mix design report for the percent asphalt content recommended except in situations as described below. Tests to establish the maximum theoretical density of the plant mixture shall be performed as often as necessary to ensure an accurate value is used in the calculation of roadway density.

The average roadway density shall be not less than the target density.

Individual roadway densities more than two percent (2%) below the target densities will not be accepted. It is the intent that the contractor achieve uniform compaction at or above the target density. The difference from the high to low percent density tested shall not exceed four percent (4%).

When Type B, M or D asphalt concrete is placed on an existing surface that has not received full-width milling, in a plan thickness of 2" or less, the average target density shall be ninety-three percent (93%) of maximum theoretical density.

When the existing surface has been milled full-width, or if a leveling course has been placed prior to the overlay, the average target density shall be ninety-four (94) percent of maximum theoretical density, (Type B, M or D).

When Type E asphalt concrete is placed, the <u>minimum</u> density shall be ninety-one (91) percent of maximum theoretical density.

In the interest of appearance and practicality, density tests on the pavement may be waived by the Engineer for resurface courses.

In order to aid the Contractor in achieving the foregoing requirements for compaction, Section W-V, "General Rolling Operations" has been included in the Asphaltic Concrete Paving Manual, J.

Rogers Martin being the author.

A self-propelled pneumatic roller may be required by the Engineer to obtain the specified density and surface texture.

R) Testing and Correcting Surface - The riding qualities of the finished surface shall be satisfactory to the Engineer. In case of dispute, the remaining provisions of the standard specifications shall apply.

For the purpose of testing the finished surface, a ten (10) foot straightedge shall be available on the work. Depressions which may develop after the first rolling shall be remedied by loosening the surface depressions not being noticeable until the final compaction has been made, the surface course shall be removed and sufficient new material laid to form a true even surface.

The finished pavement surface shall show no deviation from the general surface in excess of one-sixteenth inch (1/16") per foot as measured in the following manner:

A ten (10) foot straightedge shall be placed parallel to the centerline of the roadway so as to bridge any depressions.

Ordinates measured from the face of the straightedge to the surface of the pavement shall not exceed one-sixteenth inch (1/16") for each foot in distance from the nearest point of contact with a maximum permissible variation of three-sixteenths inch (3/16").

Such portions of the completed pavement as are defective in finish, density, or composition, or that do not comply in all respects with the requirements of these specifications shall be taken up, removed and replaced with suitable material properly laid in accordance with these specifications.

Prior to the acceptance of the pavement, the pavement shall be flooded with a sufficient quantity of water to show if areas of ponding exist. All areas of ponding in excess of one-fourth inch (1/4") in depth and any length of curb and gutter that ponds in excess of one-fourth inch (1/4") in depth shall be removed and replaced by the Contractor and at the Contractor's expense.

The water may be applied by tank truck or with fire hose if a fire hydrant is available. The water shall be applied as directed by the Engineer and all expenses borne by the Contractor.

When it is necessary to remove and replace a section of curb and gutter any remaining portion of the curb and gutter adjacent to joints that is less than ten (10) feet in length shall also be removed and replaced by the Contractor and at the Contractor's expense.

S) Opening to Traffic - No traffic shall be permitted on the asphaltic concrete pavement until it has received its final rolling.

Returns, Driveways and Other Extremities - These areas shall be placed in accordance with Section W-VII, "Resurfacing at Returns, Driveways and other Extremities", of the Asphaltic Concrete Paving Manual.

302.05 – TESTING

302.05.01 – DESCRIPTION

It is the intent of these specifications that the pavement shall be constructed strictly in accordance with the thickness shown on the plans.

Where any pavement is found not so constructed, the following rules relative to core drilling pavement, replacement of the faulty pavement and adjustment of payment shall govern. All pavements shall be cored and measured for thickness before being accepted by the City as hereinafter provided.

All hot mix asphaltic pavements that will be maintained by the City will be tested according to the following section:

A) General: The asphaltic pavement base and surface coarse will be accepted by the engineer on a

"Lot" by "Lot" base. A "Lot" is considered to be 2,000 tons or part thereof or one (1) day of plant production.

B) Acceptance Testing: The acceptance testing of a "Lot" will be performed by a qualified testing laboratory approved by the City.

C) Tests results reports: Tests reports will be mailed on a daily basis in duplicate to the following address:

Field Engineer
City of Oklahoma City
420 West Main, Suite 700
Oklahoma City, OK 73102

D) Asphaltic Concrete Mix Design: Asphaltic concrete mix design and initial job-mix formula are the responsibility of the contractor and shall be submitted to the City for approval by the engineer.

The mix design shall be prepared in a City approved laboratory. The mix design and the initial job-mix formula for the contractor should be within the limits of the City's specifications. A new mix design is required should the material source change or results with the job-mix formula prove unsatisfactory.

E) Sampling and Testing: Sampling and testing of the asphaltic concrete at the job site shall be in accordance with Table 301.05.01. In all cases, it is the responsibility of the contractor to notify the testing laboratory one (1) day in advance of the work that is to be performed. It is the responsibility of the contractor to prove the acceptability of a "Lot" that does not have the required testing. The City reserves the right to request the removal of "Lots" that do not have the required testing.

F) Acceptance: Acceptance of all asphaltic concrete lifts (new construction and overlays) 1 1/2 inches or greater in thickness will be based on density as specified in Section 301.05 F) 1). All lifts less than 1 1/2 inches in thickness will be accepted on the basis of Section 301.01 F) 2).

1) All asphaltic concrete lifts 1 1/2 inches or greater thickness. The target density of each lot shall be 94 percent (unless specified otherwise by the Engineer) of the maximum Theoretical Specific Gravity at the Job Mix Formula asphalt content determined by the most recent specific gravity of the bituminous paving mixture in accordance with the AASHTO T 209. The roadway density of each lot will be the average of tests on three (3) separate specimens taken within the limits of the area represented by the lot. The locations and times of the test specimens collection shall be established by the engineer or his/her representative.

   The approved testing laboratory shall cut test specimens for each lot from the pavement by sawing or coring a specimen having a minimum size of four (4) inches on the cut side or diameter. The cost of cutting specimens and satisfactorily repairing the specimens area shall be paid by the City or the contractor depending on the type of contract as specified in sub-section (g). Repairing the specimen area with asphalt will be the responsibility of the contractor. Density may be on the specimens or through use of nuclear density gauges. The use of a nuclear density gauge or testing on the specimens shall be at the discretion of the engineer.

   Acceptance and payment will be based on tests by the approved testing laboratory and the decision of the engineer. The minimum density of 92 percent and maximum density of 96 percent are the acceptable levels of density (unless otherwise specified by the Engineer).

2) All Lifts Less Than 1 1/2 Inches in Thickness. The acceptance of asphaltic concrete lifts that are less than 1 1/2 will be at the discretion of the engineer.

G) Payment: The City will appoint an approved testing laboratory and will compensate the laboratory for the services rendered directly for projects that are contracted and paid for by the City. Compensation for the services rendered will be in accordance with the agreement between the City and the testing laboratory.

The contractor shall retain the services of an approved testing laboratory and will compensate the testing laboratory directly for its services for projects that are not contracted and paid for by the City. Compensation for the services rendered will be based on the agreement between the contractor and the testing laboratory. However, the testing services rendered should meet the specifications and provision of the City.

TABLE 302.05.01 – SCHEDULE OF TESTS FOR ACCEPTANCE OF RECYCLED HOT-MIX ASPHALT CONCRETE PAVEMENT.

Asphalt Extraction And Gradation	1000 tons Asphalt Pavement
Roadway Density Of Asphalt Mix	4 Per 2000 Tons Asphalt Pavement or as directed by the City Engineer
Hveem Stability Test And Density Of Molded Specimen	1 Per 2000 Tons Asphalt Pavement
Maximum Theoretical Specific Gravity Of Asphalt Mix	1 Per 2000 Tons Asphalt Pavement

301.05.02 – CORE DRILLING PAVEMENT

All pavements shall be cored and measured for thickness at (minimum of three) such points as the Engineer may select in each lot of paving.

TABLE 302.05.02 – TOLERANCE IN PAVEMENT THICKNESS

GROUP	DEFICIENCY IN THICKNESS (INCHES IN DECIMALS)	PENALTY IN PERCENT
		REDUCTION IN UNIT PRICE
A	0.00” TO 0.25”	NONE
B	0.26” TO 0.30”	5%
	0.31” TO 0.35”	10%
	0.36” TO 0.40”	15%
	0.41” TO 0.45”	20%
	0.46” TO 0.50”	25%
C	0.51” TO 0.55”	60%
	0.56” TO 0.60”	70%
	0.61” TO 0.70”	80%
	0.71” TO 0.75”	90%
D	OVER 0.75”	NO PAYMENT

Should any core show a deficiency of more than 0.25 inches check cores shall be taken each way in the lane so deficient, as directed by the Engineer, until the thickness of the pavement is not more than 0.25 inch deficient. The average thickness of the deficient cores shall determine the percent of penalty that shall be used to calculate the reduction in unit price for each square yard so deficient.

All costs in connection with core drilling the pavement and refilling the core holes shall be borne by the Contractor. Core holes shall be filled in an acceptable manner with material matching the pavement from which the cores were cut. The coring of the pavement shall be performed by a City approved testing lab.

For pavement slab, the average thickness of which, determined as hereinafter provided, is within 0.25 inch, of the thickness required on the plans, the contract unit price offered shall be used in payment.

For pavement slab, the average thickness of which determined as hereinafter provided, is less than the thickness shown on the plans by more than 0.25 inch, but less than 0.75 inch, an adjusted unit price shown in Table 302.05.02 will be used in payment.

No additional payment over the contract unit price will be made for any slab the average thickness of which, determined as hereinafter provided, exceeds the thickness shown on the plans.

The thickness of the slab will be determined by average of 9 point gage jig measurement of the thickness of adjacent cores, and the average thickness determined from each pair of adjacent cores shall apply to the length of lane between those cores. The last deficient core and the first core of satisfactory thickness shall be averaged to determine what deduction in payment will be made from the length of lane laying between them. In calculating the average thickness of the slab, the Engineer shall make a decision on the pavement measurements that are in excess of the thickness specified on the plans.

If, in the opinion of the Engineer, a deficiency in slab thickness of 0.75" or more is sufficient to impair seriously the service expected from the pavement, the Contractor will be required to remove the deficient area and to replace it with slab of a satisfactory quality and thickness. The Contractor will receive no compensation for materials or labor involved in the removal and replacement of the defective slab. If, on the other hand, in the opinion of the Engineer, there is no probability of immediate failure, he may allow the Contractor the choice of leaving the defective slab in place and receiving no compensation or payment for same, or of removing and replacing the pavement as provided.

If the Contractor believes that the cores and measurements taken are not sufficient to indicate fairly the actual thickness of pavement, he may request that additional cores and measurements be taken. The cost of additional cores and measurements will be paid by the Contractor. Cores will not be spaced closer than ten (10) feet.

Deductions for deficient thickness may be entered on any estimate after the information becomes available. No pavement shall be accepted for payment until it has been cored and provisions of Section 301 have been adhered to.

302.06 – METHOD OF MEASUREMENT

Asphaltic concrete may be measured by the square yard of surface area of specified thickness or by the ton (2000 lbs.) of mixture accepted in place.

Asphaltic concrete leveling course shall be measured by the ton (2000 lbs.) of material accepted in place.

Tack coat will be measured by the gallon at the temperature applied.

302.07 – BASIS OF PAYMENT

The various items measured as provided above will be paid for at the contract unit price bid

RHM - ASPHALTIC CONCRETE TYPE (A – E) (X INCHES)	S.Y.
RHM - ASPHALTIC CONCRETE TYPE (A – E)	TON
RHM - ASPHALT CONCRETE, TYPE (A – E) (POL. MOD.)	TON
RHM - ASPHALTIC CONCRETE LEVELING COURSE	TON

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 303 – MICRO SURFACING

303.01 – DESCRIPTION.

This work shall consist of the application of micro surfacing material to an existing pavement surface in lifts 1 inch (25 mm) thick or less. The micro surfacing shall be a mixture of polymer-modified emulsified asphalt, mineral aggregate, mineral filler, water, and other additives—all properly proportioned, mixed, and spread on the surface in accordance with the plans and specifications.

303.02 – MATERIALS.

Materials shall meet the requirements of Section 931

303.03 – EQUIPMENT.

The material shall be mixed by a self-propelled Micro Surfacing machine which shall be a continuous-flow mixing unit; this unit shall accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler, and water to a revolving multi-blade mixer, and then discharge the thoroughly-mixed product on a continuous-flow basis. The machine shall have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler, and water to maintain an adequate supply to the proportioning devices. The machine shall also be equipped with self-loading devices which provide for the loading of all materials while continuing to lay Micro Surfacing, thereby eliminating unnecessary construction joints. The machine shall be equipped with opposite side driving stations to optimize longitudinal alignment. The machine shall be equipped to allow the mix operator to have full hydrostatic control of the forward and reverse speed during application of the micro surfacing material. The self-loading devices, opposite side driving stations, and forward and reverse speed controls shall be the original, manufacturer-designed equipment. Provide individual volume or weight controls for proportioning each material to be added to the mix. Calibrate and properly mark each material control device. The aggregate feed to the mixer shall be equipped with a revolution counter or similar device so the amount of aggregate used may be determined at any time. The emulsion pump shall be the positive displacement type and shall be equipped with a revolution counter or similar device so that the amount of emulsion used may be determined at any time. The mixing machine shall be equipped with a water pressure system and nozzle type spray bar to provide a water spray immediately ahead of and outside the spreader box. It shall also be equipped with an approved feeder that will provide a uniform, positive, accurately metered, predetermined amount of the specified mineral filler at the same time and location that the aggregate is fed. When construction is being performed under traffic, all equipment, including loading vehicles and supply trucks, will be required to operate in a single lane on which micro surfacing is being applied. The Contractor' s equipment for Micro Surfacing shall be operated in such a manner which will permit traffic to move safely and expeditiously through and around the work area. If the mineral aggregates are stored or stockpiled, handle them in such a manner as to prevent segregation, mixing of the various materials or sizes, and contamination with foreign materials. The grading of aggregates proposed for use and as supplied to the mixing plant shall be uniform. Furnish suitable equipment of acceptable size to work the stockpiles and prevent segregation of the aggregates. Screen and weigh the mineral aggregate at the stockpile prior to jobsite delivery. Screens and scales shall be approved by the Engineer. Keep all equipment used in the storage and handling of asphaltic material in a clean condition at all times, and operate it in such a manner that there will be no contamination with foreign matter.

303.04 – CONSTRUCTION METHODS.

1) **Weather Limitations.** Spread the material only when the atmospheric temperature is at least 50°F (10° C) or above in the shade and 4 feet (1.2 m) above the ground away from any artificial heat source, and the weather is not foggy or rainy.

2) S**urface Preparation.** Thoroughly clean area to be Micro Surfaced of all vegetation, loose aggregate, and soil. Apply water used in pre-wetting the surface at a rate to dampen the entire surface without any free-flowing water ahead of the spreader box.

3) **Test Panel.** Prior to the application of the micro surfacing mixture, place a test panel, at a location established by the Engineer, to demonstrate the compatibility of the modified emulsion and the mineral aggregate under field conditions. This test panel shall also be used to demonstrate the following:

   a) Mix uniformity; compliance of the mix to the requirements for proportioning the asphalt, mineral filler, and mineral aggregate; and adequate compliance with performance requirements for set, cure, stability, and conformance to the typical section. From this test panel, it will be determined

by the Engineer whether or not the mix is acceptable.

4) **Leveling Course.** When designated on the Plans or in the Contract or deemed necessary by the Engineer, apply a leveling course. Adequately cure the leveling course as approved by the Engineer before the final surface course is placed. At the direction of the Engineer, before the final surface course is placed, preliminary micro surfacing material may be required to fill ruts, utility cuts, depressions in the existing surface, etc. Ruts may be filled independently with a rut filling spreader box either 5 or 6 feet (1.5 or 1.8 m) in width to fill the rut or with a full-width scratch coat pass as directed by the Engineer.

5) **Spreading.** Spread the Micro Surfacing mixture uniformly by means of a mechanical-type squeegee box, equipped with augers to spread the materials uniformly throughout the box. Flexible seals shall be in contact with the road to prevent loss of mixture from the box. The rear flexible seal shall act as a strike-off and shall be adjustable. The spreader shall be maintained to prevent the loss of the Micro Surfacing product in surfacing super-elevated curves. The mixture shall be spread to fill all cracks and minor surface irregularities and leave a uniform application of fine aggregate and asphalt on the surface. The seam, where two spreads join, shall be neat appearing and uniform.

NOTE: If, in the opinion of the Engineer, the seam is rough enough to cause a noticeable effect on the steering of an automobile, the seam shall be removed and a new Micro Surfacing patch applied Patching shall be machine-applied patches with a full-width spreader box.

Operate the self-loading devices in such a manner as to eliminate unnecessary construction joints, and avoid overruns into the gutter. Remove all excess material from ends of each job site immediately.

6) **Curing and Maintaining Traffic.** Provide adequate means to protect the Micro Surfacing from damage by traffic until the mixture has cured sufficiently so that it will not adhere to or be picked up by the tires of vehicles.

NOTE: Any damage done by traffic to the Micro Surfacing shall be repaired by the Contractor and not measured for payment.

Suspend application of the surfacing materials early enough each day to permit traffic to safely travel over the completed work before dark. Work required or materials used in maintaining of traffic will not be paid for directly but shall be considered subsidiary to other items of work and shall be the responsibility of the Contractor.

303.06 – METHOD OF MEASUREMENT.

Mineral aggregate will be measured by the dry weight ton including mineral filler. *Polymer-Modified Emulsified asphalt* will be measured by the gallon (liter) or ton of residual asphalt cement.

303.07 – BASIS OF PAYMENT.

The accepted quantities, measured as provided above, shall be paid for at the contract unit price as follows:

EMULSIFIED ASPHALT	GALLON
EMULSIFIED ASPHALT	TON
TYPE I AGGREGATE	TON
TYPE II AGGREGATE	TON
TYPE III AGGREGATE	TON

Such payment shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

SECTION 304 – PORTLAND CEMENT CONCRETE PAVEMENT

304.01 – DESCRIPTION

This section covers the wearing course of Portland Cement Concrete constructed in one (1) course on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades, thickness and typical cross section shown on the plans.

304.02 – MATERIALS

All materials shall conform to the requirements specified in the special references, which are as follows:

Fly Ash	922
Portland Cement Concrete	932
Pre-molded Expansion Joint Filler	932
Hot Poured Sealing Filler	932
Cold Type Sealing Filler	932
Reinforcing Steel	941

304.03 – EQUIPMENT

The City Engineer shall approve design, capacity, and mechanical condition of equipment and tools necessary for handling materials and performing all parts of the work. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly and approved.

A) Batching Plant and Equipment

1) General - The batching plant shall include bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a bin, hopper, and separate scale for cement shall be included. The weighing hoppers shall be properly sealed and vented to preclude dusting during operation.

2) Bins and Hoppers - Bins with adequate separate compartments for fine aggregate and for each size of coarse aggregate shall be provided in the batching plant.

3) Scales - The scales for weighing aggregates and cement shall be of either the beam type or the springless dial type. They shall be accurate within 0.5% throughout the range of use. When beam-type scales are used, provision, such as a "tell-tale" dial, shall be made for indicating to the operator that the required load in the weighing hopper is being approached. A device on weighing beams shall indicate critical position clearly. Poises shall be designed to be locked in any position and to prevent unauthorized change. The weigh beam and "tell-tale" device shall be in full view of the operator while charging the hopper, and he shall have convenient access to all controls.

   Scales shall be inspected and sealed as often as the Engineer may deem necessary to assure their accuracy but not less than every six (6) months. The Contractor shall have on hand not less than ten (10) fifty (50) pound weights for frequent testing of all scales.

B) Automatic Batching Equipment - Automatic batching of aggregates and bulk cement will be permitted subject to satisfactorily proportioning aggregates and cement and compliance with the following conditions:

   The plant shall be maintained level to an accuracy necessary for the proper operation of the weighing mechanism. When necessary to check scales, any bins carrying suspended weighing equipment shall be duly loaded for not less than two (2) hours prior to any test of weighing equipment. This checking shall be done at times so as to minimize time lost in normal construction operations. The weighing mechanism shall be so constructed or shielded as to provide accurate operation during windy or other adverse weather conditions.

   At each plant stop, a single actuation of a starting device shall be the only manual operation

required to proportion the designated amount of each ingredient into the weight hopper or hoppers.

The automatic batching equipment shall be interlocked in such a manner that the charging mechanism of any weight hopper cannot be opened until the scale has returned to zero (0). When the discharge mechanism of the weight hopper has closed the discharge mechanism cannot be opened until all ingredients have been batched to their designated weights, within the specified tolerances; if separate aggregate components are weighed cumulatively in a single hopper, the aggregates will be weighed in the selected sequence.

The designated batch weight of bulk cement and of each separate aggregate component shall be preset at the direction of the Engineer before the batch cycle starts.

The automatic batching equipment shall be capable of conversion to manual operation if necessary.

C) Mixers

1) General - Concrete may be mixed at the site of construction or at a central point or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

   The mixer shall be equipped with a calibrated water measuring device so designed that the accuracy of measurement will not be affected by variations of pressure in the water supply line, and capable of accurately measuring the water to within one (1) percent of the amount of mixing water required.

2) Mixers at Site of Construction - Mixing shall be in an approved mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period, and of discharging and distributing the mixture without segregation on the prepared grade. The mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when the drum has been charged and release it at the end of the mixing period. The device shall be equipped with a bell or other suitable warning device adjusted to give a clearly audible signal each time the lock is released. In case of failure of the timing device, the mixer may be used for the balance of the day while it is being repaired, providing that each batch is mixed ninety (90) seconds.

3) Truck Mixers, Truck Agitators, and Non-Agitator Trucks - Vehicles used for mixing and hauling central-mixed concrete, shall conform to the requirements of AASHTO M-157, modified as follows:

   Permissible wear of blades shall be not more than one-sixth (1/6) of the original width of blades, according to the manufacturer's specification.

D) Finishing Equipment

1) Finishing Machine - The finishing machine shall be equipped with at least two (2) oscillating type transverse screeds or other approved method of striking off the concrete.

2) Vibrators - Vibrators, for full width vibration of concrete paving slabs, may be the internal type with either immersed tube or multiple spuds. Pan type vibrators, if used, shall be used in conjunction with internal type vibrators. They may be attached to the spreader or the finishing machine, or may be mounted on a separate carriage. They shall not come in contact with the joint, load transfer devices, subgrade, or side forms. The rated frequency of the surface vibrators shall not be less than thirty five hundred (3,500) impulses per minute. And the frequency of the internal type shall not be less than five thousand (5,000) impulses per minute for tube vibrators and not less than seven thousand (7,000) impulses per minute for spud vibrators.

   When spud type internal vibrators, either hand operated or attached to spreaders or finishing machines, are used adjacent to forms, they shall have a frequency of not less than

thirty five hundred (3,500) impulses per minute.

3) Transverse Grooving Machine - When specified, the transverse grooving machine shall be either a vibrating roller or a comb equipped with steel tines. The machine shall be self-propelled and shall automatically lift the roller or tine comb bar near the edge of the pavement to minimize edge damage. Hand grooving methods will be permitted in a manner approved by the Engineer in those areas where the mechanical equipment cannot be used.

E) Concrete Saw - When sawing joints is elected or specified, the Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions and at the required rate. The Contractor shall provide at least one standby saw in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operations. The Contractor shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and continuously during concrete placement.

F) Forms - The side forms shall be metal, of approved cross section and bracing, of a height not less than the prescribed edge thickness of the concrete section, and a minimum of ten (10) feet in length for each individual form. Forms shall be of ample strength and shall be provided with adequate devices for secure setting so that when in place they will withstand the impact and vibration of equipment imposed thereupon without appreciable springing or settlement. In no case shall the base width be less than eight (8) inches for a form eight (8) inches or more in height. The forms shall be free from warps, bends, or kinks and shall show minimum variation from the true plane for face or top. Each ten (10) foot length of forms shall be provided with at least three (3) pins for securely staking in position. Sufficient forms shall be provided for satisfactory prosecution of the work. Ten (10) foot metal form sections shall be used in forming curves with a two hundred fifty (250) foot, and larger, radius. For curves with a radius of less than two hundred fifty (250) feet, acceptable flexible metal forms or wood forms may be used upon approval by the Engineer.

Forms shall be clean of old accumulated concrete, grout, or other materials. The forms shall be sprayed or covered with a form release agent prior to their use.

G) Subgrade Machine - The subgrade machine shall be of an approved type that will cut the subgrade, subbase or base reasonably close to the lines, grades and typical cross sections shown on the plans.

H) Subgrade Roller - Subgrade rollers shall be of adequate size to compact the subgrade or subbase to the required density.

I) Header Boards - Header boards to be used when paving operations are stopped, shall be of two (2) inch material and cut to the exact cross section of the paving slab. The boards shall be so designed as to permit accurate installation of dowels or tie bars as called for on the plans.

J) Longitudinal Float - The longitudinal float may either be a mechanical float or screed mechanism meeting the approval of the Engineer or a manually operated float. The hand operated float shall be a rigid straightedge float not less than twelve (12) feet nor more than eighteen (18) feet in length with a troweling or smoothing surface not less than eight (8) inches nor more than twelve (12) inches in width, and shall be worked from bridges spanning the pavement.

Longitudinal floats shall be maintained in good repair and working order at all times. If satisfactory results are not being obtained by use of a mechanical float, a manually operated float shall be available on the job for immediate use in lieu of the mechanical float.

The mechanical float shall be so adjusted and so operated that the screed will have a small quantity of concrete in front of it at all times. The screed shall not be raised or lowered solely for the purpose of maintaining the proper amount of concrete in front of the screed.

In lieu of the mechanical or hand operated longitudinal float, the use of a finishing machine with the float pan type finisher, will be permitted provided that satisfactory performance and specified

surface smoothness and tolerances are obtained.

K) Small Tools, Belt and Burlap Drag - The Contractor shall furnish a sufficient number of work bridges, hand floats, ten (10) foot straightedges, and small tools to satisfactorily complete the pavement as specified herein. Any float or straightedge which becomes warped or distorted and any belts or finishing tools which are defective, shall be promptly replaced with acceptable appliances.

Belts shall be used only with the approval of the Engineer. The belt shall be of three-ply canvas or of canvas-rubber composition at least ten (10) inches wide, and at least two (2) feet longer than the width of the pavement slab.

The burlap drag shall consist of a seamless strip of burlap or cotton fabric, which shall produce a uniform surface of gritty texture after dragging it longitudinally along the full width of pavement. The dimensions of the drag shall be such that a strip of burlap or fabric at least three (3) feet is in contact with the full width of pavement surface while the drag is used. The drag shall consist of not less than two (2) layers of burlap with the bottom layer approximately six (6) inches wider than the upper layer.

L) Spraying Equipment - The equipment for applying the white pigmented curing membrane shall be the fully atomizing type equipped with a tank agitator which will keep the compound thoroughly mixed during application. Hand sprayers of the pressure tank type approved by the Engineer may be used to apply curing membrane to vertical surfaces, irregular areas or edges after form removal.

M) Joint Sealing Equipment - The joint sealing equipment used on the project shall meet the requirement of the Oklahoma Department of Transportation and shall be approved by the Engineer.

304.04 – CONSTRUCTION METHODS

A) Setting Forms - All forms shall be set on a firm solid subgrade which has been thoroughly compacted. Any variations in the subgrade above or below grade shall be corrected by cutting or filling with earth. Fills shall be thoroughly tamped as required by the Engineer.

The forms shall be set to the required grade and alignment with exactness and shall be joined together neatly and tightly.

The length and number of pins used in setting the forms shall be such as to maintain them at the correct line and grade. The accuracy of the alignment and grade of the forms shall be checked both while they are being set, and just before the placing of the concrete, with a straightedge not less than ten (10) feet long and a carpenter's hand level not less than three (3) feet long. The forms shall not deviate from true line by more than 0.25 inch at any point. Forms which show a variation from the correct alignment and grade, shall be reset or removed and replaced with other forms, as directed by the Engineer. If the subgrade under the forms becomes unstable at any time before concrete is placed, the forms shall be reset on a firm foundation.

Where integral curb is required, the face forms shall be accurately and securely clamped in place immediately after the slab is poured and struck off, lamps and spreaders shall be spaced close enough together to prevent bulging or spreading of the face forms during the placing and compacting of the curb concrete. Spreaders shall be metal templates not less than one-eighth (1/8) inch and not more than three-sixteenths inch (3/16”) in thickness and of the proper shape. Special devices, when approved by the Engineer, may be used for supporting the face form. In general, clamps and spreaders or other supporting devices shall be placed no more than six (6) feet apart.

All forms shall be cleaned and oiled before concrete is placed provided that when directed by the Engineer curb-face forms shall be wetted instead of oiled.

B) Optional Use of a Slip Form Paver - If the Contractor so elects, he may use a slip form paver in lieu of the conventional paving train and stationary side forms.

When a slip form paver is used, all requirements of placing pavement with rigid forms shall be complied with except as provided herein:

1) Grade - After the grade or base has been placed and compacted to the required density, the areas which will support the paving machine will be brought to the proper elevation and profile by means of a properly designed and approved machine. If the density of the base or grade has been disturbed by any of the foregoing operations, it shall be corrected by additional compaction before concrete is placed.

2) Placing Concrete - The concrete shall be placed with an approved slip form paver designed to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finish will be necessary to provide a dense and homogenous pavement in accordance with the plans and specifications. The machine shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Such vibration shall be accomplished with vibrating tubes or arms working in the concrete. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms.

3) Finishing - Final surface shall conform to the requirements of Section 304.04.05.

C) Placing Concrete

1) General - All concrete shall be placed within a maximum time of 1-1/2 hours from the time the Portland Cement and water is introduced into the mixer. No concrete shall be placed unless an Inspector is present. The prepared subgrade shall be wet down by sprinkling uniformly with water before the placing of concrete begins. Only an amount of water that will be immediately absorbed by the subgrade shall be applied, care being taken that no pools of water or muddy spots are created. During dry, warm weather, the Contractor shall wet the subgrade down thoroughly several hours before the placing of concrete begins, when required by the Engineer. No concrete shall be placed unless the subgrade has been approved by the Engineer.

   The concrete shall be deposited on the subgrade in such a manner as to require as little rehandling as possible. The necessary spreading shall be done by means of shovels. Spreading by means of rakes will not be permitted. Any portion of a batch of concrete in which there is any segregation of materials during the operation of depositing and spreading shall be thoroughly mixed with the main body of the batch during the process of spreading.

   The operation of placing concrete shall be continuous between regular transverse joints provided, however, when work is unavoidably suspended for a period longer than thirty (30) minutes after the depositing of concrete has begun or until the concrete has taken initial set, then a transverse joint as hereinafter specified shall be placed and the slab completed to this joint. Mixing and placing of concrete shall be stopped in time to allow finishing to be completed in daylight hours, unless special permission to do otherwise is granted by the Engineer. When concrete is placed or finished at night, adequate illumination satisfactory to the Engineer, shall be provided.

2) Unreinforced Slabs - The concrete shall be placed the full depth of the slab in as nearly one (1) operation as possible.

3) Reinforced Slab - When the slab is to be reinforced, concrete shall first be deposited, spread and struck off uniformly as shown on the plans. When required by the Engineer, the Contractor shall check the uniformity and accuracy of the surface of this lower portion of the slab by use of the strike-off template. All variations in excess of one inch (1”) above or below the required elevation shall be eliminated. The reinforcement shall then be placed as hereinafter specified. The placing of the top portion of the slab shall then begin immediately after the reinforcement is properly placed but in no instance shall the time interval between the placing and striking off of the lower portion of the slab be longer than fifteen (15) minutes. Any dirt or other foreign matter which collects on the surface of the first layer shall be carefully and completely removed before

the upper layer is placed. The concrete shall be brought up to and struck-off at an elevation slightly above the required finish grade.

Where it is necessary, in the opinion of the Engineer, in placing the top portion of the slab, for trucks to back upon the concrete and reinforcement already in place, sound planks not less than three (3) inches in thickness and not less than twelve (12) inches in width, shall be placed for the wheels to run on. No truck shall back over any area of concrete in which dowel or tie bars are in place. Any bending or displacing of the reinforcement by the trucks shall be immediately corrected before covering with the top concrete.

4) Placing Concrete During Cold Weather - No concrete shall be placed on a soft, wet or frozen subgrade. In general, no concrete shall be placed when the air temperature in the shade and away from artificial heat is below thirty-five degrees F (35°F) or below forty degrees F (40°F) and falling unless with the special permission of the Engineer or as hereinafter provided. However, the Engineer may require that no concrete be placed when in his opinion the concrete might become damaged from subsequent low temperatures.

304.04.01 – PLACING INTEGRAL CURB

Where integral curb is required the concrete curb shall be placed and compacted before the slab concrete has taken its initial set. The curb shall be built to the required line, grade and dimension, and shall be shaped in strict conformity with the detail plans. The concrete shall be sufficiently worked and spaded while being placed in the combed surface and assure the working of sufficient mortar to the top and front face to facilitate the obtaining of a smooth, uniform surface.

304.04.02 – PLACING REINFORCING STEEL

A) Steel Bar Reinforcement - Steel reinforcing bars including tie bars, if shown and required on the plans, shall be of the size and type indicated thereon and shall be open hearth new billet steel of structural, intermediate, or hard grade, ASTM Designation A-615, or shall be rail steel concrete reinforcement bars, ASTM Designation A-616. All steel shall be bent cold. When tie bars are to be bent they shall be of structural or intermediate grade.

1) Deformed Bars - When deformed bars are specified, the forms of the bar shall be such as to provide a net sectional area at all points equivalent to that of a plain square or round bar of equal nominal size.

2) Fabricated Steel Bar or Rod Mats - When fabricated steel bar or rod mats are specified, the mats shall meet the current requirements of specifications for "Fabricated Steel Bar or Rod Mats for Concrete Reinforcement", ASTM Designation A-184.

B) Steel Wire Fabric Reinforcement - When steel wire fabricated reinforcement is specified, or permitted as an option, the wire fabric shall conform to the gauge and wire spacing shown on the plans and the requirements of the standard specifications for "Cold-Drawn Steel Wire for Concrete Reinforcement", ASTM Designation A-82. Longitudinal and transverse wires shall be electrically welded together at all points of intersection and the welds shall be of sufficient strength that they will not be broken during handling or placing. All welding and fabrication of the fabric sheets shall conform to the requirements of the standard specifications for "Welded Steel Wire Fabric for Concrete Reinforcement", ASTM Designation A-185. Welded steel wire fabric shall be furnished in flat sheets as per plan dimensions and steel fabric having been previously bundled into rolls will not be accepted. If wire fabric is used, it will replace only the longitudinal and transverse bars. The tie bars and load transmission units at joints will not be affected.

304.04.03 – JOINTS IN PAVEMENTS

A) General - The type and dimensions of joints shall be as shown on the plans or called for in these specifications. All joints shall be constructed true to line, having no variation therefrom greater than

one-half (1/2) inch at any joint. Transverse joints shall be perpendicular to, and longitudinal joints shall be parallel to, the centerline of the pavement. The plane of all joints shall be perpendicular to the subgrade. All joints shall extend the full length and width of the slab, and, with the exception of dummy joints, shall extend the full depth of the slab so as to entirely separate slabs, or slabs and structure. All headers or forms used in joint construction shall be securely held in place so as to be rigid and unyielding during the entire operation of placing and finishing the concrete and constructing the joint. Headers shall be held in place by iron pins of sufficient length to serve the purpose properly, unless permission to do otherwise is granted by the Engineer. After the concrete is placed, all iron pins shall be removed. Headers shall be kept oiled or greased while in use. All formed or tooled joints shall be edged with a one-fourth inch (1/4") radius edging tool.

B) Location of Joints - The location of joints in pavements shall be as shown on the plans, and as provided in these specifications, or as directed by the Engineer. Where shown on the plans or directed by the Engineer, expansion joints one inch (1") in thickness shall be placed between the pavement slab and all rigid structures projecting into or confined within the pavement slab. In general, expansion joints shall be placed at the PC & PT of each intersection return. Contraction joints shall be evenly spaced between expansion joints. Spacing will be not less than twelve (12) feet, nor more than eighteen (18) feet. When, due to unavoidable suspension of work, a joint is required, such joint shall be located not nearer than ten (10) feet to any other transverse joint. When the concrete deposited on the subgrade is not sufficient to permit the location of the joint ten (10) feet or more past the last joint constructed, the concrete shall be removed from the subgrade and disposed of by the Contractor. During the placing of any longitudinal slab section, the joint as required above shall be a transverse construction joint having bonded dowel bars, provided that the location of the joint be ten (10) feet or more past the last transverse joint and not nearer than ten (10) feet to the next transverse joint located in compliance with these specifications. All slabs placed adjacent to an existing slab shall have joints placed to match those in the existing slab.

C) Longitudinal Joints - Longitudinal joints shall be formed by sawing or by a parting strip of metal or other approved premoulded material securely held in place while placing the concrete slab. Deformed steel tie bars of specified length, size, spacing and material shall be placed perpendicular to longitudinal joints.

The parting strip shall be securely held in place perpendicular to the surface and true to line and grade, by metal pins, at intervals that average not greater than three (3) feet. The minimum length of parting strips shall be ten (10) feet and adjoining sections shall be securely fastened together by lapping and pinning by means of a slip joint or other approved method. The Contractor shall furnish an approved gauge riding on the side forms for accurately checking the position of the parting strip before concrete is placed against it.

For sawed longitudinal joints, tie bars shall be placed perpendicular to the longitudinal joints. They shall be placed by approved mechanical equipment or rigidly secured by chairs or other approved supports to prevent displacement. Tie bars shall not be painted or coated with asphalt or other material, or enclosed in tubes or sleeves.

When tested with a straightedge, the surface across any joint shall not vary from the straightedge by more than one-eighth (1/8) inch. Concrete edges at joints which are not sawed shall be tooled to one-eighth (1/8) inch radius or as otherwise shown on the plans.

The longitudinal joint shall be sawed before the end of the curing period or shortly thereafter and before any equipment or vehicles are allowed on the pavement. The sawed area shall be thoroughly cleaned and, if required, the joint shall immediately be filled with sealer.

D) Transverse Expansion Joints - The expansion joint filler shall be continuous from form to form, shaped to the subgrade and to the keyway along the form. Preformed joint filler shall be furnished in lengths equal to the pavement width or equal to the width of one lane. Damaged or repaired joint filler shall not be used unless approved by the Engineer.

The expansion joint filler shall be held securely in position. An approved installing bar, or other device, shall be used if required to secure preformed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete. Finished joints shall not deviate more than one-fourth inch (1/4") in the horizontal alignment from a straight line. If joint fillers are assembled in sections, there shall be no offsets between adjacent units. No plugs of concrete shall be permitted anywhere within the expansion space.

The installing bar shall be a substantial metal plate or shape and shall have a length of one-half (1/2) inch less than the specified width of the slab and shall be cut to the specified crown of the slab in cross section with a width not to exceed one-half (1/2) inch less than the specified depth of the slab and shall be staked in position so that the top edge, unless otherwise provided on the plans, will be not more than one inch (1") below the proposed pavement surface; the lower edge shall be cut to conform to the prescribed cross section of the subgrade; the installing bar shall be slotted from the bottom as necessary to permit the installation of the required dowels and may be further cut away at intervals along its length so as to allow the concrete to make contact with the pre-molded filler at close intervals. Suitable means shall be provided on the bar for facilitating its removal. Header boards, sheet metal holders, or other devices in lieu of the installing bar, must meet the approval of the Engineer.

Pre-molded joint filler shall be appropriately punched to the exact diameter and location of the dowels. It shall, unless otherwise provided, be furnished in lengths equal to the pavement width; however, in cases where pavement two or more traffic lanes wide is being placed, the pre-molded filler may be furnished in sections, provided the length of each section is equal to the width of one lane. Where more than one section is used in a joint, the sections shall be securely laced or clipped together. The pre-molded joint filler shall be placed on the side of the installing bar nearest the mixer. The bottom edge of the filler shall project to or slightly below the bottom of the slab and unless otherwise prescribed, the top edge shall be one inch (1") below the surface of the pavement. While the concrete is being placed, the top edge of the filler shall be protected by a metal channel cap of at least one and one-half (1 1/2) inch sheet thickness material, having flanges not less than one and one-half (1 1/2) inch in depth.

After the concrete has been placed on both sides of the joint and struck off, the installing bar shall be slowly and carefully withdrawn leaving the pre-molded filler in place. Before the installing bar and channel cap is completely withdrawn, the concrete shall be carefully vibrated and additional freshly mixed concrete worked into any depression left by the removal of the installing bar. The filler must be exposed for the full width of the slab. The installing bar must be cleaned and re-oiled prior to each installation of a joint. After the removal of the side forms, the ends of the transverse joints at the edges of the pavement shall be carefully opened for the entire depth of the slab. Before the pavement is opened to traffic, pre-molded joints shall be sealed or topped out with the joint sealing filler specified for poured joints leaving a neat uniform strip of joint sealing filler slightly below the surface of the pavement.

Joints in concrete curbing that cannot be satisfactorily sawed shall be formed by means of steel templates or other approved joint forming dividers installed at the time the concrete is poured and at the location of the joint to be sawed.

E) Transverse Contraction Joints shall be formed by sawing or tooling. Sawing of transverse contraction joints shall begin as soon after pouring the pavement as can be done without causing undue raveling. Succeeding joints shall be sawed consecutively from beginning to end of the day's run, and all transverse joints shall be sawed to the depth specified on the plans soon enough to prevent uncontrolled transverse cracking.

F) Construction Joints: Unless otherwise directed, transverse construction joints shall be constructed when there is an interruption of more than thirty (30) minutes in the concrete operations. No transverse joint shall be constructed within ten (10) feet of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has not been mixed at the time of interruption to form a

slab at least ten (10) feet long, the excess concrete back to the last preceding joint shall be removed and disposed of as directed.

A rigid header shall be provided with holes or slots for dowel bars that shall be of the spacing and dimensions as for expansion joints.

G) Load Transfer Devices: Approved load transfer devices shall be firmly held in the position indicated on the plans. Dowels shall be held in position parallel to the surface and centerline of the slab by an approved support. Dowels for expansion joints shall be capped as shown on the plans.

In lieu of using dowel assemblies at contraction joints, dowel bars may be placed in the full thickness of pavement by a mechanical device approved by the Engineer.

304.04.04 – PLACING DOWEL BARS AND TIE BARS

A) General - Dowel bars and tie bars shall be accurately spaced during the placing of concrete, as shown on the plans. The bars shall be carefully placed so that they will project an equal distance into each slab adjacent to the joint and so that they will be parallel to the subgrade and perpendicular to the joint. All bars shall be maintained in their proper position using metal supports approved by the Engineer, until firmly and securely embedded in the concrete. All forms, headers or premoulded expansion joint material used shall have the necessary holes drilled or punched, or the necessary notches or slots provided at proper locations to permit the bars extending through them. Bars shall be placed at the midpoint of the depth of the slab.

B) Tie Bars - Tie bars (across all joints other than expansion or contraction joints) shall be deformed bars. The concrete shall be thoroughly spaded adjacent to the bars to secure good bond throughout the length of the bars and prevent the formation of voids.

The ends of tie bars which are to protrude from the edge of the pavement slab where driveway slabs are to be built, or in other instances where special permission is given by the Engineer, may be carefully bent at right angles so as to lay along the form or header, when the concrete is placed. As soon as the form is removed, the bent and partially embedded portion of the bar shall be carefully pried out and straightened to its proper position, care taken not to damage the concrete or the bar.

C) Slip Dowel Bars for Expansion Joints - Dowel bars across expansion joints shall be plain bars mounted in a supporting cage as shown on the plan. On one side of the joint, the bars shall be completely coated with a heavy paint. The ends of the bars which are painted shall be encased in a metal or cardboard tube. Where necessary to provide a grip on the bar to prevent the tubes being displaced from their proper position, the tubes shall be knocked out-o-round slightly. The open end of the tube shall be maintained in its proper position on the bar by means of a felt plug or wire across tube.

Dowels shall be held in place accurately parallel to the surface and centerline of the slab by a device of metal rods, which is left in the pavement. Dowels shall be installed in this device before it is placed on the subgrade. The device shall be rigid enough to hold the dowels in proper position. None of the members of the device shall cross the joints in such a way as to restrict the free opening and closing of the joint.

304.04.05 – CONSOLIDATING AND FINISHING CONCRETE PAVEMENT

A) General - The sequence of operations shall be the strike-off and consolidation, floating and removal of laitance, straight-edging, and final surface finish.

In general, the addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted. If the application of water to the surface is permitted, it shall be applied as a fog spray by means of approved spray equipment.

B) Machine Finishing - The concrete shall be distributed or spread as soon as placed. As soon as the

concrete has been placed, it shall be struck off and screeded by an approved finishing machine. The machine shall go over each area of pavement as many times and at such intervals as necessary to give the proper compaction and to leave a surface of uniform texture. Excessive operation over a given area shall be avoided. The tops of the forms shall be kept clean by an effective device attached to the machine and the travel of the machine on the forms shall be maintained true without lift, wobbling, or other variation tending to affect the precision finish.

During the first pass of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed for its entire length. Vibrators for full width vibration of concrete paving slabs shall meet the requirement in Section 304.03. If uniform and satisfactory density of the concrete is not obtained by the vibratory method at joints, along forms, at structures, and throughout the pavement, the Contractor will be required to furnish equipment and methods which will produce pavement conforming to the specifications.

C) Hand Finishing - Hand finishing methods will not be permitted except under the following conditions:

In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade or in transit when the breakdown occurs.

Narrow widths or areas of irregular dimensions where operation of the mechanical equipment is impractical may be finished by hand methods.

Concrete as soon as placed shall be struck off and screeded. An approved portable screed shall be used. A second screed shall be provided for striking off the bottom layer of concrete if reinforcement is used.

The screed for the surface shall be at least two (2) feet longer than the maximum width of the slab to be struck off.

Consolidation shall be attained by the use of a suitable vibrator or other approved equipment.

In operation, the screed shall be moved forward on the forms with a combined longitudinal and transverse shearing motion, moving always in the direction in which the work is progressing and so manipulated that neither end is raised from the side forms during the striking off process. If necessary, this shall be repeated until the surface is of uniform texture reasonably true to grade and cross section, and free from porous areas.

D) Floating - After the concrete has been struck off and consolidated, it shall be further smoothed, trued, and consolidated by means of a longitudinal float using one of the following methods as specified or permitted.

1) Hand Method - The hand operated longitudinal float shall be not less than twelve (12) feet in length and six (6) inches in width, properly stiffened to prevent flexibility and warping. The longitudinal float operated from foot bridges resting on the side forms and spanning but not touching the concrete, shall be worked with a sawing motion, while held in a floating position parallel to the road centerline, and passing gradually from one side of the pavement to the other. Movement ahead along the centerline of the pavement shall be in successive advances of not more than one-half (1/2) the length of the float. Any excess water or soupy material shall be wasted over the side forms on each pass.

2) Mechanical Method - The mechanical longitudinal float shall be of a design approved by the Engineer and shall be in good working condition. The tracks from which the float operates shall be accurately adjusted to the required crown. The float shall be accurately adjusted and coordinated with the adjustments of the transverse finishing machine so that a small amount of mortar is carried ahead of the float at all times. The forward speed shall be adjusted so that the float will lap the distance specified by the Engineer on each transverse trip. The float shall pass over each area of pavement at least two (2) times, but excessive operation over a given area will not be permitted. Any excess water or soupy material shall be wasted over the side forms on each pass.

3) Alternative Mechanical Method - As an alternative to Item 2 above, the Contractor may use a machine composed of a cutting and smoothing float, or floats, suspended from and guided by a rigid frame. The frame shall be carried by four (4) or more visible wheels riding on and constantly in contact with the side forms.

   If necessary, following one of the preceding methods of floating, long-handled floats having blades not less than five (5) feet in length and six (6) inches in width may be used to smooth and fill in open-textured areas in the pavement. Long-handled floats shall not be used to float the entire surface of the pavement in lieu of, or supplementing, one of the preceding methods of floating. When strike-off and consolidation are done by the hand method and the crown of the pavement will not permit the use of the longitudinal float, the surface shall be floated transversely by means of the long-handled float. Care shall be taken not to work the crown out of the pavement during the operation. After floating, any excess water and laitance shall be removed from the surface of the pavement by a straightedge ten (10) feet or more in length. Successive drags shall be lapped one-half (1/2) the length of the blade.

E) Belting (Paving with Rigid Forms) - When straightedging is completed and water sheen has practically disappeared and just before the concrete becomes nonplastic, the surface may be belted with a suitable belt meeting the requirements of Section 304.03(k). The belt shall be operated with short strokes transverse to the road centerline and with a rapid advance parallel to the road centerline.

   Either machine belting or hand belting will be permitted. The transverse belt will not be required if a satisfactory finish can otherwise be obtained.

F) Burlap Drag - A burlap drag shall be used for the finish of the pavement surface. The burlap or cotton fabric drag shall produce a uniform surface of gritty texture after dragging it longitudinally along the full width of pavement. For pavement sixteen (16) feet or more in width, the drag shall be mounted on a bridge which travels on the forms. The drag shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags substituted.

G) Final Surface Finish Requirements - The pavement surface shall be worked and finished during the operation of consolidating and finishing so that the final surface will conform to the following test requirements:

   A ten (10) foot straightedge shall be placed on the pavement surface parallel to the centerline and bridging any depressions or with one end on any high spot. Ordinates measured from the face of the straightedge to the pavement surface shall not exceed one-sixteenth inch (1/16”) for each one (1) foot distance from the nearest point of contact, provided that no ordinate shall exceed a maximum of one-fourth inch (1/4”).

   When tested with the straightedge as soon as the concrete has hardened sufficiently to permit walking on it without marring the surface, any high spots found in excess of the tolerance above permitted shall be removed by rubbing with a carborundum stone. In any event the rubbing shall cease when the coarse aggregate is reached and care shall be taken not to loosen any coarse aggregate.

   Prior to acceptance of the pavement, the pavement shall be flooded with a sufficient quantity of water to indicate areas of ponding, should they exist. All areas of ponding in excess of one-fourth inch (1/4”) in depth, and any length of curb and gutter that ponds in excess of one-fourth inch (1/4”) in depth, shall be removed and replaced by the Contractor and at the Contractor's expense.

   The water may be applied by tank truck or with fire hose if a fire hydrant is available. The water shall be applied as directed by the Engineer and all expenses borne by the Contractor.

   Any area or section of pavement removed shall be not less than ten (10) feet in length nor less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab and/or curb and gutter, adjacent to joints, that is less

than ten (10) feet in length, shall also be removed and replaced to the particular joint by the Contractor and at the Contractor's expense.

304.04.06 – CONSOLIDATING AND FINISHING INTEGRAL CONCRETE CURB

While the curb forms are being filled, the concrete shall be thoroughly spaded next to the forms to assure a smooth, dense surface. The concrete shall then be carefully tamped, using a tamper approved by the Engineer, until a uniformly dense concrete is obtained. After this initial compacting, additional concrete shall be added, tamped and struck off to the required finish curb grade, care being taken to work the coarse aggregate well beneath the surface. As soon as the concrete has set sufficiently to retain its shape without support of the face form, the clamps, spreaders and face form shall be removed. The back forms shall be removed within twenty-four (24) hours after pouring the concrete. Any honeycombed or rough surfaces shall be immediately corrected when the forms are removed, using mortar when necessary. The edges of the curb shall be neatly rounded to the required radii. The top and front face shall be thoroughly floated with a moist wooden float, apply clean water ahead of the float, until all form marks or other irregularities are completely removed. The curb surfaces shall be checked with a ten (10) foot straightedge immediately after removal of the forms, and all variations greater than one-fourth inch (1/4") in ten (10) feet from a true surface shall be corrected immediately. The final finish shall be obtained by uniformly brushing the entire top and front face before the concrete sets hard, using a brush approved by the Engineer and applying clean water during the operation. The brush strokes shall be made up the front face and outward across the top and vice versa.

304.04.07 – CURING CONCRETE PAVEMENT

A) General - A membrane type-curing compound will be used for curing all concrete pavement.

B) Method of Application - The curing compound shall be applied under pressure by means of a spray nozzle in such a manner as to cover the entire exposed surface thoroughly and completely with a uniform film. Sufficient pressure shall be applied to the spray machine to force the compound to leave the nozzle as a fine mist.

   The compound shall be applied to the fresh concrete immediately after the surface has been finished and before the initial set of the cement has taken place. The application of curing compound shall be close to the finishing at all times and all finished concrete shall be sprayed immediately after the superficial water, if any has subsided.

   The edges of paving slab shall be coated with the sealing compound within thirty (30) minutes after removal of the forms. This shall be a continuous process, and waiting until all forms have been removed before making application will not be permitted.

   When concrete is cast in forms, the concrete shall be kept continuously wet during the stripping operations, and when the surface does not require finishing after removal of the forms, the curing compound shall be applied immediately after removal of the form before the surface has had an opportunity to dry out. On the surface requiring a carborundum finish, the curing compound shall be applied immediately following the finishing operations before the surface dries.

   If hair checking develops before the curing compound can be applied, the procedure set forth above shall be performed as specified in standard specifications for the particular type of work under construction, and the curing compound shall be applied after the burlap has been removed.

   If, in the opinion of the Engineer, discontinuities, or pinholes, or abrasions in the membrane exist, a second coat shall be applied to the effected areas. No walking on the cured surface will be permitted for twenty-four (24) hours after application to prevent breaking the membrane. If this is done, the abrasions will be corrected by the use of additional curing compound.

C) Rate of Application - The sealing compound shall not be applied at a coverage rate lighter than specified below without express approval of the Engineer in charge.

Steel trowel finish	25 sq. yds. per gallon
Rough float finish	22 sq. yds. per gallon
Walls, smooth forms	25 sq. yds. per gallon or until solution drips and runs

Whenever the atmospheric temperature is one hundred degrees F (100°F) or more, the Engineer shall have the right to require an additional coat at a rate of approximately thirty (30) square yards per gallon, if he deems the additional material essential to obtain adequate water retention, in which case the second coat shall be applied thirty (30) minutes after the first.

D) Membrane Curing Compound - The membrane curing compound shall conform to the requirements of Section 932, and shall be of a suitable consistency for spraying, at the time of application. The membrane curing compound shall be applied to the green concrete as soon as the excess water has disappeared from the surface and the slab is finished, but before the concrete has taken initial set. The membrane curing compound shall be applied as specified in Section 932.

304.04.08 – PROTECTION OF CONCRETE IN COLD WEATHER

When concrete is placed while the temperature is below thirty-five degrees F (35°F) or below forty degrees F (40°F) and falling, the headers and curb back shall not be removed for seven (7) days and the slab and curb shall be covered with visqueen and dry burlap, cotton blankets, or equal.

When concrete is placed under the temperature conditions given above, or, when at any time within seventy-two (72) hours after concrete is poured, the air temperature goes below thirty-five (35) degrees F, a layer of dry straw not less than eight (8) inches in thickness shall be placed on the burlap and loose, dry dirt shall then be placed over the straw layer in sufficient quantity only to prevent the straw becoming displaced or blown off.

The straw layer shall be placed regardless of the curing method which may be in effect at the time and shall remain in place throughout the regular curing period. While cold weather prevails during the curing period, water shall be applied to the pavement or covering material only as directed by the Engineer. In general, no water shall be applied while the temperature is forty degrees F (40°F) or lower.

304.04.09 – PROTECTION OF PAVEMENT FROM TRAFFIC

As soon as the placing of concrete begins, the Contractor shall provide means for completely protecting the pavement from any and all damage or marring of the surface. Barricades, lights and signs shall be provided where directed by the Engineer. At all places where it is necessary to maintain public or private crossing over the pavement, the Contractor shall at his own expense provide and maintain bridges or other devices that will prevent the damage or marring of the concrete.

304.04.10 – BACKFILLING SLAB EDGES AND INTEGRAL CURB

Slab edges and the back side of integral curbs shall be banked with earth as soon as the forms are removed and the required finishing operations completed. Before the pavement is opened to traffic or the work accepted, the area outside the slab edges or back of the curbs shall be backfilled with select earth approved by the Engineer, thoroughly compacted in layers not exceeding six (6) inches in depth and neatly graded off flush with the top of the slab or top of curb or as shown on the plans.

Where the general elevation of the parking area is lower than the top of the curb or slab where there is no curb, the minimum width of the backfill shall be two (2) feet, unless otherwise shown on the plans, measured at the top of curb or slab surface.

304.04.11 – OPENING TO TRAFFIC

Between April 1, and October 15, pavement shall be opened to traffic in not less than seven (7) days from the date the concrete is placed. A fourteen (14) day curing period will be required at all other times.

304.04.12 – OPENING FOR DRIVEWAYS

Opening for driveways shall be left in the curb where directed by the Engineer, and shall be constructed in conformity with the detailed drawing and "Oklahoma City Standard Residential Driveway Openings". Two (2) inch to six (6) inch curb in the driveway opening shall be considered the same as regular curb insofar as measurement and payment are concerned.

304.05 - TESTING

The maximum number of concrete cylinder tests to be ordered by the Engineer and paid for by the Contractor shall be in accordance with the following schedule. (A test shall consist of four (4) cylinders, two (2) to be tested at an age of seven (7) days and two (2) to be tested at an age of twenty-eight (28) days.)

TABLE 304.05 - TESTING SCHEDULE PORTLAND CEMENT CONCRETE PAVEMENT

Description	Method of Test	Maximum quantity represented by one test
Concrete Cylinders	ASTM C-31-03a	600SY concrete paving

One test for slump, temperature and entrained air content shall be made for each set of four (4) concrete test cylinders or test beams cast.

Air entrainment tests shall be made in accordance with ASTM Designation C-173 or C-231 or subsequent revisions thereto.

In the event the slab on a street is poured in strips or lanes of less than twenty-six (26) feet in width, a minimum of one (1) set of concrete cylinders will be made in each block of each strip or lane so poured.

304.05.01 – STRENGTH REQUIREMENTS

Portland Cement Concrete shall meet the requirements of Section 932.

304.05.02 – TOLERANCE IN THICKNESS

It is the intent of these specifications that the pavement shall be constructed strictly in accordance with the plans. Any deficiency shall be governed by Section 301.

304.06 – METHOD OF MEASUREMENT

Portland Cement Concrete Pavement. The yardage to be paid for under this item shall be number of square yards of concrete pavement of the type shown on the Plans or in the Proposal, completed and accepted, measured complete in place. The width for measurement will be the width from outside to outside of the completed pavement, but not to exceed the width as shown on the Plans or as directed by the Engineer. The length will be the actual length measured along the riding surface of the centerline of the road, and shall exclude the length occupied by bridges, approach slabs, and all other exceptions. Reinforcing steel, load transfer devices, joint fillers and joint sealers will not be measured for payment.

Approach Slabs. The yardage to be paid for under this item will be measured as provided above for portland cement concrete pavement.

304.07 – BASIS OF PAYMENT

The accepted quantities of concrete pavement, and approach slabs, measured as provided above, will be paid for at the contract unit price for:

PORTLAND CEMENT CONCRETE PAVEMENT	SY
APPROACH SLABS	SY

PORTLAND CEMENT CONCRETE PAVEMENT (CONTINUOUSLY REINFORCED) SY

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

No additional compensation will be allowed when the Contractor, at his option, uses high-early-strength portland cement in lieu of standard cement.

SECTION 305 - CONCRETE CURB AND GUTTER

305.01 - DESCRIPTION

This section covers the construction of concrete curbs and gutters, either separate or in combination, for pavements and roadways in accordance with these specifications and in conformity with the lines, grades, and cross sections shown on the plans. The mixture of the Portland Cement Concrete shall conform to the strength requirements specified for Portland Cement Concrete, Section 932.

Integral concrete curb shall be constructed as specified under Portland Cement Concrete Pavement.

305.02 – MATERIALS

All materials shall conform to the requirements specified in Section 900 and the special references, which are as follows:

Portland Cement Concrete	932
Pre-molded Expansion Joint Filler	932
Hot Poured Sealing Filler	932
Cold Type Sealing Filler	932
Reinforcing Steel	941

305.04 – CONSTRUCTION METHODS

A) Excavation - Excavation shall be made to the required depth, and the base upon which the curb is to be set shall be compacted in accordance with applicable density requirements for the base material.

B) Forms - The forms shall be of metal, wood, or other suitable material, straight and free from warp, and of such construction that there will be no interference to the inspection of grade or alignment. All forms shall extend for the entire depth of the curb or curb and gutter and shall be braced and secured sufficiently so that no deflection from alignment or grade will occur during the placing of the concrete. All forms shall be cleaned thoroughly and oiled before the concrete is placed against them.

Fastening hardwood strips to the bottom of the forms, not to exceed two (2) inches in built-up thickness to provide the specified thickness may be permitted. Prior to use the Engineer shall approve the material and method of fastening the built-up section.

C) Equipment - A self-propelled curb machine may be used when approved by the Engineer. The curb machine shall be capable of extruding a uniformly textured material to the shape and density specified and placing it in reasonably close conformity to the established line and grade.

D) Placing Concrete - The subgrade and/or base, and forms shall have been checked and approved by the Engineer before concrete is placed. During placing, the concrete shall be thoroughly consolidated next to the forms by use of a suitable vibrator or other approved equipment.

E) Surface Finish - As soon as the curb concrete has set sufficiently to retain its shape without support, the final surface finish shall be obtained by uniformly brushing the surface in a manner approved by the Engineer. The edges of the curb shall be neatly rounded to the required radii. The top and front face of curbs shall be checked for irregularities during the finishing operation using a ten (10) foot straightedge, and all variations greater than one-fourth inch (1/4”) shall be corrected immediately.

F) Joints - All joints in curb and gutters shall be perpendicular to the subgrade, at right angles to the longitudinal axis of the curb and shall entirely separate the adjacent sections of concrete. Expansion and contraction joints shall be constructed at the same location as similar joints in the paving slab (if present).

Expansion joints shall be pre-molded expansion joint filler and shall be of the thickness and placed at the locations shown on the plans or as directed by the Engineer. Joints shall, in general, be placed in the curb, gutter, or combined curb and gutter opposite the joints in the pavement.

G) Curb Openings - Where curb is to be omitted for driveways or other cause, the top of the curb shall be constructed slightly higher at the back than at the front as shown on the plans or as directed by the Engineer. Such curb may be classified as "Lip Curb" in the special provisions or proposal, but unless so classified shall be considered as regular curb.

H) Extruded Method - When the extruded method is used to construct curb and gutter, the extrusion machine shall be operated on a string or wire line set to reproduce the line and grade shown on the plans.

Concrete shall be uniformly fed to the machine, and shall be of such consistency that after extrusion, the concrete will maintain the shape of the curb and gutter without support. The finished curb and gutter shall present a well-compacted mass with a surface free from voids and honeycombs, and reasonably true to established shape, line, and grade. Joints shall be constructed at the same locations as required when form construction is being used. Weakened joints spaced at twenty (20) foot intervals shall be made by sawing unless other methods are approved by the Engineer.

I) Curing - Protection - Opening to Traffic - Concrete curbs and gutters shall be cured, protected during cold weather, and opened to traffic in accordance with the requirements specified from Portland Cement Concrete Pavement.

J) Placing Dowel Bars - Where shown on the plans, dowel bars or tie bars shall be placed across joints or for tying curbs and gutters to adjacent curbs or slabs.

The ends of the tie bars which are to protrude from the edge of a slab, curb or gutter may be carefully bent at right angles so as to lay along the form or header when the concrete is placed. As soon as the form is removed the bent and partially embedded portion of the bar shall be carefully pried out and straightened to its proper position, care being taken to disrupt the concrete as little as possible.

K) Backfill - The back side of curbs and gutters shall be backfilled as soon as the forms have been removed and the required finishing operations completed. The backfill shall be of earth approved by the Engineer and neatly graded off flush with the top of the curb or gutter, or as shown on the plans. Backfill material shall be wheel rolled as it is placed. Care shall be taken not to damage the concrete in placing or compacting the backfill.

Where the general elevation of the parking area is lower than the top of the curb or gutter, or where there is no curb, the minimum width of the backfill shall be two (2) feet at the level of the top of the curb or gutter, unless shown as otherwise on the plans.

L) Driveways - See Section 304.04.12.

305.05 – TESTING

The maximum number of concrete cylinder tests to be ordered by the Engineer and paid for by the Contractor shall be in accordance with the following schedule. A test shall consist of four (4) cylinders, two (2) to be tested at seven (7) days and two (2) at twenty-eight (28) days.

TABLE 305.05 – TESTING SCHEDULE CURB AND GUTTER		
Description	Method of Test	Maximum quantity represented by one test
Concrete Cylinders	ASTM C-31 – 03a	800 LF Curb and Gutter

One test for entrained air content, slump and temperature shall be made for each set of four (4) concrete test cylinders or test beams cast.

Air entrainment tests shall be made in accordance with ASTM Designation C-173 or C-231 or subsequent revisions thereto.

305.06 – METHOD OF MEASUREMENT

Concrete curb and gutter will be paid for at the contract unit price per linear foot. The price bid per linear foot shall include the cost of the required depression at sewer inlets as shown on the inlet design of the required construction, expansion and contraction joints including the expansion joint filler and expansion joint filler seal, any reinforcing or dowels required by the plans, and any extra or special height curb required at inlet depressions. Such price shall be full compensation for all labor, materials, tools, equipment, tests and incidentals necessary to complete the work in accordance with the plans and specifications.

305.07 – BASIS OF PAYMENT

The curb and gutter measured as provided above will be paid for at the contract unit price bid

CURB AND GUTTER L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 306 – HIGH-EARLY-STRENGTH CONCRETE PAVEMENT

306.01 – DESCRIPTION

A) General Requirements. When high-early-strength concrete pavement is specified, it shall meet the requirements of Section 932, except that the compressive strength shall not be less than 3000 PSI when tested 72 hours after being batched. All other requirements herein before specified for concrete pavement shall be applicable subject to the following modifications.

B) Slip-Form Paver. If slip-form paver is used in place of conventional paving methods, in addition to all requirements of conventional paving methods the following requirements must also be followed.

1) Grade. After the grade or base has been placed and compacted to the required density, the areas which will support the paving machine shall be cut to the proper elevation by means of a properly designed machine. The grade on which the pavement is to be constructed shall then be brought to the proper profile by means of a properly designed machine. If the density of the base is disturbed by the grading operations, it shall be corrected by additional compaction before concrete is placed. The grade shall be constructed sufficiently in advance of the placing of the concrete. When the foundation for the surface is stabilized with an admixture, the area under the pavement and the supporting area for the paving machine shall be within the specified tolerances for the foundation type before concrete is placed.

2) Placing Concrete. The concrete shall be placed with an approved slip-form paver designed to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine in such manner that a minimum of hand finish will be necessary to provide a dense and homogeneous pavement in conformance with the Plans and Specifications. The machine shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Such vibrations shall be accomplished with vibrating tubes or arms working in the concrete or

with a vibrating screed or pan operating on the surface of the concrete. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms.

The slip-form paver shall be operated with a continuous forward movement and all operations of mixing, delivering and spreading concrete shall be so coordinated as to provide a uniform progress with stopping and staring of the paver held to a minimum. If, for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately.

3) Finishing. A tube float finishing machine shall be used immediately following the slip-form paver, in a manner approved by the Engineer.

4) Tolerances. Tolerances of the finished pavement shall meet the requirements of Section 414.04(t) of Oklahoma Department of Transportation Specifications except that for the outer 6 inches along the edges of the pavement, a maximum deviation of 1/4 inch from a 10 foot straightedge placed perpendicular to the center line of the roadway will be permitted. When auxiliary parallel lanes are constructed using a slip-form paver, there shall be no appreciable slump along edges of adjoining lanes. Any valleys or depressions that will not drain properly shall be corrected by the Contractor at his own expense to the satisfaction of the Engineer.

5) Curing. Unless otherwise specified, curing shall be done in accordance with the method of Section 304.04. The curing media shall be applied at the appropriate time and shall be applied uniformly and completely to all surfaces and edges of the pavement.

6) Joints. All joints shall be constructed in accordance with Section 304.04.

7) Protection Against Rain. In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the Contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete. Such protective materials shall consist of standard metal forms or wood plank having a nominal thickness of not less than 2 inches and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges, and covering material such as burlap or cotton mats, curing paper, or plastic sheeting material for the protection of the surface of the pavement. When rain appears eminent, all paving operations shall stop and all available personnel shall begin placing forms against the sides of the pavement and covering the surface of the unhardened concrete with the protective covering.

306.05 – TESTING

Pavement tolerances will be according to Section 304.05.

Pavement slabs may be rejected because of unsound concrete, uncontrolled cracking, malfunctioning of the sawed joints, spalling, honeycombing, surface irregularities, insufficient thickness, or for any deficiencies commonly associated with poor quality pavements. Rejected slabs shall be removed and replaced with new pavement conforming to these requirements. The removal and replacement shall be at least one lane in width and ten feet in length. Where the linear extent of removal falls within ten feet of a transverse joint, the removal limits shall be extended to the joint.

306.06 – METHOD OF MEASUREMENT

High Early Strength Concrete Pavement. The yardage to be paid for under this item shall be number of square yards of concrete pavement of the type shown on the Plans or in the Proposal, completed and accepted, measured complete in place. The width for measurement will be the width from outside to outside of the completed pavement, but not to exceed the width as shown on the Plans or as directed by the Engineer. The length will be the actual length measured along the riding surface of the centerline of the road, and shall exclude the length occupied by bridges, approach slabs, and all other exceptions. Reinforcing steel, load transfer devices, joint fillers and joint sealers will not be measured for payment.

Approach Slabs. The yardage to be paid for under this item will be measured as provided above for portland cement concrete pavement.

306.07 – BASIS OF PAYMENT

The accepted quantities of concrete pavement, and approach slabs, measured as provided above, will be paid for at the contract unit price for:

HIGH-EARLY-STRENGTH CONCRETE PAVEMENT	SY
HIGH-EARLY-STRENGTH CONCRETE APPROACH SLABS	SY
HIGH-EARLY-STRENGTH CONCRETE PAVEMENT (CONTINUOUSLY REINFORCED)	SY

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

No additional compensation will be allowed when the Contractor, at his option, uses high-early-strength portland cement in lieu of standard cement.

SECTION 307 – PLANER PROFILING PAVEMENTS

307.01 – DESCRIPTION

This work shall consist of profiling the existing pavement surface to a depth shown on the Plans below the present finished grade and removing gouges, spalls, ridges, ruts or other imperfections. The planer profiling work shall produce a plane surface with surface aggregate sheared by the scarifying action yielding a surface of uniform texture free from longitudinal ridges, with a pattern which will meet straightedge requirement for "plant mix asphalt concrete pavement" Section 301 and textured in a manner approved by the Engineer

307.03 – EQUIPMENT

The planer profiling machine shall be one piece of equipment especially designed and built for this type of work. It shall be self-propelled, fully automated to control the depth of cut and slope from a preset or traveling reference line. The machine shall be capable of cutting reasonably flush to the curb and to inlets, manholes, or similar items within or adjacent to the pavement. The planing operation shall be performed continuously by the forward motion of the machine. If a heater planer machine is used it shall have, in addition to the above, the means in combination, for controlled heating and planing the existing surfaces without burning or tearing the surface. The blades for cutting shall be self-sharpening, controlled from the operator's station and shall deliver the cuttings into windrows in a manner approved by the Engineer. The width of the heating and cutting shall be not less than four (4) feet and the effective wheel base of the machine shall be not less than eighteen (18) feet. The heating method used shall not detrimentally soot or oil-coat the aggregates or asphaltic materials.

307.04 – CONSTRUCTION METHODS

The Contractor shall provide all necessary warning lights, barricades, flagmen and signs incidental to the protection of the public and workmen during the planer profiling operations as required by the current edition of the Manual on Uniform Traffic Control Devices. The existing pavement surface shall be uniformly profiled. If a heater planer is used the surface shall be heated to a temperature of no more than two hundred seventy-five degrees F (275°F) and shall be shaved or cut to the new planed surface.

The temperature at which the work is performed, the nature and condition of the equipment, and the manner of performing the work shall be such that the pavement is not torn, broken, burned or otherwise damaged by the planing operation. The machine shall make as many passes as necessary to remove the irregularities and to profile the surface to the depth shown on the Plans in a manner approved by the Engineer. Unless otherwise shown on the Plans, all material removed from the surface will not be paid for separately but shall become

the property of the Contractor and shall be disposed of by him in a manner approved by the Engineer.

307.06 – METHOD OF MEASUREMENT

Planer profiling will be measured by the square yard of surface area of completed and accepted work.

307.07 – BASIS OF PAYMENT

Accepted quantities of planer profiling, measured as provided above, will be paid for at the contract unit price for:

PLANER PROFILING SY

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

SECTION 309 – COLD MILLING PAVEMENT

309.01 – DESCRIPTION

This work shall consist of cold milling and removing existing pavement surfaces below the present grade to a depth shown on the plans, removing ridges, ruts and other imperfections as determined by the Engineer. The milling operation shall produce a plane surface that will provide a smooth riding surface for traffic.

309.03 – EQUIPMENT

The Contractor shall provide a power operated milling machine capable of planing a minimum depth of one and one-half inches in a single pass. The equipment shall be self-propelled with sufficient power, traction and stability to maintain accurately and automatically establishing profile grades along each edge of the machine by referencing the existing pavement by means of a ski, or matching shoe or from an independent grade control, and shall have an automatic system for controlling cross slope at a given rate. The machine shall be equipped with an integral loading means to remove the material being cut from the pavement surface and to discharge the cuttings into a truck, all in a single operation.

309.04 – CONSTRUCTION METHODS

The existing pavement shall be uniformly milled to provide a uniform texture, true to line, grade and cross section, it shall have no deviations in excess of three-sixteenths inch (3/16”) in ten (10) feet. Any portion of the planed surface not meeting this requirement shall be corrected in a manner approved by the Engineer.

The machine shall make as many passes as necessary to remove irregularities and to profile the surface to the depth and cross slope shown on the Plans.

Cold milling shall be done in a manner that will not create undue traffic hazards.

The milling operation shall be performed in each lane in such a manner that the milled lanes are evened up as near as practical at the end of each day's operation so as to eliminate the hazard of an exposed vertical edge when traffic is carried through construction.

All materials removed shall become the property of the Contractor and shall be disposed of by him in a manner approved by the Engineer.

309.06 – METHOD OF MEASUREMENT

Cold milling pavement will be measured by the square yard of surface area.

309.07 – BASIS OF PAYMENT

Accepted quantities of cold milling pavement, measured as provided above, will be paid for at the contract unit price for:

COLD MILLING PAVEMENT SY

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

SECTION 310 – CONCRETE JOINT REHABILITATION

310.01 – DESCRIPTION

This work shall consist of sawing, cleaning and sealing contraction joints in existing portland cement concrete pavement in reasonably close conformity with the details shown on the Plans or as approved by the Engineer.

310.02 – MATERIALS

Materials shall meet the requirements of Section 932 for the type joint filler or sealer shown on the Plans or designated in the Proposal.

310.03 – EQUIPMENT

All necessary equipment shall be furnished by the Contractor. The minimum requirements for the construction equipment as required to complete the work as specified herein.

A) Concrete Saw - Sawing equipment adequate in size and power to complete the sawing of concrete joints to the required dimensions.

B) High Pressure Water Pumping System - High pressure water pumping system capable of delivering sufficient pressure and volume of water to thoroughly flush concrete slurry from sawed joints.

C) Sand Blasting Unit - Compressed air pressure type sand blasting equipment of proper size and capacity to clean joint surfaces as specified. The unit shall be equipped with suitable traps for removal of all free water and oil from the compressed air.

D) Air Compressors - Air compressors capable of delivering compressed air having a pressure in excess of 90 psi and equipped with suitable traps for removal of all free water and oil from the compressed air.

E) Extrusion Pump - Air powered extrusion pumps as required for applying joint sealer with an output capable of delivering a sufficient volume of material to the joint.

F) Injection Tool - A mechanical injection device as required for applying the sealer into the joint.

310.04 – CONSTRUCTION METHODS

A) Sawing Joints - The existing contraction joints shall be cut to the width and depth shown on the Plans. Sawing shall be done in such a manner as to produce a new joint having a cut face on both sides and be uniform in width along its full length.

B) Flushing Joints - Within five (5) minutes after sawing, the resulting slurry shall be removed from the joint and immediate area flushed with a high-pressure water system and other equipment necessary to thoroughly remove the slurry.

C) Cleaning Joint Faces

1) General - The cut faces of the joints shall be thoroughly cleaned of all foreign materials, as may be required for proper installation and bonding of the joint sealer or filler, including old sealant or any residue from water flushing operations, by sandblasting as required. The use of portable hand saws will not be permitted for cleaning joint faces.

   The cut faces of the joint shall be thoroughly air dried for a minimum of forty-eight (48) hours after flushing with water. Blow-drying of the joints with compressed air will not be permitted.

2) Sandblasting - After complete drying, the joint shall be sandblasted. The sandblaster nozzle shall be attached to a mechanical aiming device so as to direct the sandblast to approximately a forty-five (45) degree angle and at a maximum of two (2) inches from the faces of the joint. Both

joint faces shall receive sandblasting.

After sandblasting the joints shall be blown out using filtered oil free and moisture free air at a minimum of 90 psi and 120 cfm. Blowing out of the joint shall be accomplished by using a blow tube that will fit into the joint.

After blowing, the joint shall be checked for any residual dust or coating. If any is found the sandblasting and blowing operations shall be repeated until the joint is cleaned. The cleaned joints shall be sealed the same day as cleaned. Joints left open overnight shall be recleaned prior to sealing.

3) Joint Contamination - In the event the open joints prepared for installation of joint sealing materials become contaminated by traffic, or the result of weather conditions, they shall be recleaned as specified above or as approved by the Engineer.

D) Bond Breaker Rod - When shown on the plans or recommended by the sealant manufacturer, a bond breaker rod shall be installed prior to application of the joint sealant. The bond breaker rod shall be of the type recommended by the manufacturer of the sealant material. The bond breaker rod shall be installed in a manner that will produce the dimensions (width and depth) described on the Plans.

E) Sealing Joints

1) Approval of Joints for Sealing - The Department's inspectors will examine joints prepared for sealing just prior to installation of the joint filler or sealer. Joints will not be approved for sealing if contaminated or not adequately dry as required for bonding of sealing materials.

2) Installation of Joint Sealers and Fillers: A representative of the joint filler and/or joint sealer manufacturer shall be on the job site at the beginning of the joint sealing operation to demonstrate to the Contractor and to the Department's inspectors the manufacturer's acceptable standards for installation of the joint sealant materials.

3) Application of Joint Sealers: Joint Sealers - The joint sealer shall be applied, using a mechanical injection tool approved by the Engineer. Application of the joint sealer will not be permitted when the joint temperature is less than forty degrees F (40°F). Joints shall not be sealed unless they are thoroughly clean and dry. Sealers to fill the joint shall be injected into the joint and applied in a manner which causes it to bond to the joint face surfaces. The surfaces of sealers requiring tooling shall be tooled, using an approved mechanical device to produce a slightly concave surface approximately 0.25 to 0.50 inch below the pavement surface. Tooling shall be accomplished before a skin forms on the surface of the sealer. The use of soap or oil as a tooling aid will not be permitted. Tooling will not be required if the sealer is self-leveling.

4) Bonding Failures - Failure of the sealant to bond to sawed surfaces of the concrete joint will be cause for rejection and repair shall be at the Contractor's expense.

F) Traffic - Traffic shall not be allowed on the fresh applied sealant until it becomes tack free.

310.06 – METHOD OF MEASUREMENT

Concrete joint rehabilitation will be measured by the linear foot after the joint sealant is in place.

310.07 – BASIS OF PAYMENT

The accepted quantities, measured as provided above, will be paid for at the contract unit price for:

CONCRETE JOINT REHABILITATION LF

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

SECTION 311 – FABRIC REINFORCEMENT FOR ASPHALT CONCRETE PAVEMENT

311.01 – DESCRIPTION

This work shall consist of the application of reinforcement fabric for plant mix asphalt concrete pavement in accordance with these Specifications and in reasonably close conformity with the locations and dimensions shown on the Plans or established by the Engineer.

311.02 – MATERIALS

Materials shall meet the requirements specified in 900 - Materials.

311.03 – EQUIPMENT

A) General - Equipment and tools necessary for performing all parts of the work shall be furnished by the Contractor in conformance with Section 100 General Provisions.

B) Fabric Laydown Equipment - Mechanical laydown equipment shall be capable of handling full or partial rolls of fabric and shall be capable of laying the fabric smoothly without excessive wrinkles and/or folds. When manual laydown is required, a length of standard one inch (1") pipe, together with suitable roll tension devices shall be used for proper roll handling.

C) Miscellaneous Equipment - Miscellaneous equipment shall include stiff bristle brooms to smooth the fabric, scissors or blades to cut the fabric, and brushes as required for use in appyling asphalt binder to fabric overlap as spliced joints.

311.04 – CONSTRUCTION METHODS

A) Surface Preparation - The surface on which the fabric is to be placed shall be free of dirt, dust, water, oil or other foreign matter.

B) Application of Bituminous Binder - Bituminous binder material shall be heated and uniform spray applied over the area to be fabric covered. Laps shall be mopped between layers of fabric. The longitudinal lap may be sprayed with the distributor. The minimum application temperature of the bituminous binder shall not be less than two hundred ninety degrees F (290°F). If the fabric is oversprayed, the maximum application temperature shall not exceed three hundred twenty-five degrees F (325°F) to avoid damage to the fabric. The bituminous binder shall be applied at the rate of 0.20 to 0.35 gal./SY (actual application rates will be based on asphalt retention tests for the fabric used) as established by the Engineer. Application of the bituminous material shall be accomplished with an asphalt distributor. Areas not accessible to the distributor shall be hand sprayed. The distributor shall be started and stopped over paper or roofing felt to provide neat cutoff lines. The width of binder application shall be two (2) to six (6) inches wider than the fabric width. Care shall be exercised in the application of the binder to avoid spills or excessive application to cause flushing of the bituminous material.

C) Placement of Reinforcement Fabric - The fabric shall be placed after the bituminous binder has been applied and before the binder has cooled and lost tackiness. The fabric shall be unrolled and placed into the binder with the unfused (fuzzy) side down with a minimum of wrinkles. Every effort shall be made to lay the fabric as smoothly as possible. The fabric shall be broomed to remove air bubbles and maximize fabric contact with the pavement surface. Wrinkles shall be cut and laid out flat. If misalignment of the fabric occurs the fabric shall be cut, realigned and jointed as directed by the Engineer. Overlap of fabric at joints shall be between four (4) and six (6) inches. Transverse joints shall be shingled in the direction of paving to prevent edge pick up by the paver. Additional binder shall be applied to joints at the rate specified by the Engineer. Transverse joints shall be mopped, brushed or hand sprayed. The longitudinal joints shall be sprayed with the distributor. The reinforcement fabric shall be embedded into the bituminous binder and bonded to the pavement. Self-propelled pneumatic tired rollers may be used if deemed necessary by the Engineer. Fabric not overlaid the same day shall be blotted with clean apparently dry sand before

being turned to traffic. Sand for blotting will be included in other items for payment.

D) Weather Limitations - Asphalt binder shall not be applied for installation of the fabric when the air temperature is less than fifty degrees F (50°F) unless otherwise approved by the Engineer.

E) Tack Coat - Tack coat, if required, for the pavement overlay shall be applied in accordance with Section 313. The bituminous material type, grade, rate of application and temperature shall be approved by the Engineer. Cut-back asphalt or emulsified asphalt containing petroleum distillate additives shall not be used.

F) Pavement Overlay - Placement of the asphalt concrete pavement overlay should closely follow fabric lay down unless otherwise permitted by the Engineer. Any damage or disbonding of the fabric reinforcement membrane caused by traffic or wet weather conditions due to unnecessary delay or negligence of the Contractor shall be repaired at his own expense. In the event excess binder bleeds through the fabric before the overlay is placed, the excess material shall be blotted by spreading sand on the affected area as directed by the Engineer. The temperature of the paving mix at time of placement on the reinforcement fabric membrane shall not exceed three hundred twenty-five degrees F (325°F) to prevent damage to the fabric. The turning of pavers or other vehicles should be gradual and kept to a minimum to avoid damage to the fabric. Should equipment tires pick up the fabric or the paver cause movement of the membrane during paving operations asphalt paving mix may be broadcast ahead of trucks and the paver to prevent damage. Any damage to the reinforcement membrane due to equipment shall be repaired by the Contractor at his expense.

311.06 – METHOD OF MEASUREMENT

Fabric reinforcement will be measured by the square yard in place.

Bituminous binder will be measured by the gallon in accordance with Section 311.04.

311.07 – BASIS OF PAYMENT

The accepted quantities of fabric reinforcement and bituminous binder, measured as provided above, will be paid for at the contract unit price for:

FABRIC REINFORCMENT	S.Y.
BITUMINOUS BINDER	GAL

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

SECTION 312 – DIAMOND GRINDING CONCRETE PAVEMENT

312.01 – DESCRIPTION

This work shall consist of grinding portland cement concrete pavement to restore drainage and riding characteristics to the pavement surface. This work shall be accomplished in accordance with these Specifications and in reasonably close conformity to the details shown on the Plans.

312.03 – EQUIPMENT

The grinding equipment shall be a power driven, self-propelled machine that is specifically designed to smooth and texture portland cement concrete pavement with diamond blades. The effective wheel base of the machine shall not be less than twelve (12) feet. It shall have a set of pivoting tandem bogey wheels at the front of the machine and the rear wheels shall be arranged to travel in the track of the fresh cut pavement. The center of the grinding head shall be no further than three (3) feet forward from the center of the back wheels.

The equipment shall be of a size that will cut or plane at least three (3) feet wide. It shall also be of a shape and dimension that does not encroach on traffic movement outside of the work area. Equipment that causes excessive ravels, aggregate fractures, spalls or disturbance of the transverse and

longitudinal joints or cracks will not be permitted.

312.04 – CONSTRUCTION

A) Grinding Pavement - The Plans will designate the areas of pavement surfaces to be ground. Grinding shall be performed in the longitudinal direction so that grinding begins and ends at lines normal to the pavement centerline. The entire area designated on the Plans shall be ground until the pavement surfaces of adjacent sides of transverse joints and cracks are in the same plane. Extra depth grinding to eliminate minor depressions in the pavement to obtain one hundred (100) percent texturing will not be required.

The construction operation shall be scheduled and proceed in a manner that produces a uniform finished surface. Grinding shall be accomplished in a manner that eliminates joint or crack faults, while providing positive lateral drainage by maintaining a constant cross-slope between the edges of grinding operations. Auxiliary or ramp lane grinding shall transition as required from the mainline edge to provide positive drainage and an acceptable riding surface.

1) Surface Texture and Grooving - The grinding process shall produce a pavement surface that is uniform in appearance with a longitudinal line type texture. The surface shall have grooves between 0.09 to 0.15 inches wide, spaced up to 0.125 inches apart. The peaks of the ridges shall be approximately one-sixteenth inch (1/16") higher than the bottom of the grooves.

2) Slurry Removal - The Contractor shall provide positive means for removal of grinding slurry or residue by vacuum or other continuous methods. Slurry shall not be allowed to flow across lanes being used by traffic.

3) Pavement Smoothness

i) Profiling Pavement Surface - All ground surfaces shall be profiled by the Contractor for smoothness using the profilograph specified on the Plans or in the Proposal. Profiles will be made three (3) feet from and parallel to each edge of pavement and at the approximate location of each longitudinal joint for all pavement areas. Pavement so test shall have a profile index of five (5) inches per mile or less using 0.2 inch blanking width. Individual high points in excess of 0.3 inch, as determined by measurements of the profilograph shall be reduced by grinding, until such high points as indicated by reruns of the profilograph do not exceed 0.3 inch.

After grinding has been completed to reduce individual high points in excess of 0.3 inch, additional grinding shall be performed as necessary to reduce the profile index to values specified above in any 0.1 mile section along any line parallel with the pavement edge.

Additional grinding shall be performed as necessary. All ground areas shall be neat rectangular areas of uniform surface appearance.

ii) Straight Edge Tolerance - The surface may be straightedged, at locations to be determined by the Engineer, with a straightedge ten (10) feet long. When the straightedge is laid on finished pavement parallel to centerline or normal to the centerline, the maximum distance to the roadway surface from the bottom edge of the straightedge shall not exceed one-eighth (1/8) inch at any point. Additional grinding will be required at the locations found in excess of the one-eighth (1/8) inch tolerance.

B) Traffic Control - Traffic control shall be in accordance with the Manual on Uniform Traffic Control Devices.

312.06 – METHOD OF MEASUREMENT

Diamond grinding concrete pavement will be measured by the square yard. The square yards measured will be the final textured surface area regardless of the number of passes required to achieve acceptable results. Minor areas of untextured pavement within the designated areas to be textured will

be included in the measurement.

312.07 – BASIS OF PAYMENT

The accepted quantities, measured as provided above, will be paid for at the contract unit price for:

DIAMOND GRINDING SY

SECTION 313 – TACK COAT

313.01 – DESCRIPTION.

This work shall consist of preparing and treating an existing bituminous or concrete surface with bituminous material in accordance with these Specifications and in reasonably close conformity with the lines shown on the Plans or established by the Engineer.

313.02 – MATERIALS.

Materials shall meet the requirements specified in the following Section of Section 900-Materials:

Asphalt Materials 931.03

The emulsified asphalt may be diluted as specified or approved by the Engineer.

313.03 – EQUIPMENT.

Distributors, heating equipment, and supply tanks shall meet the requirements of Section 301.

313.04 – CONSTRUCTION METHODS.

Clean the existing surface or course to the satisfaction of the Engineer before tack coat is placed. Apply the tack coat, as directed by the Engineer, at the rate of—and not to exceed—0.1 gallon per square yard of surface. Paint all contact surfaces of curbs and gutters, manholes, and other structures with a thin, uniform coat of asphalt material used for the tack coat. Apply the tack coat in such manner as to minimize damage, offer the least inconvenience to traffic, and permit one-way traffic without pickup or tracking of the bituminous material.

NOTE: Do not apply tack coat during wet or cold weather, when wind drift presents a potential problem to the traveling public or adjacent property, after sunset, or to a wet surface; however, the surface may be damp. Tack coat that is not "covered" the same day may be reapplied at a rate that insures proper adhesion as directed by the Engineer.

The quantity, rate of application, temperature, and areas to be treated shall be approved prior to application.

313.06 – METHOD OF MEASUREMENT.

Tack coat will be measured by the gallon before dilution.

NOTE: Water used in dilution of emulsified asphalt will not be measured for payment.

313.07 – BASIS OF PAYMENT.

The accepted quantities, measured as provided above, will be paid for at the contract unit price as follows:

TACK COAT GAL

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.

SECTION 390 – PAVEMENT AND SURFACES CONSTRUCTION STANDARD BID ITEMS

390.01 – DESCRIPTION

This section covers Standard Bid Items used in the contract documents for the construction of pavements and surfaces. Additional bid items may be called out in the Special Provisions, other sections of the Standard Specifications, or as directed by the Engineer for additional work covered and change orders.

SECTION	CODE	DESCRIPTION	UNIT
301	301-01	ASPHALTIC CONCRETE TYPE (A – E) (X INCHES)	S.Y.
301	301-02	ASPHALTIC CONCRETE TYPE (A – E)	TON
301	301-03	ASPHALT CONCRETE, TYPE (A – E) (POL. MOD.)	TON
301	301-04	ASPHALTIC CONCRETE LEVELING COURSE	TON
302	302-01	RHM - ASPHALTIC CONCRETE TYPE (A - E) (X INCHES)	S.Y.
302	302-02	RHM - ASPHALTIC CONCRETE TYPE (A - E)	TON
302	302-03	RHM - ASPHALT CONCRETE, TYPE (A - E) (POL. MOD.)	TON
302	302-04	RHM - ASPHALTIC CONCRETE LEVELING COURSE	TON
303	303-01	EMULSIFIED ASPHALT	GAL.
303	303-02	EMULSIFIED ASPHALT	TON
303	303-03	TYPE I AGGREGATE	TON
303	303-04	TYPE II AGGREGATE	TON
303	303-05	TYPE III AGGREGATE	TON
304	304-01	PORTLAND CEMENT CONCRETE PAVEMENT	S.Y.
304	304-02	APPROACH SLABS	S.Y.
304	304-00	PORTLAND CEMENT CONCRETE PAVEMENT (CONTINUOUSLY REINFORCED)	S.Y.
305	305-00	CURB AND GUTTER	L.F.
306	306-00	HIGH-EARLY-STRENGTH CONCRETE PAVEMENT	S.Y.
306	306-00	HIGH-EARLY-STRENGTH CONCRETE APPROACH SLABS	S.Y.
306	306-00	HIGH-EARLY-STRENGTH CONCRETE PAVEMENT (CONTINUOUSLY REINFORCED)	S.Y.
307	307-00	PLANER PROFILING	S.Y.
309	309-00	COLD MILLING PAVEMENT	S.Y.
310	310-00	CONCRETE JOINT REHABILITATION	L.F.
311	311-00	FABRIC REINFORCMENT	S.Y.
311	311-00	BITUMINOUS BINDER	GAL.
312	312-00	DIAMOND GRINDING	S.Y.
313	313-00	TACK COAT	GAL.

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SECTION 400

SECTION 400 – STRUCTURES CONSTRUCTION

SECTION 401 – STRUCTURAL EXCAVATION

401.01 – DESCRIPTION

401.01.01 – GENERAL

This section covers structural excavation which consists of the removal of material for the construction of foundations for bridges, retaining walls, head walls for culverts, or other structures, and other excavation designated on the plans or in these specifications or in the special provisions as structural excavation, and the subsequent backfill of these same structures.

Structural backfill shall consist of furnish material, if necessary, and placing and compacting backfill material around structures to the lines designated on the plans as specified or directed by the Engineer.

Structural excavation and structural backfill shall include the furnishing of all materials and equipment; the construction or installation of all cofferdams and other facilities which may be necessary to perform the excavations and place and compact the backfill; and the subsequent removal of such facilities, except where they are required or permitted by the plans or specifications to remain in place.

401.01.02 – COFFERDAMS

Cofferdams for foundation construction shall be carried well below the bottom of the footings and shall be well braced and reasonably watertight. The interior dimensions of cofferdams shall provide sufficient clearance inside the wales for constructing forms and driving piles and to permit pumping outside the forms.

If, in the judgment of the Contractor, the clearance provided on the plans between the outside line of the footing and any pile or interior wall or surface is not sufficient to permit the driving of piles or building of forms, he may provide such necessary clearance by constructing the cofferdam sufficiently large to provide such clearance as he may deem necessary. Any such enlargement in excess of one (1) foot outside the dimensions of the footing as shown on the plans shall be considered as being for the sole purpose of expediting the work of the Contractor and such excavation and backfill shall be at the Contractor's expense.

Cofferdams which are tilted or moved out of position by any cause during the process of sinking shall be plumbed or enlarged so as to provide the necessary clearance and proper pier location and such work shall be at the Contractor's expense.

In tidal water or in streams at a time of probable flood, cofferdam walls shall be vented at low water elevation to insure equal hydrostatic head both inside and outside of the cofferdam during the period of pouring and setting of seals.

No shoring will be permitted in cofferdams which will induce stress, shock, or vibration in the permanent structure.

For substructure work, the Contractor shall submit drawings showing his proposed method of cofferdam construction and other details left open to his choice or not fully shown on the plans. The type and clearance of cofferdams, insofar as such details affect the character of the finished work, will be subject to the approval of the Engineer, but other details of design will be left to the Contractor who will be submitted a minimum of ten (10) to thirty (30) days in advance of the time the Contractor begins construction of the cofferdams.

After completion of the substructure, the cofferdams will all sheeting and bracing, shall be removed at least two (2) feet below the level of the stream bed, by the Contractor at his expense, and such removal shall be performed in a manner that will not disturb or mar the finished concrete or masonry.

401.04 – CONSTRUCTION METHODS

A) Excavation

1) When footing concrete or masonry is to rest upon rock, the rock shall be removed to a depth sufficient to expose sound rock. The rock shall be roughly leveled off or cut to approximate horizontal and vertical steps, and shall be roughened. Seams in the rock shall be grouted under pressure or treated as the Engineer may direct and the cost thereof will be included for payment in the quantities for the unit of the structure for which the excavation is made. When footing concrete or masonry is to rest on an excavated surface other than rock, care shall be taken not to disturb the bottom of the excavation and final removal of the foundation material to grade shall not be made until just before the concrete or masonry is placed. Except when overexcavation is directed by the Engineer, excavation below grade shall be replaced at the Contractor's expense with the same class of concrete specified for the structure and at the time the concrete for the structure is being placed.

2) Excavated material required to be used for backfill may be deposited by the Contractor in storage piles at points convenient for rehandling of the material during the backfilling operations. The location of storage piles shall, however, be subject to the approval of the Engineer who may require that the survey centerline of the structure and the transverse or hub line of any unit of the structure be kept free of any obstruction.

3) Excavated material required to be wasted shall be disposed of as directed by the Engineer, and the disposal shall be in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure or other part of the work.

4) For all single and multiple box culverts, pipe culverts, and pipe arch culverts where the soil encountered at established footing grade is a quicksand, muck, or similar unstable material, the following procedure shall be used unless other methods are called for on the plans:

   All unstable soil shall be removed to a depth of two (2) feet below bottom of culvert for culverts two (2) feet or more in height, and to a depth equal to the height of culvert for culverts less than two (2) feet in height. Such excavation shall be carried at least one (1) foot beyond the horizontal limits of the structure on all sides. All unstable soil so removed shall be replaced with suitable stable material, placed in uniform layers of suitable depth for compaction as directed by the Engineer, and each layer shall be wetted if necessary, and compacted by rolling or tamping as required to provide a stable foundation for the structure. Soil which is considered to be of sufficient stability to sustain properly the adjacent sections of the roadway embankment will be considered a suitable foundation material for the culvert.

5) When the material encountered at footing grade of a culvert is found to be partially rock or incompressible material, and partially a soil or material that is compressible but otherwise satisfactory for the foundation, the incompressible material shall be removed for a depth of six (6) inches below the footing grade and backfilled with a material similar to the compressible foundation used for the rest of the structure.

6) When the material encountered at footing grade of a bridge bent or pier is found to be partially of rock or incompressible material, and partially of a compressible material, the foundation shall not be placed until the Engineer has inspected the footing and authorized such changes found necessary to provide an adequate foundation.

B) Backfill - Structural back fill shall not be placed until the structure footings or other portions of the structure or facility have been inspected by the Engineer and approved for backfilling. As soon as practicable all spaces excavated under this item and not occupied by the permanent structure shall be backfilled, except that no backfill shall be placed against any abutment or retaining wall until such structure has been in place at least seven (7) days. No backfill shall be placed adjacent to box culverts until the top slab has been in place at least four (4) days. When called for on the plans, special backfill material, such as pit run gravel, shall be placed at the locations and in the manner called for on the plans. All other backfill material shall be earth, free of any appreciable amount of stone or gravel particles more than four (4) inches in greatest dimension, large or frozen lumps, wood or other extraneous material, and shall be of such gradation as to permit thorough

compaction.

That portion of backfill which will support any portion of the roadway or embankment shall be placed in uniform layers not to exceed six (6) inches in depth (loose measurement) and compacted to that each layer and the completed backfill has a density of not less than ninety-five (95) percent of the maximum density as determined by ASTM Designation D-698.

That portion of backfill which will not support any portion of the completed roadway or embankment shall be placed in layers not more than ten (10) inches in depth and compacted to a density comparable with the adjacent, undisturbed material. The compacted layers of backfill shall be brought up uniformly on all sides of the structure or facility.

Care shall be taken to prevent any wedging action when placing backfill around abutments or wingwalls.

Compaction of structural backfill by ponding and jetting will be permitted when, as determined by the Engineer, the backfill material is of such character that it will be self-draining when compacted and that foundation materials will not soften or be otherwise damaged by the applied water, and no damage to the structure from hydrostatic pressure will result. Ponding and jetting of the upper two (2) feet below finished subgrade will not be permitted in roadway areas. When ponding and jetting is permitted, material for use as structural backfill shall be placed and compacted in layers not exceeding four (4) feet in thickness. The work shall be performed without damage to the structure or softening of the embankment, and in such a manner that excess water will not be impounded. Ponding and jetting methods shall be supplemented by the use of vibratory or other compaction equipment when necessary to obtain the required compaction.

401.06 – METHOD OF MEASUREMENT

Measurement for payment will be for material excavated within the limits shown on the plans or as directed by the Engineer.

Unless otherwise provided in the special provisions or proposals, no payment will be made for structural excavation or backfill as such; the cost thereof under normal circumstances being considered as included in the price bid for the construction or installation of the items to which such excavation or backfill is incidental or appurtenant.

Payment for such excavation or backfill will be made only when the special provisions or proposal provide.

When provided for, payment for work performed under these specifications will be made at the unit price bid per cubic yard for Unclassified Excavation which price shall be full compensation for all excavation and backfill and for all materials, labor, tools, and incidentals necessary to complete the work.

401.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

STRUCTURAL EXCAVATION C.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 402 – DRILL SHAFT FOUNDATIONS

402.01 – DESCRIPTION

This section covers the construction of foundations consisting of reinforced concrete shafts with or without bell type concrete footings. Concrete shafts shall be placed in drilled excavation when the

shafts are without bell type footings and in drilled and underreamed excavation when shafts are with bell type footings. Such foundations shall be constructed in accordance with this item and in conformance with the details and governing dimensions shown on the plans.

402.02 – MATERIALS

All concrete materials and their preparations shall be in accordance with the requirements of Section 932, "Portland Cement Concrete", and the additional requirements herein.

When Casing of the shaft is required, the following shall apply:

A) The maximum size coarse aggregate shall be one and one-half (1 1/2) inches.

B) The elapsed time from beginning of placement of concrete in the cased portion of the shaft until extraction of the casing is begun, shall not exceed thirty (30) minutes. If a set retarding admixture is used, this time shall not exceed one (1) hour. If nonagitating equipment is used to haul the concrete from a central mixing plant the elapsed time from discharge of concrete from the mixer to placement in the shaft shall not exceed ten (10) minutes. If a set retarding admixture is used, this time shall not exceed thirty (30) minutes.

C) When the temperature of the air or concrete is above eighty-five (85) degrees F, an approved set retarding admixture will be required in all drilled shaft concrete.

D) Reinforcing steel shall conform to the requirements of Section 941, "Reinforcing Steel". The sizes and dimensions shall be as shown on the plans.

402.04 – CONSTRUCTION METHODS

The Contractor shall do all excavation required for the shafts and bell footings through whatever materials are encountered, and to the dimensions and elevations shown on the plans or required by the site conditions. Unless otherwise shown on the plans, all shafts shall be bored plumb to a tolerance of one and one-half (1 ½) inches for depths up to and including ten (10) feet plus an additional tolerance of five hundredths (0.05) inch per foot for depths in excess of the first ten (10) feet. When bells are required, they shall be excavated so as to form a bearing area of the size and shape shown on the plans. Shafts and bells may be excavated either by hand or by mechanical methods. Blasting methods shall be used only with permission of the Engineer and when used shall be so conducted as to avoid disturbance of the formations below or outside the limits of the proposed shaft concrete.

The plans indicate the expected depths and elevations at which satisfactory bearing material will be encountered, and this information will be used as a basis for the contract. If satisfactory foundation materials are not encountered at plan elevations, the footings may be raised or lowered as determined by the Engineer. Alterations in plan depths shall be made as judged proper to satisfactorily comply with the design requirements.

Casings will be required for shaft excavations when such provision is necessary to prevent caving of the material or when necessary to shut off seepage water. Casings shall be of metal and of ample strength to withstand handling stresses, the pressure of concrete and of the surrounding earth or backfill materials, and shall be watertight. The inside diameter of the casing shall not be less than the nominal size of the shaft. No extra compensation will be allowed for the concrete required to fill an oversize casing or oversize excavation.

When the drilling operation reaches a point where caving conditions and/or excess groundwater is encountered, no further drilling will be allowed until a construction method is employed which will prevent any caving that tends to make the excavation appreciably larger than the size of casings to be used. Drilling in a mud slurry without the removal of cuttings, or other construction methods which will control the size of excavation, will be permitted.

If the elevation of the top of the shaft is below ground level at the time of concrete placement, an oversize casing from ground elevation to a point below the top of the shaft shall be required to control caving of any material into the freshly placed concrete.

Any excavation for the footing bells or shafts beyond the lines required, shall be backfilled with concrete at the Contractor's expense. Where casings are used, the Contractor will be permitted to backfill around the upper portion of the casing with pea gravel or other granular material. Where a double casing is required for a portion of the shaft, no material shall be placed between the casings but this area will be filled with concrete.

Under normal operations when the casing is to be removed, the removal shall not be started until all concrete placement is completed in the shaft. Movement of the casing for short pulls of a few inches, or rotating of the casing to insure the breaking of bond of the concrete to the casing will be permitted. When unusual conditions warrant, the casing may be pulled in partial stages. In all cases a sufficient head of concrete shall be maintained at all times above the bottom of the casing to overcome hydrostatic pressure. Extraction of the casing shall be at a slow, uniform rate and the pull shall be in a truly vertical direction.

If any upward movement of the concrete and/or steel inside the casing occurs at any time during the pulling operation, the following criteria shall govern:

If the upward movement is one (1) inch or less, the casing may be left in place and the shaft used if the concrete is vibrated or rodded to reconsolidate the concrete. Vibration or rodding shall not be used to attempt to break the casing loose for extraction unless the entire shaft is to be replaced.

If the upward movement is greater than one (1) inch, all of the material shall be removed and the entire drilled shaft operation shall be redone.

Placing of drilled shaft concrete under water shall not be done without the permission of the Engineer.

Material excavated from shafts and bells and not used in the backfill around the completed bents or piers shall be disposed of as directed by the Engineer. The disposal of such material shall be in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure or other parts of the works.

At the time concrete is placed, the excavation shall be free from accumulated seepage water and all loose material shall be removed from the base area.

The Contractor shall provide suitable access and lighting for the Engineer to inspect the completed foundation excavation and check the dimensions and alignment of drilled shafts and the underreamed excavation when underreaming is required.

At any time when a person is in the hole, provisions shall be made for pumping fresh air to the workman. Any required lighting shall be by electric lights. Any mechanical equipment used in the excavation shall be operated by air or electricity. The use of gasoline driven engines placed in the excavation for pumping or drilling will not be permitted.

In order that the Engineer may judge the adequacy of a proposed foundation, the Contractor, if requested, shall make soundings or take cores at his expense to determine the character of the supporting materials. The depth of such soundings or cores will not be required to exceed five (5) feet below the proposed footing grade. It is the intent of this provision that soundings shall be made or cores taken at the time the excavation in each foundation is approximately complete.

When the plans require drilled shafts in the end bents, the embankment at the bridge ends shall be made to grade shown and thoroughly compacted as provided in the governing specifications prior to drilling for end bent shafts.

A) Reinforcing Steel - The reinforcing steel cage for the shaft consisting of longitudinal bars and spiral hooping or lateral ties shall be completely assembled and placed into the shaft as a unit. Generally, the reinforcing steel unit shall not be placed until immediately before concreting operations are to be started.

   The longitudinal bars shall be tied to the spiral hooping at intervals not to exceed twelve (12) inches on centers to provide a rigid unit.

For cased shafts where the reinforcing steel cage is over thirty (30) feet in length, the longitudinal bars shall be tied at each intersection of the spiral hooping for a distance of one-fifth (1/5) the depth of shaft from the bottom of the cage.

The cage of reinforcing steel shall be supported from the top by some positive method to prevent slumping downward during extraction of the casing.

In uncased shafts, side spacer blocks of concrete shall be used at intervals along the shaft to insure concentric spacing for the entire length of shaft. In cased shafts, concrete spacer blocks shall not be used, but metal "chair" type spacers shall be placed vertically at intervals around the steel cage to insure concentric spacing inside the casing.

B) Concrete - The work shall be performed in accordance with the provisions of Section 403, and in conformance with the requirements herein.

Preferably, concrete shall be placed immediately after all excavation is complete and reinforcing steel placed.

Concrete placing shall be continuous from the beginning of placing in the shaft or footing bell to the top of shaft or to construction joint as may be indicated on the plans. Time intervals will be allowed for pulling casings, for placing forms, and other operations necessarily carried on in sequence with the placing operations. The reinforcing steel cage shall be held vertical in some manner to restrain the steel from slumping during the concrete placement operation.

Concrete shall be placed through a suitable tube to prevent segregation of concrete materials and unnecessary splashing on the reinforcing steel cage. The tube shall be made in sections to permit the discharge and raising as the placement progresses. A nonjointed pipe may be used if sufficient openings of the proper size are provided to allow for the flow of concrete into the shaft.

Wherever a casing is used, the casing shall be smooth and well oiled and shall extend sufficiently above the grade of the finished shaft to provide excess concrete to be placed for the anticipated slump due to the casing removal. Where a casing is to be pulled, the concrete placed in casing shall be of such workability as to require no vibrating or rodding.

Where a cap block or groundline strut is shown on the plans to be placed at the top of the drilled shaft, and the cap or strut is shown to be placed monolithic with the drilled shaft, a time interval will be allowed for placing the required form and reinforcing after any necessary casing removal.

After a placement is completed, the top surface shall be cured and any construction joint area shall be treated as prescribed in Section 404.

402.04.01 – TEST HOLES

When shown on the plans, or when ordered by the Engineer in writing, test holes will be required to establish elevations for "belling" to determine elevation of groundwater, or to determine other soil characteristics.

The diameter and depth of test hole or holes shall be as shown on the plans or as directed by the Engineer.

402.04.02 – TEST BELLS

When shown on the plans, or when ordered by the Engineer in writing, the underreaming of bells, on specified test holes, will be required to establish the ability to underream in the soil strata present.

The diameter and shape of the test bell shall be as shown on the plans or as directed by the Engineer.

402.06 – METHOD OF MEASUREMENT

Acceptable drilled shaft in place of the specified diameter will be measured by the linear foot. The length shall be based on the plan elevation or elevation as approved by the Engineer. Drilled shaft length would be measured by the linear foot from the shaft base elevation to the top of the shaft

elevation.

Footing bells, constructed to the specified dimensions, or to the altered dimensions as authorized by the Engineer will be measured by the cubic yard of concrete in the acceptable footings placed. The bell shall consist of the authorized footing volume outside the dimensions of the drilled shaft, which for the purpose of measurement, will be considered as extending to the bottom of the bell.

Test holes of the specified diameter will be measured from the elevation of the ground at the time drilling begins, by the linear foot of acceptable test hole drilled.

Test bells of the specified diameter and shape will be measured by each test bell acceptably under reamed.

Drilled shafts will be paid for at the unit price bid per linear foot of the specified diameter of "Drilled Shafts", measurements being made as outlined above. Where vertical and spiral reinforcing bars from the shaft extend into footings, caps, columns, or other concrete members, the cost of such reinforcing shall be included with and paid for as a part of "Drilled Shafts".

A) Drilled Shaft will be paid for the completed length per the plan quantity or authorized by the Engineer.

B) Footing bells, constructed to the specified dimensions or to the altered dimensions as authorized by the Engineer, will be paid for at the contract unit price bid per cubic yard for "Bell Footings".

C) Test holes, of the specified diameter, will be paid for at the contract unit price bid each for "Test Hole".

D) Test bells, of the specified diameter, will be paid for at the contract unit price bid for each "Test Bell".

The foregoing unit prices shall be full compensation for making all excavations, for drilling all test holes and test bells, pumping, placing and removing any required casings, furnishing and placing all concrete and reinforcing steel, all backfilling, and furnishing all tools, labor, equipment, materials, and incidentals necessary to complete the work. No extra payment will be made for casings left in place.

402.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

DRILLED SHAFT (DIAMETER)	L.F.
BELL FOOTING	C.Y.
TEST HOLE	EA.
TEST BELL	EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 403 – CONCRETE STRUCTURES

403.01 – DESCRIPTION

Before starting work, the Contractor shall inform the Engineer fully of the methods of construction he proposes to follow and the amount and character of equipment he proposes to use, the adequacy of which shall be subject to the approval of the Engineer. Plans for forms and falsework for concrete piers and concrete superstructure spans over twenty (20) feet in length and for all widening details shall be submitted to the Engineer for review and approval. Similar plans shall be submitted for other units of structure if requested by the Engineer. The plans shall be prepared on standard twenty-two (22) inch by thirty-six (36) inch sheets. They shall show all essential details of the proposed forms, falsework, and bracing so that a structural analysis may be made. Four (4) sets of such plans will be required.

Concurrence on the part of the Engineer in any proposed construction methods, approval of equipment, or approval of form and falsework plans does not relieve the Contractor of the responsibility for the

safety or correctness of his methods and adequacy of his equipment or from carrying out the work in full accordance with the contract.

Unless otherwise provided, the following requirements shall govern for the time sequence in which construction operations may be carried on and for the opening of completed structures to traffic.

No superstructure members, forms, falsework, or erection equipment shall be placed on the substructure before the substructure concrete has attained 80% of the 28-day specified compressive strength.

The use of completed portions of a structure for storage of materials will not be permitted until all curing requirements for that particular part of the structure have been met.

Forms for walls or columns shall not be erected on concrete footings until the concrete in the footing has cured at least two (2) days. Concrete may be placed in the wall or column as soon as the forms and reinforcing steel placement are approved.

The support of tie beams and/or cap forms by falsework placed on previously placed tie beams is permissible provided such supporting beams have attained 80% of the 28-day compressive strength, curing requirements completed, and are properly supported to eliminate stresses not provided for in the design.

Structures shall not be opened to construction traffic or to the traveling public until authorized by the Engineer. Authorization may be given after the last slab concrete has been in place at least fourteen (14) days for light construction traffic not to exceed a three-fourths (3/4) ton vehicle.

Authorization may be given after the last slab concrete has been in place thirty (30) days or as authorized by the Engineer for the structures to be opened for normal construction traffic and to the traveling public. Construction vehicles with a minimum of three (3) axles may be operated across structures if the total gross load does not exceed fifty-one thousand (51,000) pounds. Because of possible damage to the new structures, care shall be exercised to reduce impact on the new structures by limiting the speed of such vehicles to ten (10) miles per hour or less.

Where a detour is not readily available or is not economically feasible, and an occasional crossing of a structure with overweight construction-equipment such as a concrete paving machine is necessary, the Engineer may permit such crossing after a structural analysis is made giving consideration to the dimensions of the equipment axle spacing and axle loads.

Unless otherwise shown on the plans, the placement of roadway slabs may be by the sequence shown on the plans, using a longitudinal screed or a self-propelled transverse mechanical finishing machine; or by continuous placement using a transverse mechanical finishing machine only. The screed shall be adequately supported on a header or rail system which shall have sufficient stability to withstand the longitudinal or lateral thrust of the equipment.

Supports for a transverse finishing machine shall be installed so that they may be removed without damage to the slab. Bond between the removable supports and the concrete shall be prevented in a manner acceptable to the Engineer. Portions of the rail support system which remain embedded in the slab shall not project above the upper mat of reinforcing steel. Attachment of the rail support system by welding to I-beams or girders will be permitted subject to the following requirements:

A) Welds shall be parallel to the web of the member. Circular or transverse welds will not be permitted.

B) Welds will not be permitted on the tension flange of the members in that area where the stress exceeds seventy-five (75) percent of the allowable stress.

C) Welds shall be made with low hydrogen electrodes.

D) Welding shall be done by a certified welder.

403.01.01 – DRAINS

Weep hole drains and roadway drains shall be installed and constructed as shown on the plans in the designated locations.

Unless otherwise shown on the plans, the size of the weep holes will be three (3) inches in diameter with a permissible variation of plus or minus one-fourth (1/4) inch. A neat pocket shall be excavated at each weep hole for placing the indicated volume of gravel. Washed gravel from three-eights (3/8) inch to one and one-half (1 1/2) inch in size shall be placed in the excavated pocket. When the concrete is not formed at the weep hole location, a sheet of building paper shall be placed over the gravel to prevent the entrance of concrete into the pocket during operations.

403.01.02 – EXPANSION JOINTS

Expansion joints and devices to provide for expansion and contraction shall be constructed where and as indicated herein or on the plans.

The bearing area under the expansion ends of concrete slabs, Pre-stressed concrete beams, girders and slab and girder spans, shall be given a steel trowel finish. These areas shall be finished to the exact grades required. The material used to separate expansion surfaces shall be that shown on the plans and shall be placed carefully so that concrete or mortar cannot be subsequently worked around or under the material.

Concrete adjacent to armor joints and finger joints shall be placed carefully in order to avoid defective anchorage and to avoid porous or honeycombed concrete adjacent to same.

All open joints, and joints to be filled with joint sealing material, shall be constructed using forms adaptable to loosening or early removal. To avoid damage to the adjacent concrete caused by expansion or contraction, these forms shall be loosened as soon as possible after final concrete set to permit free movement of the span without the necessity for full form removal.

Prior to placing the joint sealing material, the vertical faces of the joint shall be cleaned of all laitance by sandblasting or by mechanical routing. Care shall be taken to prevent spalling of adjacent surfaces. Edges which are cracked or spalled shall be removed. The joint shall be blown clean of all foreign material and sealed.

Preformed fiber joint material, whichever used, shall be anchored to the concrete on one side of the joint by means of light wire or nails sufficient to preclude the tendency of the material to fall out of the joint.

Careful workmanship shall be exercised in the construction of all joints. The finished joint shall conform to the indicated outline and the concrete sections shall be completely separated by the specified opening or joint material.

Immediately after the removal of forms and again where necessary after surface finishing, all projecting concrete shall be removed along exposed edges in order to secure full effectiveness of the expansion joints.

403.01.03 – CONSTRUCTION JOINTS

The joint formed by placing plastic concrete in direct contact with concrete that has attained its initial set shall be deemed a construction joint. When concrete is to be placed monolithic, the term monolithic shall be interpreted to mean that the manner and sequence of concrete placing shall be such that construction joints will not be created.

Construction joints will be of the type and at the locations shown on the plans. Additional joints will not be permitted without written authorization from the Engineer. Any additional construction joints shall have details equivalent to those shown on the plans for joints in similar locations.

Unless otherwise provided, construction joints shall be square and normal to the forms. Bulkheads shall be provided in the forms for all joints except horizontal joints.

Construction joints requiring the use of joint sealing material shall be as detailed on the plans. The material will be specified on the plans without reference to joint type.

The top surface of a concrete placement which terminates at a horizontal construction joint shall have the surface roughened thoroughly as soon as practicable after the concrete has attained initial set. The surfaces at bulkheads shall be roughened as soon as the forms are removed.

Before joining plastic concrete to concrete that has already set, the surface of the concrete in place shall be free from all loose material, laitance, dirt, or foreign matter, shall be washed, scrubbed clean and drenched thoroughly with water until saturated, and shall be kept moist until the plastic concrete has been placed. Immediately prior to the placing of additional concrete, all forms shall be drawn tight against the existing concrete and the existing joint surface shall be flushed with a coating of grout mixed in the proportions of one (1) part cement to two (2) parts sand, or painted with an approved bonding agent.

403.01.04 – FALSEWORK

All falsework shall be designed and constructed to safely carry the maximum anticipated loads and to provide the necessary rigidity.

When the falsework is no longer required, it shall be removed. Falsework piling shall be pulled or cut off a minimum of six (6) inches below finished ground level. Falsework and piling in a stream or lake shall be removed completely to a point specified by the Engineer to prevent any obstruction to the waterway.

403.01.05 – FORMS

A) General - Forms shall be of suitable material and of a type, size, shape, quality, and strength to insure construction as designed. The forms shall be true to line and grade, mortar tight, and sufficiently rigid to resist deflection during placing of the concrete. The responsibility for their adequacy shall rest with the Contractor. All dirt, chips, sawdust, nails, and other foreign matter shall be completely removed from forms before any concrete is deposited therein. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes that would deface the finished surfaces. Forms previously used shall be thoroughly cleaned of all dirt, mortar, and foreign matter before being reused. Before concrete is placed in forms, all inside surfaces of the forms shall be thoroughly treated with an approved releasing agent which will leave no objectionable film on the surface of the forms that can be absorbed by the concrete. Care shall be exercised that no releasing agent is deposited on previously placed concrete.

   Forms for all surfaces that will not be completely enclosed or hidden below the permanent surface of the ground shall be made of surfaced lumber, or material which will provide a surface at least equal to surfaced lumber or plywood. Any lumber or material which becomes badly checked or warped, prior to placing concrete, shall not be used.

   Forms for all exposed surfaces of bridges, viaducts, overcrossings, and similar structures shall be constructed of plywood or an approved equal. Plywood for forms shall be Exterior Type, of the grade "Concrete Form Exterior", conforming to the specifications of the U.S. Department of Commerce, National Bureau of Standards, Commercial Standards, latest edition. Plywood shall be furnished and placed in forty-eight (48) inch widths and in uniform lengths of not less than ninety-six (96) inches, except where the dimension of the member formed is less than the specified panel dimension. Plywood shall be placed with the grain of the outer plies in the direction of the span.

B) Molding - Molding specified for chamfer strips and other uses shall be made of material of such grade that will not split when nailed and which can be maintained to a true line without warping. The molding shall be mill cut and dressed on all faces.

C) Form Ties and Spreaders - Metal form ties of an approved type or an approved substitute shall be used to hold forms in place. Pipe spreaders will not be permitted. Metal and wooden spreaders which are separate from the forms shall be entirely removed as the concrete is being placed. All

metal ties, wire, or other appliances used inside the forms to hold them in correct alignment shall be removed to a depth of at least one-half (1/2) inch from the surface of the concrete. Burning off of rods, bolts, or ties will not be permitted. The cavities produced shall be carefully cleaned and completely filled with retempered sand cement mortar mixed in proportions of one (1) to three (3), and the concrete shall be left smooth and even.

D) Form Supports for Overhanging Slabs - Form supports which transmit a horizontal force to a steel girder or beam or to a Pre-stressed concrete beam will be permitted, but shall not be used unless a structural analysis has been made of the effect on the girder or beam and approval is granted by the Engineer.

Holes in steel members for support of overhanging brackets may be punched or drilled full size or may be torch cut to one-fourth (1/4) inch under size and reamed full size. In no case shall the holes be burned full size.

Holes shall be left open unless specified on the plans to be filled with a button head bolt. In no case shall the holes be filled by welding.

403.02 – MATERIALS

A) Concrete - All concrete shall conform to the provisions of Section 932, "Portland Cement Concrete". The class of concrete for each type of structure or unit shall be as specified on the plans, or by pertinent governing specifications.

B) Expansion Joint Material

1) Preformed Fiber Material - Preformed fiber expansion joint material shall be of the dimensions shown on the plans, and shall conform to the provisions of Section 932.
2) Joint Sealing Material - Joint sealing material shall conform to the provisions of Section 932.
3) Asphalt Board- Asphalt board shall consist of two (2) liners of 0.016 asphalt impregnated paper, filled with a mastic of asphalt and vegetable fiber and/or mineral filler. Boards shall be smooth, flat, and sufficiently rigid to permit installation. When tested in accordance with ASTM Designation D-944, the asphalt board shall not deflect from the horizontal more than one (1) inch in three and one-half (3 1/2) inches.

C) Waterstop

1) Unless otherwise designated on the plans, copper waterstop shall be sixteen (16) ounce material.
2) Rubber waterstop or PVC waterstop shall be in conformance with Section 943, "Elastomeric Materials".
3) Other types as specified on the plans.

D) Curing Materials - The membrane curing compound shall conform to the provisions of Section 932.

403.04 – CONSTRUCTION METHODS

403.04.01 – PLACING REINFORCEMENT

Reinforcement in concrete structures shall be placed carefully and accurately and rigidly supported as provided in Section 941, "Reinforcing Steel".

403.04.02 – PLACING CONCRETE - GENERAL

The minimum temperature of concrete at the time of placement shall be not less than fifty (50) degrees F.

The maximum temperature of cast-in-place concrete used in bridge superstructure shall not be more than eighty-five (85) degrees F, at the time of placement. Concrete diaphragms, parapets, concrete portions of railing, curbs and sidewalks, unless monolithically placed with the slab, shall not be subject to the above control. Other portions of structures, when so noted on the plans, shall require the temperature control specified thereon.

A retarding admixture shall be used when the continuous placing method is used in the deck of continuous units. The initial set of the concrete shall be retarded sufficiently to insure that the concrete remains plastic in not less than three (3) spans immediately preceding the one being placed. For simple spans retardation shall be required only if necessary to complete finishing operations.

The retarding admixture shall be in accordance with the requirements of Section 932, "Concrete Admixtures".

The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When conditions are such that additional moisture is needed for finishing, the required water shall be applied to the surface by fog spray only, and shall be held to a minimum amount.

The maximum time interval between the addition of cement to the batch, and the placing of concrete in the forms shall not exceed the following:

Air or Concrete

Max Temperature	Time
Non Agitated Concrete	
80º F or Above	15 Minutes
35º to 79º F	40 Minutes
Agitated Concrete	
90º F or Above	45 Minutes
75º F to 89º F	60 Minutes
35º F to 74º F	90 Minutes

The use of an approved cement dispersing agent in the concrete will permit the extension of each of the above temperature time maximums by thirty (30) minutes, except that for nonagitated concrete, the maximum time shall not exceed thirty (30) minutes.

The Contractor shall give the Engineer sufficient advance notice before starting to place concrete in any unit of the structure to permit the inspection of forms, the reinforcing steel placement, and preparations for casting. No concrete shall be placed in any unit prior to the completion of the formwork and the placement of the reinforcement.

Concrete mixing, placing, and finishing shall be done in daylight hours, unless adequate provisions are made to light the entire site of all operations.

Concrete placement will not be permitted when impending weather conditions may result in rainfall or low temperatures which impair the quality of the finished work. In case rainfall should occur after placing operations are started the Contractor shall provide ample covering to protect the work. In case of drop in temperature, the provisions set forth in Section 403, shall be applied.

The method of handling, placing, and consolidation of concrete shall minimize segregation or the displacement of the reinforcement, and shall produce a compact mass of uniform texture. Concrete shall not have a free fall of more than three (3) feet except in the case of thin walls such as culvert walls. The spattering of forms or reinforcement bars shall be prevented if the concrete so spattered will dry or harden before being incorporated in the mass. Any hardened concrete spatter ahead of the plastic concrete shall promptly be removed from the work.

Each part of the forms shall be filled by depositing concrete as near its final position as possible. The coarse aggregate shall be worked back from the face and the concrete forced under and around the reinforcement bars without displacing them. Depositing large quantities at one point in the forms and running or working it along the forms will not be allowed.

After the concrete has taken initial set, the forms shall not be jarred or strain placed on projecting reinforcement.

Chutes, troughs, conveyors, or pipes used in placing concrete shall be arranged and used so that the

ingredients of the concrete will not be separated. When steep slopes are necessary, the chutes shall be equipped with baffle boards or made in short lengths that reverse the direction of movement, or the ends of such chutes shall terminate in vertical down spouts. Open troughs and chutes shall extend, if necessary, down inside the forms or through holes left in the forms. All chutes, troughs, conveyors, and pipes shall be kept clean and free from coatings of hardened concrete by a thorough flushing with water before and after each placement. Water used for flushing shall be discharged clear of the concrete.

Successive layers or adjacent portions of concrete shall be placed in a sequence so that they can be vibrated into a homogeneous mass with the previously placed concrete without a cold joint. Not more than one (1) hour shall elapse between adjacent or successive placement of concrete. Unauthorized construction joints shall be avoided by placing required portions of abutments, piers, walls, or superstructure in one continuous operation.

For mass placements, placements on falsework where differential setting time may induce stress cracking, placement in deep girder stems, etc., and approved retarder (cement dispersing agent) in accordance with Section 932, "Concrete Admixtures", shall be used to control stress cracks and/or unauthorized cold joints.

Laitance or foreign matter of any kind shall not be permitted to accumulate inside the forms; and openings in forms necessary for removal of same shall be provided.

All concrete shall be well consolidated and the mortar flushed to the surface of the forms by continuous working with mechanical vibrators of an approved type. Vibrators of the type which operate by attachment to forms or reinforcement will not be permitted, except that external vibration will be allowed when the forms are of steel.

At least one (1) standby vibrator shall be provided for emergency use in addition to the ones required for placement.

The vibrators shall be applied to the concrete immediately after deposit. Prior to the beginning of work, a systematic spacing of the points of vibration shall be established to insure complete consolidation of the concrete being placed and the thorough working of the concrete around the reinforcement, embedded fixtures, and into the corners and angles of the forms. Immersion type vibrators shall be inserted vertically, at points eighteen (18) to thirty (30) inches apart, and slowly withdrawn. For shallow slabs or for concrete inaccessible to vertical insertion of the vibrator, the vibrator may be inserted in a sloping or horizontal position. The entire depth of each lift of concrete shall be vibrated, and the vibrator shall be allowed to penetrate several inches into the preceding lift of plastic concrete. New concrete placed against hardened concrete or against fresh concrete that is not plastic shall be thoroughly consolidated along the joint surface. The vibration shall be of sufficient duration to produce thorough consolidation, and complete embedment of reinforcement and fixtures, but shall not be done to an extent that will cause segregation. Vibration may be supplemented by hand spading or rodding, if necessary, to insure the flushing of mortar to the surface of all forms.

Holes for anchor bolts in piers, abutments, bents, or pedestals may be drilled or may be formed by the insertion of oiled wooden plugs or metal sleeves in the plastic concrete. The plugs or sleeves shall be withdrawn after the concrete has set. Formed holes shall be of such diameter to permit horizontal adjustments of the bolts. The bolts shall be set carefully in mortar. In lieu of the above methods of placing, anchor bolts may be set to exact locations in concrete when it is placed.

The placing of concrete for deck slabs shall be done from a mixing plant located off the structure. Carting or wheeling concrete batches over a completed slab will not be permitted until the slab has aged at least four (4) full curing days. If carts are used, timber planking will be required for the remainder of the curing period. Carts shall be equipped with pneumatic tires. Curing operations shall not be interrupted for the purpose of wheeling concrete over finished slabs.

The storing of reinforcing or structural steel on completed roadway slabs generally shall be avoided and, when permitted, such storage shall be limited to quantities and distribution that will not induce

excessive stresses.

403.04.03 – PLACING CONCRETE UNDER ADVERSE WEATHER CONDITIONS

Concrete for structures shall not be placed on frozen ground nor shall it be mixed or placed while the atmospheric temperature is below thirty-five (35) degrees F, or when conditions indicate that the temperature may fall to thirty-five (35) degrees F within twenty-four (24) hours, except with the written permission of the Engineer and only after such precautionary measures for the protection of the work have been taken as he may direct.

Concrete shall be effectively protected from freezing or frost for a period of five (5) days after placing.

When the temperature of the air is above eighty-five (85) degrees F, an approved retarding mixture will be required in all concrete used in superstructures, top slabs of direct traffic culverts and cased drilled shafts.

Concrete placement shall be stopped when rainfall is sufficient to cause damage to the work.

403.04.04 – PLACING CONCRETE IN WATER

Concrete shall be deposited in water only when specified on the plans or with written permission of the Engineer. The forms, cofferdams, or caissons shall be sufficiently tight to prevent any water current passing through the space in which the concrete is being deposited. Pumping will not be permitted while the Concrete is being placed, nor until it has set for at least thirty-six (36) hours.

The concrete shall be placed carefully in a compact mass by means of a tremie, closed bottom dumping bucket, or other approved method that does not permit the concrete to fall through the water without adequate protection. The concrete shall not be disturbed after being deposited. Depositing shall be regulated to maintain approximately horizontal surfaces at all times.

When a tremie is used, it shall consist of a tube having a diameter of not more than ten (10) inches constructed in sections having water tight connection. The tremie shall be equipped with a device for sealing the bottom of the tube, the positive opening thereof, and for the placing of the tremie through the water to the point of placement. The means of supporting the tremie shall permit the movement of the discharge over the entire surface of the work and shall permit the tremie to be lowered rapidly when necessary to choke off or retard the flow.

Shifting the location of the tremie, for any continuous placement of concrete, shall be held to a minimum. During the placing of concrete, the tremie shall be kept full. When a batch is dumped into the hopper, the tremie shall be raised slightly, but not out of the concrete at the bottom, until the batch discharges to the level of the bottom of the hopper, then the flow shall be stopped by lowering the tremie. The placing operations shall be continuous until the work is complete. If the placement is confined to a small area requiring very little movement, the tremie diameter may be increased.

When concrete is placed by means of a bottom dump bucket, the bucket shall have a capacity of not less than one-half (1/2) cubic yard. The bucket shall be lowered gradually and carefully until it rests upon the concrete already placed. Then it shall be raised very slowly during the upward travel, the intent being to maintain still water at the point of discharge and to avoid agitating the mixture.

403.04.05 – PLACING CONCRETE IN SUPERSTRUCTURE

To insure proper operation and maintenance of grades and clearances, one or more passes of the screed shall be made over the section of bridge spans to be placed prior to the placement of concrete.

For longitudinal screeding concrete shall be placed in longitudinal strips. Placing, preferably, shall be started at a point in the center of the section adjacent to one curb, and the strip thus started shall be completed by depositing concrete uniformly in both directions toward the ends except that for spans on a grade of one and one-half (1 1/2) percent or more, the placing shall start at the lowest end. The width of strips shall be such that the concrete therein will remain plastic until the adjacent strip is placed.

The forms for the bottom surface of concrete slabs, girders, and overhangs shall be maintained true to

the required vertical alignment during the concrete placing. For convenience in checking the vertical alignment, an approved system of "tell-tales" attached to the forms shall be installed and maintained by the Contractor. They shall provide a convenient means of matchmarking with reference to points set on stakes or other suitable reference points set independent of the forms and falsework for the span being placed. Unless otherwise provided, the girders, slab, and curbs of deck girder spans shall be placed in one continuous operation.

The filling of girder stems ahead of placing the concrete in the slab will be permitted provided the slab concrete is placed in the time as specified in Section 403.04.02. The location of construction joints and the sequence of placements of the slab on steel and Pre-stressed concrete beams shall be as shown on the plans. Where plans do not specify a particular sequence, any logical placing sequence which will not result in the overstressing of any of the supporting members will be permitted subject to the approval of the Engineer.

On steel truss spans the falsework under the span shall be released and the span swung free on its permanent supports before placing any concrete in the floor slab.

When the curb forms are filled, the curbs shall be brought to the correct camber and alignment, struck off, and float finished as described in Section 403.04.02.

As soon as concrete is placed in a section of the slab of sufficient width to permit finishing operations, the slab shall be finished as specified in Section 403.04. When the surface of the slab is to receive an additional wearing surface or level-up (widening), the slab shall be given a reasonably smooth float or screed finish and shall not be finished as stated above.

403.04.06 – PLACING CONCRETE IN BOX CULVERTS

In general, construction joints will be permitted only at the points shown on the plans.

Where the top slabs and sidewalls are placed monolithic in culverts more than four (4) feet in clear height, an interval of not less than one (1) hour nor more than two (2) hours shall elapse between the placing of the concrete in the walls and that in the top slab; such interval is to allow for shrinkage in the wall concrete.

The top surface of the base slab shall be finished accurately at the proper time to provide a smooth uniform surface. The upper surface of the top slab which will carry direct traffic shall be finished as specified for finishing roadway slabs in Section 403.04.09. On a fill type culvert which does not carry direct traffic, the top slab shall be given a reasonably smooth finish.

403.04.07 – PLACING CONCRETE IN FOUNDATIONS AND SUBSTRUCTURE

Concrete shall not be placed in footings until the depth and character of the foundation has been inspected by the Engineer and permission has been given to proceed.

The placing of concrete bases above seal courses will be permitted after the caissons or cofferdams are free from water and the seal course cleaned. Any necessary pumping or bailing during the concreting operation shall be done from a suitable sump located outside the forms.

All temporary wales or braces on the inside of cofferdams or caissons shall be constructed or adjusted as the work proceeds to prevent unauthorized construction joints in bases or shafts.

When footings can be placed in dry foundation pits without the use of cofferdams or caissons, forms may be omitted if desired by the Contractor and approved by the Engineer, and the entire excavation filled with concrete to the elevation of the top of footing. Where this procedure is followed, no measurement for payment will be made for concrete placed outside of the footing dimensions shown on the plans.

Concrete in columns shall be placed monolithically unless otherwise provided. Columns and caps and/or tie beams supported thereon may be placed in the same operation. To allow for shrinkage of the column concrete, it shall be placed to the slower level of the cap or each tie beam and placement delayed for not less than one (1) hour nor more than two (2) hours before proceeding.

403.04.08 – TREATMENT/ FINISHING OF HORIZONTAL SURFACES

All upper surfaces not covered by forms shall be struck off to grade and finished. The use of mortar topping for surfaces under this classification will not be permitted.

After the concrete has been struck off as described above, the surface shall be floated with a suitable float. Bridge sidewalks shall be given a wood float or broom finish or may be striped with a brush, as specified by the Engineer. Unless otherwise specified, top of caps and piers shall be given a smooth finish with a steel trowel. Other surfaces shall be wood float finished and striped with a fine brush leaving a fine grained texture.

403.04.09 – FINISH OF ROADWAY SLABS

As soon as the concrete has been placed and vibrated in a section of a sufficient width to permit working, the surface shall be approximately leveled, struck off and screeded, carrying a slight excess of concrete ahead of the screed to insure filling of all low spots. The screed shall be designed to provide the rigidity necessary to hold true to shape and shall have sufficient adjustments to provide for the required camber. A vibrating screed may be used if it is sufficiently heavy to withstand distortion. The screeds shall be provided with a metal edge.

Longitudinal screeds shall be moved forward across the concrete with a combined longitudinal and transverse motion with ends resting on headers or templates, set true to the roadway grade or on the adjacent finished slab. The surface of the concrete shall be screeded a sufficient number of times (not less than three (3)) and at such intervals to produce a uniform surface true to grade and free of voids.

Spans over fifty (50) feet in length may be screeded in two (2) or more sections if suitable intermediate templates are installed and if adequate equipment is provided. Unless otherwise provided, the templates shall be designed to permit early removal in order to avoid construction joints and to permit satisfactory finishing at the template site.

If necessary, the screeded surface shall be worked to a smooth finish with a long handled wood or metal float of the proper size, or hand floated from bridges over the slab.

While the concrete is still plastic, the Contractor shall have the surface checked with a long handled ten (10) foot straightedge. The check shall be made with the straightedge parallel to the centerline. Each pass of the straightedge shall lap half of the preceding pass. All high spots shall be removed and all depressions over one-sixteenth (1/16) inch in depth shall be filled with fresh concrete and floated. The checking and floating shall be continued until the surface is true to grade and free of depressions, high spots, voids, or rough spots.

Unless otherwise shown, the surface shall be given a burlap drag, wood float, broom, tine or a belt finish. If a burlap drag is used, it shall consist of layers of continuous burlap fabric, free of seams, dirt or hardened concrete. The burlap drag shall be kept wet when in use. The drag shall be attached to a work bridge and drawn over the surface of the slab as necessary to obtain the desired surface texture. Work bridges shall be provided from which to perform all finishing operations.

Rail support holes shall be filled with concrete and finished to match the top of the slab.

After the final set of the concrete, the roadway surface shall be tested again with a standard ten (10) foot metal straightedge for irregularities and the surface shall be corrected, if necessary, to conform to the following:

The straightedge shall be placed parallel to the centerline of road so as to bridge any depressions and touch high spots. Ordinates measured from the face of the straightedge to the surface of the slab shall not exceed three-sixteenths (3/16) inch. The surface shall be corrected by grinding off the high spots as required to conform to these limits. Vertical curvature and required camber shall be taken into account when straightedging.

In all roadway slab finishing operations camber for specified vertical curvature and transverse slopes shall be provided.

For concrete slab or concrete girder spans which are cast-in-place on falsework, an additional amount of camber shall be provided to offset the initial and final deflections of the span. The additional amount of camber shall be determined from the dead load deflection diagram shown on the plans. When dead load deflection is not shown on the plans, the additional amount of camber shall be one-eighth (1/8) inch per ten (10) feet of span length but not greater than one-half (1/2) inch. For concrete girder spans the additional camber for initial and final deflections shall be one-half (1/2) inch for thirty (30) foot spans and three-fourths (3/4) inch for forty (40) foot spans.

Roadway slabs supported on Pre-stressed concrete, steel beams, or girders shall receive no additional amount of camber, except that for slabs without vertical curvature, the longitudinal camber shall be approximately one-fourth (1/4) inch.

Dead load deflection shall be taken into account in the setting of headers and rail systems.

403.04.10 – CURING CONCRETE

Careful attention shall be given to the proper curing of all concrete. The Contractor shall inform the Engineer fully of the methods and procedures proposed for curing; shall provide the proper equipment and material in adequate amounts; and shall have approval of the proposed method, equipment, and material prior to placing concrete.

Inadequate curing facilities or lack of attention to the proper curing of concrete shall be cause for the Engineer to stop all construction on the job until approved curing is provided.

All concrete shall be cured for a period of four (4) days except as noted herein:

TABLE 403.04.01 – EXCEPTIONS TO 4-DAY CURING

Description	Required Curing
Upper Surfaces of Bridge Roadway, Median and Sidewalk Slabs and Top Slabs of Direct Traffic Culverts	8 Curing Days

A curing day is defined as a calendar day when the temperature, taken in the shade away from artificial heat, is above fifty (50) degrees F for at least nineteen (19) hours (or colder days if satisfactory provisions are made to maintain the temperature at all surfaces of the concrete above forty (40) degrees F for the entire twenty-four (24) hours).

In continuous placement of concrete, the required curing period shall begin when all concrete has been placed and attained its initial set.

The following methods are permitted for curing concrete subject to the requirements of these specifications for each method of curing:

A) Form Curing - When forms are left in contact with the concrete, other curing methods will not be required except for cold weather protection.

B) Water Curing - All exposed surfaces of the concrete shall be kept wet continuously for the required curing time. Curing will be started immediately as soon as finishing is completed. When concrete temperature is above ninety (90) degrees F, water spray or ponding will not be allowed. The water used for curing shall meet the requirements for concrete mixing water as specified in Section 932.

   1) Wet Mat - Cotton mats shall be used for this curing method. The mats shall not be placed in contact with the concrete until such time that damage will not occur to the surfaces. Damp burlap blankets made from nine (9) ounce stock may be placed on the damp concrete surface for temporary protection prior to the application of the cotton mats. The mats may be placed dry and wetted down after placement. Mat curing, except for continuous placements, shall commence not later than three (3) hours after finishing of the roadway slab.

      The mats shall be weighted down adequately to provide continuous contact with all concrete surfaces where possible. The surfaces of the concrete shall be kept wet for the required curing

time. Surfaces which cannot be cured by contact shall be enclosed with mats, anchored positively to the forms or to the ground so that outside air cannot enter the enclosure. Sufficient moisture shall be provided inside the enclosure to keep all surfaces of the concrete wet.

2) Water Spray - This method will be accomplished by overlapping sprays or sprinklers so that all unformed surfaces are kept continuously wet.

3) Ponding - This method requires the covering of the surfaces with a minimum of two (2) inches of clean granular material kept wet at all times, or a minimum of one (1) inch depth of water. Satisfactory provisions shall be made to provide a dam to retain the water or saturated sand.

C) Membrane Curing - Unless otherwise shown on the plans, Type 2 membrane curing compound may be used where permitted. Material requirements and construction methods shall be as required in Section 932. Membrane shall be applied in a single, uniform coating at the rate of coverage recommended by the manufacturer and as approved by the Engineer, but not less than one (1) gallon per two hundred ten (210) feet of area. Tests for acceptance shall be at this specified rate.

Membrane curing shall not be applied to dry surfaces, but shall be applied to horizontal surfaces just before free moisture has disappeared. Formed surfaces and surfaces which have been given a first rub shall be dampened and shall be moist at the time of application of the membrane.

When membrane is used for complete curing, the film shall remain unbroken for the minimum curing period specified. Membrane, which is damaged, shall be corrected immediately by reapplication of membrane. Membrane wire will not be used in areas where concrete is to be placed and bonded later.

403.04.11 – REMOVAL OF FORMS AND FALSEWORK

Except as herein provided, forms for vertical surfaces may be removed when the concrete has aged not less than one (1) day for normal concrete and not less than one-half (1/2) day for High Early Strength Concrete, provided the forms can be removed without damage to the concrete.

Forms for inside curb faces may be removed in approximately three (3) hours provided the concrete has set sufficiently to permit form removal without damage to the curb.

Weight supporting forms and falsework for all bridge components and culvert slabs shall remain in place a minimum of four (4) curing days. Forms may then be removed if the concrete has attained a 80% of the 28-day specified compressive strength as evidenced by strength tests using specimens made from the same concrete and cured under the same conditions as the portion of the structure involved. Forms for other structural components may be removed as specified by the Engineer.

If all beams made for the purpose of form removal have been broken without attaining the required strength, forms shall remain in place for a total of fourteen (14) curing days.

The above provisions relative to form removal shall apply only to forms or parts of forms which are so constructed as to permit removal without disturbing forms or falsework which are required to be left in place for a longer period on other portions of the structures.

403.04.12 – FINISHING EXPOSED SURFACES

All top surfaces, such as the top of retaining walls, curbs, abutments, rails, etc., shall be treated by tamping and floating with a wooden float in such a manner as to flush the mortar to the surface and provide a uniform surface, free from pits or porous places. The surface thus obtained shall be troweled to produce a smooth surface and brushed lightly with a damp brush to remove the glazed surface.

All concrete surfaces shall be reasonably true and even, free from stone pockets, excessive depressions or projections beyond the surface. The concrete in bridge seats and walls shall be brought flush with the finished top surface and struck off with a straightedge and floated. The concrete surfaces which are not in an acceptable condition or which are designated on the plans to be surface finished, shall be rubbed to a smooth and uniform texture with a carborundum brick and clean water as soon as

the forms are removed and the concrete is ready to hone. The loose material formed on the surface, due to the rubbing with a carborundum brick, shall be removed as soon as it dries by means of rubbing the surface with burlap or by other approved methods. The finished surface shall be free from all loose material. A neat cement wash shall not be used.

Transverse Groove Final Finish for Overlays. Do not tine finish overlays within 2 inches of a construction joint.

High Density Concrete. After completing the finishing and before applying the transverse groove final finish, seal all vertical joints with adjacent concrete by painting with thinned grout. After joint painting, apply the transverse groove final finish. Grooving passes shall not be overlapped but shall be within 1 inch of the preceding pass.

Latex Modified Concrete. After completing the finishing, apply the transverse groove final finish. Grooving passes shall not be overlapped but shall be within 1 inch of the preceding pass. This must be done before the plastic film forms on the surface, approximately 25 minutes in hot, dry weather. Separate screed rails and construction dams from the newly placed material by passing a point trowel along their inside face. Exercise care to insure that this trowel cut is made for the entire depth and length of rails or dams after the concrete has stiffened sufficiently to not flow back.

Unless otherwise provided on the plans, all reasonably true and even surfaces obtained by use of a form liming, which are of a uniform color, free from stone pockets, honeycomb, excessive depressions or projections beyond the surface shall be considered as acceptable surfaces and a rubbed surface finish will not be required.

The above provisions for surface finish shall not preclude requiring the use of a dry carborundum brick for straightening molding lines, removing fins, etc., or requiring a rubbed surface finish on all portions of the structure which do not present an acceptable surface even though a form lining is used.

When so indicated on the plans, or with written permission of the Engineer, painting of concrete surfaces in lieu of rubbing will be permitted. When painting is permitted, all surfaces to be coated shall be prepared in the following manner:

Soon after form removal any porous spots, honeycombed areas, untrue surfaces, and lines shall be corrected. All fins, form marks, runs, drips, or mortar shall be removed leaving a smooth and uniform surface.

When preparing the completed structure for final acceptance, all grease, dirt, mortar drips, and remaining curing membrane shall be removed from the pertinent surfaces after which the surfaces shall be painted with a latex-base adhesive grout.

The grout shall consist of one (1) part latex base adhesive, two (2) parts white cement, two (2) parts natural cement, two (2) parts fine masonry sand, and one (1) part water. Mixture should have the consistency of a thick paint.

The finished surface shall have a uniform appearance and texture. Thickness of coating shall be approximately one-sixteenth (1/16) to one-eighth (1/8) of an inch.

403.05 – TESTING

All tests prescribed in this Section 400 and Section 900 as applicable will be made of each designated sample specified after concrete is placed. Testing to be performed by a laboratory approved by the City. Any defective work discovered after the forms have been removed shall be repaired as soon as possible. If the surface of the concrete is bulged, uneven, or shows excess honeycombing or form marks, which in the opinion of the Engineer cannot be repaired satisfactorily, the entire section shall be removed and replaced. In repairing honeycombed areas, all loose material shall be removed before the repair work is started. No extra compensation will be allowed for the extra work or materials involved in repairing or replacing defective concrete.

403.06 – METHOD OF MEASUREMENT

Concrete Structures will be measured by each, cubic yard, linear foot or square foot in accordance with the dimensions shown on the plans or directed by the Engineer.

403.07 – BASIS OF PAYMENT

No direct measurement or payment will be made for the work to be done or the equipment to be furnished under this item, but it shall be considered subsidiary to the particular pay items required by the plans and the contract.

SECTION 404 – STRUCTURAL CONCRETE

404.01 – DESCRIPTION

This section covers the furnishing and placing of Portland Cement Concrete for structures and incidental construction in accordance with these specifications and in reasonably close conformity with the lines, grades and dimensions as shown on the plans or established by the Engineer.

404.02 – MATERIALS

Materials shall meet the requirements specified in the following Sections of Section 900 - MATERIALS:

Portland Cement Concrete	932
Elastomeric Bearing Pads	980
Concrete Surface Finish for Structures	403

404.03 – EQUIPMENT

Equipment and tools necessary for handling materials and performing all parts of the work shall meet the requirements of Section 932.

404.04 – CONSTRUCTION METHODS

A) Handling, Measuring and Batching materials shall be in accordance with Section 304.04

B) Mixing - The mixing of concrete shall be in accordance with Section 304.03

C) Forms - Forms shall be so designated and constructed that they will hold reasonably true to lines and grades as shown on the plans and may be removed without injuring the concrete.

The material to be used in the forms for exposed surface shall be sized and dressed lumber, masonite, plywood or equal, or metal in which all bolt and rivet heads are countersunk, so that in any case a plain, smooth surface is obtained. Undressed lumber may be used for backing or other unexposed surfaces.

The forms shall be built reasonably true to line and grade and braced in a substantial and unyielding manner. They shall be mortar tight. All corners, except at tops of footings or bases, shall be chamfered. Chamfer or molding strips shall be finished lumber, cut with true edges, and shall not be warped, cracked or frayed. No. 2 pieces of chamfer strips of unequal width shall be used in the same chamfer line. Chamfer shall be held true to line and kept securely nailed tº Forms while placing concrete.

Form lumber for all curbs on bridges and culverts shall have a nominal thickness of two (2) inches or more. Studding on all forms shall be spaced so that no bulge or deflection is apparent between the studs.

For lumber which is to be used a second time, shall be free from bulge or warp and shall be thoroughly cleaned. The forms shall be inspected immediately preceding the placing of concrete and any bulging, warping or offset in adjacent boards shall be remedied.

All dimensions shall be carefully checked by the Contractor after the forms are erected and before any concrete is placed. The Contractor will be held responsible for the accuracy of all construction.

The interior surfaces of the forms shall be adequately oiled or greased to insure the non-adhesion of mortar.

D) Handling, Placing and Vibrating Concrete

1) General - In preparation for the placing of concrete, all sawdust, chips, and other debris shall be removed from the interior of forms. Struts, stays and braces, serving temporarily to hold the forms in correct shape and alignment pending the placing of concrete at their locations, shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. All temporary wood members shall be removed from the forms and not buried in the concrete.

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. The Engineer may order the discontinuance of any type of conveyance or method of placing if the concrete is not being satisfactorily placed.

Open troughs and chutes shall be mortar tight. Where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths that change the direction of movement.

All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. Water used for flushing shall be discharged clear of the structure.

When placing operations would involve dropping the concrete more than five (5) feet, it shall be deposited through approved sheet metal chutes, pipes, or flexible tubing. As far as practicable, the pipes shall maintain an even flow of concrete during the placing and their lower ends shall be kept level with the newly placed concrete. After the initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of reinforcing bars which project.

Concrete, during and immediately after depositing, shall be thoroughly consolidated by mechanical vibration subject to the following provisions:

The vibration for concrete shall be internal unless special authorization of other methods is given by the Engineer or as provided herein.

Vibrators shall be of a type and design approved by the Engineer. The manufacturer's rated capacity shall be not less than four thousand (4000) impulses per minute.

The intensity of vibration shall be such as to visibly affect a mass of concrete of one (1) inch slump over a radius of at least eighteen (18) inches.

The Contractor shall provide a sufficient number of vibrators to properly consolidate each batch of concrete immediately after it is placed in the forms.

Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and embedded fixtures and into the corners and angles of the forms. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued so as to cause segregation.

Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective

Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms.

Vibration shall be supplemented by such spading as is necessary to insure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

The provisions of this article shall apply to the filler concrete for steel grid floor, except that the vibrator shall be applied to the steel.

The provisions of this article shall apply to pre-cast piling, concrete cribbing and other pre-cast members except that, if approved by the Engineer, the manufacturer's methods of consolidation may be used.

Concrete shall be placed in horizontal layers no more than twelve (12) inches thick except as hereinafter provided. When less than a complete layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and compacted before the preceding batch has taken initial set. Each layer shall be compacted, so as to avoid the formation of a construction joint with a preceding layer, before it has taken initial set.

When the placing of concrete is temporarily discontinued the concrete, after becoming firm enough to retain its form, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete. To avoid visible joints as far as possible upon exposed faces, the top surface of the concrete adjacent to the forms shall be smoothed with a trowel. Where a "feather edge" might be produced at a construction joint, as in the sloped top surface of a wingwall, inset form work shall be used to produce a blocked out portion in the preceding layer which shall produce an edge thickness of not less than six (6) inches in the succeeding layer. Work shall not be discontinued within eighteen (18) inches of the top of any face, unless provision has been made for a coping less than eighteen (18) inches thick, in which case, if permitted by the Engineer, the construction joint may be made at the underside of the coping.

Immediately following the discontinuance of placing concrete, all accumulation of mortar splashed upon the exposed reinforcing steel and surfaces of the forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. Care shall be exercised not to injure or break the concrete steel bond at and near the surface of the concrete while cleaning the reinforcing steel.

2) Reinforced Concrete Boxes - In general, the base slab or footings of box culverts shall be placed and allowed to set before the remainder of the culvert is constructed. Provisions shall be made for bonding the sidewalls to the culvert base by means of longitudinal keys so constructed as to prevent the percolation of water through the construction joint.

   Before concrete is placed in the sidewalls, the culvert footings shall be thoroughly cleaned and the surface carefully chipped and roughened in accordance with the method of bonding construction joints as specified herein. In the construction of box culverts four (4) feet or less in height, the sidewalls and top slab may be constructed as a monolith. When this method of construction is used, any necessary construction joints shall be vertical and at right angles to the axis of the culvert.

   In the construction of box culverts more than four (4) feet in height, the concrete in the walls shall be placed and allowed to set before the top slab is placed. Appropriate keys shall be left in the sidewalls for anchoring the cover slab.

3) Girders, Slabs and Columns - Concrete, preferably, shall be deposited by beginning at the center of the span and working from the center toward the ends. Concrete in girders shall be deposited uniformly for the full length of the girder and brought up evenly in horizontal layers not more than twelve (12) inches thick.

   Concrete in girder haunches less than three (3) feet or more, the abutment or columns, the haunch and the girder shall be placed in three (3) successive stages; first up to the lower side of the haunch; second, to the lower side of the girder; and third, to completion.

   Concrete in slab spans shall be placed in one continuous operation for each span unless otherwise provided.

   The floors and girders of through girder superstructures shall be placed in one continuous operation unless otherwise specified. When placement is not continuous, special shear anchorage shall be provided to insure monolithic action between girder and floor.

Concrete in T-beam or deck girder spans may be placed in one continuous operation or may be placed in two (2) separate operations. Each separate operation shall be continuous; the first, to the top of the girder stems; and the second, to completion. The bond between stem and slab shall be positive and mechanical, and shall be secured by means of suitable shear keys in the top of the girder stem unless other methods are approved by the Engineer. The size and location of these keys shall be computed. In general, suitable keys may be formed by the use of timber blocks approximately two (2) inches by four (4) inches in cross section and having a length four (4) inches less than the width of the girder stem. These key blocks shall be spaced along the girder stems as required, but the spacing shall be not greater than one (1) foot center to center. The blocks shall be beveled and oiled in such manner as to insure their ready removal, and they shall be removed as soon as the concrete has set sufficiently to retain its shape.

Concrete in columns shall be placed in one continuous operation, unless otherwise directed. The concrete shall be allowed to set at least two (2) hours before the caps are placed.

Concrete shall not be placed in the superstructure until the column forms have been stripped sufficiently to determine the character of the concrete in the column. The load of the superstructure shall not be allowed to come upon the bents until they have been in place at least five (5) days, unless otherwise permitted by the Engineer.

4) Pneumatic Placing - Pneumatic placing of concrete will be permitted only if specified in the special provisions.

5) Pumping - Placement of concrete by pumping will be permitted provided the equipment is so arranged that vibrations will not damage freshly placed concrete.

   Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall be suitable in kind and adequate in capacity for the work. Aluminum pipe shall not be used. The operation of the pump shall be such that a continuous stream of concrete without air pockets is delivered.

E) Placing Concrete under Water - Concrete shall be deposited in water only with the permission of the Engineer and under supervision. When depositing in water is allowed, the concrete shall be carefully placed in the space in which it is to remain in a compact mass by means of a concrete pump that does not permit the concrete to fall through the water. Concrete placed under water shall be deposited in one continuous operation and shall be allowed to set for a period of at least forty-eight (48) hours before the caisson is dewatered. After dewatering, the laitance and soft concrete shall be cut away and the top surface cleaned. Concrete shall not be placed in running water, and forms which are not reasonably watertight shall not be used for holding concrete deposited under water. The concrete shall not be disturbed after being deposited.

   Ten (10) percent of additional cement shall be added to all concrete placed under water. No allowance will be made the Contractor for additional cement required for placing concrete under water. The water pressure shall be equal inside and outside the forms before any concrete is placed under water. The quantity of mixing water shall be the minimum amount to permit the passage of concrete through the concrete pump.

F) Joints - Whenever the work of placing concrete is delayed until the concrete shall have taken its initial set, the point of stopping shall be deemed a construction joint. So far as possible, the location of construction joints shall be planned in advance and the placing of concrete carried continuously from joint to joint. These joints shall be perpendicular to the principal lines of stress.

   Where dowels, reinforcing bars, or other adequate methods are not shown on the plans, keys shall be made by placing water soaked beveled timbers of a size shown on the details, or as directed by the Engineer. The key material shall be removed when the concrete has set. In resuming work the surface of the concrete previously placed shall be thoroughly cleaned of laitance, or other soft material with stiff wire brushes, and if deemed necessary by the Engineer, shall be roughened by a

steel tool.

Construction joints shall be made only where located on the plans or shown in the placing schedule, unless otherwise approved by the Engineer. Shear keys or continuous reinforcement shall be used to transmit shear and/or bond the two sections together.

In parapets, railings, and other light work superimposed on heavy work, the expansion joints shall be placed as shown on the plans.

In order to maintain the proper alignment of the different parts of the work, they shall be provided with keys at approximately one-third (1/3) of the area of the cross sections of the wall or with the equivalent thereof in dowels.

G) Curing Concrete - All concrete shall be cured as provided in these specifications for the various parts of structures. Specific references are as follows:

Concrete Bridge Floors	409

The side forms on all piers, abutments, retaining walls, wingwalls, and reinforced concrete boxes may be left in place for at least three (3) days or if removed before the three (3) days have elapsed, the surfaces shall be cured for the remaining part of the three (3) day period by one of the following methods:

1) Cured for at least three (3) days with an approved polyethylene burlap.

2) Cured for at least three (3) days with three (3) layers of wet burlap.

3) Cured for at least three (3) days with wetted cotton mats as specified. The surface of the concrete shall be entirely covered with mats. The mats used shall be of such length or width that as laid they will extend at least twice the thickness of the slab beyond the edges of the slab. The mat shall be placed so that the entire surface and both edges of the slab are completely covered. Prior to being placed, the mats shall be saturated thoroughly with water. The mats shall be so placed and weighted down as to cause them to remain in intimate contact with the surface covered, and the covering shall be maintained fully wetted and in position for seventy-two (72) hours after the concrete has been placed unless otherwise specified.

4) Cured with an approved membrane curing compound (Red) as specified below and in Section 932.

   The curing compound shall be applied under pressure, by means of a spray nozzle, in such a manner as to cover the entire exposed surface thoroughly and completely with a uniform film. Sufficient pressure shall be applied to the spray machine to force the compound to leave the nozzle as a fine mist. The application of curing compound shall be close to the finishing at all times and all finished concrete shall be sprayed immediately after the superficial water, if any, has subsided.

   Formed surfaces shall be coated with the curing compound as soon as practicable after removal of the forms.

   The curing compound shall be applied on concrete for sidewalks, curbs and floors, other than concrete bridge floors, as soon as possible after finishing. On surfaces requiring a surface finish or surfaces poured against forms, the curing materials shall not affect concrete surface bond.

   If hair checking develops before the curing compound can be applied, the procedure set forth above shall be modified in that initial curing with wet burlap shall be performed as specified in standard specifications for the particular type of work under construction.

   If discontinuities, or pinholes, or abrasions in the membrane exist, a second coat shall be applied to the affected areas. Walking on the cured surface will not be permitted for twenty-four (24) hours after application. If any abrasions occur within twenty-four (24) hours, they shall be

corrected by the use of additional compound.

H) Rate of Application - The curing compound shall not be applied at a coverage rate lighter than specified below:

Steel Trowel Finish	225 SF/GAL
Rough float Finish	200 SF/GAL

Whenever the atmospheric temperature is one hundred (100) degrees F or more, the Engineer may require an additional coat at a rate of approximately two hundred seventy (270) square feet per gallon, if he deems the additional material essential to obtain adequate water retention. When required, the second coat shall be applied thirty (30) minutes after the first.

When the desired results are not obtained by this method, the membrane method shall be discontinued and the curing shall be by other methods specified in these specifications.

I) Removal of Forms - In order to make possible the obtaining of satisfactory surface finish, forms on ornamental work, railings, parapets, and vertical surfaces which do not carry loads and which require a special concrete surface finish shall be removed as soon as practicable.

Forms supporting the main slabs and girders shall remain in place at least twenty-one (21) days and during unfavorable curing conditions as much longer as the Engineer may direct.

The above specified time may be decreased in case test beams are cast at the time the concrete is placed. Beams shall be made, cured and tested as provided in Section 404.

The forms may be removed when the test beams meet strength requirements as provided in Section 404., except as modified hereafter.

In no case shall the forms supporting main slabs, girders or concrete beams be removed in less than ten (10) days after the concrete is placed. Forms for vertical walls on columns, piers, abutments, and retaining walls requiring a concrete surface finish shall be removed in warm weather within twenty-four (24) hours after the concrete is placed and in the cool weather within forty-eight (48) hours - at least as soon as they may be removed without damaging the concrete. Forms under concrete caps on pile bents and under web walls shall remain in place at least five (5) days, provided that test beams have the required strength as provided above.

As soon as the forms are removed, all rough places, holes, and porous spots shall be filled and all bolts, wires or other appliances used to hold the forms and which pass through the concrete shall be cut off flush with the surface. For all finished surfaces, all wires shall be cut off one-fourth (1/4) inch below the surface and the depression filled with cement mortar at once. This shall be left rough for several hours and then rubbed smooth with the surface.

Honeycomb shall be repaired as soon as the forms are taken off by removing any aggregate that is loose or that is not thoroughly bonded to concrete mass, washing the surface with clean water, using a wire brush to remove any loose particles, and applying a thin coating of neat cement mortar. Patched areas shall be dressed flush with the surrounding area.

Small cavities shall be neatly pointed up with cement mortar of the same mix as used in the body of the work, immediately after removing forms. Care shall be taken to remove any thin surfaces or edges and expose the whole cavity before pointing up.

J) Defective Work - Any defective work discovered after the forms have been stripped shall be removed immediately and replaced. If the surface of the concrete is bulged, uneven, or shows excess honeycombing or settlement, which cannot be repaired satisfactorily, the entire section shall be removed and replaced. No additional compensation will be allowed for this work.

K) Drainage and Weep Holes - Drainage openings and weep holes shall be constructed in the manner and where indicated on the plans or directed by the Engineer.

L) Placing Pipes and Conduits - Pipes and conduits for utility service lines which are to be encased in

the concrete shall be placed by the Contractor during construction.

M) Placing Anchors, Bolts, Grillages, Etc. - The Contractor shall place all anchors, bolts, grillages, etc., securely and accurately in the locations shown on the plans or as otherwise required.

404.05 – TESTING

Slump will be determined using AASHTO T-119, and air content using AASHTO T-152 for gravel and stone aggregate and AASHTO T-196 for slag and other highly porous coarse aggregate. Test specimens will be made and cured in accordance with AASHTO T-23 except that after the initial curing, quality control specimens will be cured in a medium maintained at forty (40) degrees F to eighty-five (85) degrees F until they are delivered to the laboratory. Specimens will be tested in accordance with AASHTO T-22 for cylinders or AASHTO T-97 for beams (third point loading) or AASHTO T-177 for beams (center loading).

Unless otherwise provided, the minimum modulus of rupture when test beams are permitted as a criteria for removal of forms, placing a structure in service, driving piling, etc., shall be five hundred fifty (550) psi when tested with the third point method or six hundred fifty (650) psi when tested with the midpoint method and the minimum compressive strength of cylinders shall be thirty-five hundred (3500) psi.

404.06 – METHOD OF MEASUREMENT

Structural concrete will be measured by the cubic yard in accordance with the dimensions shown on the plans or directed by the Engineer.

404.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

STRUCTURAL CONCRETE	C.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 405 – PRE-STRESSED CONCRETE FOR STRUCTURES

405.01 – DESCRIPTION

This section covers the furnishing and placing in the structure of the Pre-stressed beams or other members in accordance with these specifications and in reasonably close conformity with the lines, grades and dimensions shown on the plans or established by the Engineer.

Plans for particular members will show Pre-stressing by one of the following methods:

A) Pre-tensioning: In which the reinforcing tendons are stressed initially, after which concrete is placed and cured and the stress is released from anchorages to concrete after development of specified concrete strength.

B) Post-tensioning: In which the reinforcing tendons are installed in voids or ducts within the concrete and are stressed and anchored after the development of specified concrete strength. As a final operation under this method the voids or ducts are pressure grouted.

C) Combined Method: In which part of the reinforcing is Pre-tensioned and part Post-tensioned. Under this method all applicable requirements for Pre-tensioning and for Post-tensioning shall apply to the respective reinforcing elements using these methods.

405.02 – MATERIALS

Materials shall meet the requirements specified in the following Section 900 – Materials:

Portland Cement Concrete	932

Joint Fillers and Sealers	932
Reinforcing Steel	941
Bearing Pads	943
Strands for Pre-tensioning	941
Bars for Post-tensioning	941
Parallel Wire Assemblies for Post-tensioning	941
Anchorages	941

405.04 – CONSTRUCTION METHODS

A) Concrete for Pre-stressed Members - The concrete shall have the minimum compressive strength at twenty-eight (28) days as shown on the plans and as specified in Section 932. The strength of the concrete at transfer of Pre-stress shall be eighty (80) percent off, or four thousand (4000) psi, whichever is greater.

B) If steam curing is used, the methods shall meet the following requirements:

1) Steam curing shall be done under a suitable enclosure to contain the live steam in order to minimize moisture and heat losses. The initial application of the steam shall be from two (2) to four (4) hours after the final placement of concrete to allow the initial set of the concrete to take place. If retarders are used, the waiting period before application of the steam shall be increased from four (4) to six (6) hours.

2) The steam shall be at one hundred (100) percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. Live steam shall not be applied directly on the concrete or in harmful, concentrated jets of the forms.

3) During application of the steam the ambient air temperature shall increase at a rate not to exceed forty (40) degrees F per hour until a maximum temperature of one hundred-forty (140) degrees F to one hundred-sixty (160) degrees F is reached.

4) The maximum temperature shall be held until the concrete has reached the desired strength. In discontinuing the steam, the ambient air temperature shall not decrease at a rate to exceed forty (40) degrees F, per hour until the approximate temperature of the air to which the concrete will be exposed has been reached.

C) Forms - Forms and centering shall be made and maintained during their use true to the shapes and dimensions shown on the approved drawings.

Forms shall be well braced and stiffened against deformation under pressure of the wet concrete and shall have smooth joints and inside surfaces accessible for adequate cleaning before each use.

Forms may be treated with a commercial quality form oil or other equivalent coating which will permit the ready release of the forms and will not discolor the concrete. Adequate measures shall be taken by the Contractor, as approved by the Engineer, to prevent the contamination or corrosion of the Pre-stressing steel.

D) Stressing Requirements - General - In all methods of tensioning, the stress induced in the reinforcing members shall be measured both by jacking gauges and by elongations of the reinforcement. Elongations and jacking pressures shall make appropriate allowance for friction and all possible slippage or relaxation of the anchorage. All jacks shall be equipped with accurate and calibrated gauges for registering jacking pressures. Means shall be provided for measuring the elongation of reinforcement to at least the nearest one thirty-second (1/32) inch.

Prior to use in manufacture of Pre-stressed members under these specifications, all jacks to be used, together with their gauges, shall be calibrated by a reputable testing laboratory at the expense of the Contractor. Calibration of jacks and gauges shall be repeated at intervals of not more than one (1) year. During progress of the work if any jack or gauge appears to be giving erratic results, or if gauge pressure and elongation indicate materially differing stresses, recalibration will be required.

It is anticipated that there may be a possible difference in indicated stress between jack pressure and elongation of about five (5) percent. In such event the error shall be so placed that the discrepancy shall be on the side of a slight overstress rather than understress. In the event of an apparent discrepancy between gauge pressure and elongation of more than five (5) percent, the entire operation shall be carefully checked and the source of error determined before proceeding further.

Straight tendons may be tensioned from one end. The draped tendons shall be stressed by jacking from both ends of the bar unless otherwise provided on the plans or in the proposal.

In all stressing operations the stressing force shall be kept symmetrical about the vertical axis of the members.

E) Stressing Procedure - The Contractor shall submit his plan and procedure for stressing each type of unit to the Engineer for approval prior to fabrication. The procedure should include, but not be limited to: initial tensioning force to equalize stresses and eliminate slack in the strands; uplift and hold down devices; method of Pre-tensioning and detensioning; measurement of elongation; and anchorage details.

1) Pre-tensioning - The amount of stress to be given each cable shall be as shown on the plans. Cable stress shall be maintained between anchorages until the concrete has reached the required compressive strength.

2) Post-tensioning - For all Post-tensioned bars, the anchor plates shall be set exactly normal in all directions to the axis of the bar. Parallel wire anchorage cones shall be recessed within the beams. Tensioning shall not be done until the concrete has reached the required compressive strength.

3) Combined Method - In the event that the girders are manufactured with part of the reinforcement Pre-tensioned and part Post-tensioned, the applicable portions of requirements listed above shall apply to each type.

4) Ducts for Post-tensioning Bars - Ducts in the girders for the Post-tensioning bars or parallel wire cables shall be formed by means of flexible metal conduits, metal tubing, or other approved means. They shall be mortar tight, accurately placed, and accurately held in place. Metallic conduit shall be of a ferrous metal.

   The ducts through Post-tensioned members in which the bars or cables are installed shall be equipped with approved grouting vents. After completion of stressing, the annular space between sides of the bar or cable and sides of hole shall be grouted in a manner approved by the Engineer.

F) Construction, Testing and Inspection - Construction methods and testing shall be in accordance with the AASHTO Standard Specifications for Highway Bridges and as supplemented herein.

1) The Contractor shall notify the Engineer of the time at which the stressing procedure, casting procedure, or releasing of strands are to take place so that an Inspector can be present during casting and Pre-stressing of the beams.

2) After the stressing of Pre-tensioned strands has been completed and before side forms are erected, the Inspector shall examine the strands, and any strand found contaminated with the bond breaking substance used on the forms shall be replaced or satisfactorily cleaned with a solvent.

The Inspector shall inspect batching and placement and make six (6) cylinders for each casting operation: three (3) of the cylinders shall be used to determine when concrete has reached the required strength and is ready for stressing, and the remaining cylinders shall be tested at twenty-eight (28) days to determine that the design strength has been reached. Cylinders shall be cured in the same manner as the structural member which is represented by the cylinders until the requirements for stressing have been attained and the remaining period for the twenty-eight (28)

day cylinders shall be in accordance with AASHTO T-23. Cylinders shall be tested in accordance with AASHTO T-22.

G) Transportation and Storage - Pre-cast girders should be maintained in an upright position, and points of support and directions of the reactions with respect to the girder shall be approximately the same during transportation and storage as when the girder is in its final position.

Care shall be taken during storage, hoisting, and handling of the pre-cast units to prevent cracking excessive camber, side bow, or other damage. Units damaged by improper storing or handling shall be replaced by the Contractor at no additional cost to the City. Minor chipping, spalling and scars may be repaired if approved by the Engineer.

H) Erection, Bearings and Anchorage - All bearing areas on the Pre-stressed members, as well as on the bridge seats, shall be finished to a true surface to give full and uniform bearing over the entire bearing area. In case such a uniform bearing is not obtained, the defect shall be corrected in a manner approved by the Engineer.

All anchorages shall be carefully constructed as shown on the plans. Before any member is erected, the Engineer will check the elevations of all bridge seats. Any elevation which is off more than .02 feet shall be corrected in a manner approved by the Engineer. Pre-stressed beams shall be blocked or braced as they are set in place to assure lateral stability.

I) Tolerances - Maximum dimensional tolerances are listed below. It is intended that the dimensions of all members shall be well within these tolerances and the maximum values shall be permitted to be approached or equaled only occasionally. The Inspector shall document to the Engineer any unit with dimensions out-of-tolerance.

Pre-stressed Concrete I-Beams Tolerance in Inches

Depth (flanges, web and fillets)	¼”
Depth (overall)	½” to -¼”
Width (flanges and fillets)	⅜” to -¼”
Width (web)	⅜” to -¼”
Length of Beams	1”
Exposed Beam Ends Deviation from Square or Designated Skew – Horizontal	½”
Diaphragm Bolt Holes (spacing between centers of inserts and from the centers of inserts to the ends of the beams)	½”
Bearing Plates (spacing between the centers of bearing plates)	$^1/_8$” per 10 LF
Bearing Plates (spacing from the centers of bearing plates to the ends of the beams)	½”
Bearing Plat or Bearing Area Deviation from Plane	$^1/_8$”
Stirrup Bars – Projection Above Top of Beam	¾”
Stirrup Bars – Longitudinal Spacing	1”
End Stirrup Bars	½” from Plan
Horizontal Alignment (deviation from a straight line parallel to the centerline of beam)	$^1/_8$” per 10 LF
Camber Differential between Adjacent Beams 1/8 per 10 ft. of span to maximum of 1	¼”
Center of Gravity of Strand Group	½”
Center of Gravity of Depressed Strand Group at end of Beam	¼”
Position of Post-Tensioning Duct	6”
Position of Hold Down Points for Depressed Strand	6”
Position of Handling Devices	6”

Variations greater than specified above shall be corrected to within these tolerances or be subject to a structural review by the Engineer for acceptance.

J) Finish - The facia girder on grade separation structures shall receive a surface finish consistent with

other areas of the superstructure. Surface finish shall be in accordance with Section 403.

405.06 – METHOD OF MEASUREMENT

Accepted Pre-stressed concrete beams will be measured by the linear foot of Pre-stressed concrete beam complete in place as specified and as shown on the plans.

Joint fillers, joint sealers, shoes, bearing plates, and elastomeric bearing pads will not be a separate pay item, but the cost of same shall be included in the price of other bid items unless otherwise shown on the plans. When approved by the Engineer, twenty (20) percent additional cement and admixture can be used in lieu of High Early Strength Portland Cement.

405.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

PRE-STRESSED CONCRETE BEAMS LF

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 406 – HIGH EARLY STRENGTH CONCRETE

406.01 – DESCRIPTION

High Early Strength Concrete shall be composed of High Early Strength Portland Cement, fine and coarse aggregate, and water, each measured separately and mixed as provided in Section 932. It shall be used for structures or portions of structures only when approved by the Engineer or called for on the plans or in the special provisions.

406.02 – MATERIALS

Materials shall meet the requirements specified in Section 932.

406.04 – CONSTRUCTION METHODS

A) Tests - Test specimens shall be in accordance with Section 932.

B) Curing

1) Floor slabs shall be cured as provided in Section 409.

2) The side forms on curbs and piles may be left in place for at least three (3) days or if removed before the three (3) days have elapsed, the surfaces shall be cured for the remaining time by one of the methods specified herein. Surfaces that require a concrete surface finish shall be shrouded with wet burlap or wet mats from the time the forms are removed until the three (3) day curing period has elapsed.

C) Removal of Forms - In order to obtain a satisfactory surface finish, forms on ornamental work, railings, parapets, curbs, and vertical surfaces, which do not carry loads and will be exposed in the finished work, shall be removed within forty-eight (48) hours, depending upon weather conditions, and in any event while a satisfactory finish can still be obtained.

Before forms are removed or the concrete placed in service on portions of structure carrying loads the compressive strengths of test cylinders or modulus of rupture of test beams shall be as provided in Section 932.

In no case shall forms under parts of structures carrying loads be removed in less time than shown by the following table. Days on which the temperature falls below fifty (50) degrees F shall not be counted.

TABLE 406.03.01 – Form Removal Time

Shores and Centering Under Slabs, Beams, Girders and Arches Less than 20 feet	4 days
Over 20 feet and less than 35 feet	6 days
Over 35 feet and less than 50 feet	8 days
Over 50 feet and less than 60 feet	9 days
Over 60 feet	10 days
Floor slabs on steel stringers	3 days
All other parts	3 days

After removal of forms, supports, and centering, concrete may be subjected to not more than the design load of the structure.

D) Reinforced Concrete Piling - High Early Strength Concrete piling shall not be moved and stacked in less than three (3) days after casting, nor driven in less than seven (7) days after casting, and in no event until a compressive strength of thirty-five hundred (3,500) psi or a modulus of rupture of six hundred (600) psi when tested with third point method or seven hundred (700) psi when tested with midpoint method in accordance with Section 932.

406.06 – METHOD OF MEASUREMENT

Measurement of the various structures when High Early Strength Concrete is used will be in the same manner as elsewhere provided in these specifications for items of the same kind.

Payment for the various items in which High Early Strength Concrete is used shall be made on the same basis as provided elsewhere in these specifications for items of the same kind. No additional compensation will be allowed when the Contractor uses High Early Strength Concrete at his own option.

406.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

HIGH EARLY STRENGTH CONCRETE C.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 407 – PNEUMATICALLY PLACED CONCRETE

407.01 – DESCRIPTION

This section covers premixed sand and Portland Cement pneumatically transported through a pipe or hose in a dry state to a nozzle where hydration takes place immediately prior to expulsion.

407.02 – MATERIALS

The cement, water, and sand shall conform to the requirements of Section 932, "Portland Cement Concrete". The sand, when tested by approved laboratory methods, shall conform to the following gradation requirements:

Passing No. 4 Sieve	98-100% (by weight)
Passing No. 20 Sieve	60-85%
Passing No. 50 Sieve	15-35%
Passing No. 100 Sieve	0-5%

Bar reinforcement and wire fabric reinforcement shall conform to the requirements of Section 941, "Reinforcing Steel".

Expansion joint material shall conform to the requirements of Section 932, "Preformed Expansion Joint

Filler for Concrete".

Steel drive pins or studs used for the attachment of reinforcing when covering designed portions of concrete structures with pneumatically placed concrete shall be capable of being driven to the specified depth without deforming or otherwise becoming unsuitable for the purpose intended. The pins shall have a minimum diameter of one-eighth (1/8) inch and a minimum length of two (2) inches. Size and location of drive pins or studs and method of attachment of reinforcing shall be as specified herein or as detailed on the plans.

The equipment used for driving the pins or studs shall be of the type which uses an explosive for the driving force, and shall be capable of inserting the stud or pin to the required depth without damage to the concrete. The Engineer may require that a test be made of the equipment prior to approving it for use.

Unless otherwise specified, the concrete shall consist of a mixture of cement and sand in the proportions by volume of one (1) part cement to four and one-half (4 1/2) parts sand. The sand shall contain not less than three (3) percent nor more than six (6) percent of moisture by weight. The sand and cement shall be mixed thoroughly in a power mixer for at least one and one-half (1 1/2) minutes before placement in the chamber of the gun mechanism. The dry mixed material shall be used promptly after mixing and any material that has been mixed for more than forty-five (45) minutes shall be rejected and removed from the worksite.

The mixer shall be cleaned at regular intervals to remove all adherent material from the mixing vanes and from the drum.

At the beginning of work the Engineer may require that cylinders be made to represent the quality of the pneumatically placed concrete. Additional cylinders will be made during prosecution of the work as directed by the Engineer. If, in the opinion of the Engineer, the cylinder strengths are indicating undesirable variation in the concrete, the Contractor may be required to change the mix design and/or method of placing so as to correct this condition.

The Contractor shall furnish especially constructed cylinders six (6) inches in diameter and twelve (12) inches high, made of three-fourths (3/4) inch square mesh hardware cloth. Test cylinders for pneumatically placed concrete shall be shot with the same air pressure and nozzle tip as the pneumatically placed concrete. At the end of the first twenty-four (24) hours curing period the hardware cloth form shall be removed and the cylinders stored and cured as directed by the Engineer.

The use of approved admixtures conforming to the requirements of Section 932, "Concrete Admixtures", will be permitted at the option of the Contractor.

407.03 – EQUIPMENT

The gun mechanism should be operated at a minimum air pressure of forty-five (45) pounds per square inch on the gun tank when one hundred (100) feet or less of material hose is used and the pressure should be increased five (5) pounds for each additional fifty (50) feet of hose required. Nozzles used for guniting shall have a maximum size of one and five-eighths (1 5/8) inch unless otherwise permitted by the Engineer.

Water used for hydration shall be maintained at a uniform pressure, which shall be at least fifteen (15) pounds per square inch above air pressure at the gun.

407.04 – CONSTRUCTION METHODS

A) Placement - Earth surfaces to which concrete is to be applied shall be neatly trimmed to line and grade and shall be free of all loose material.

   No high subgrade will be permitted. Excavation made below subgrade shall be backfilled with compacted fill or, at the Contractor's option, with concrete. However, no additional compensation will be allowed for such compacted fill nor for increased thickness of concrete placed because of low subgrade.

Asphaltic concrete surfaces shall be thoroughly cleaned of any organic Material, silt and clay, or any other material detrimental to the concrete and then washed with water under pressure.

Masonry, rock, and concrete surfaces shall be examined and all loose material removed therefrom. The surface shall be thoroughly cleaned with steel scrapers or brushes to remove all dust, dirt, mortar, grease, or other deleterious substances and then washed with water.

Whenever brushing and scraping do not secure suitable results, sandblasting may be required.

All surfaces shall be wetted with water before application of concrete. Concrete shall not be applied to surfaces on which free water exists.

The velocity of the material as it leaves the nozzle shall be maintained uniformly at a rate determined for given job conditions. Material which rebounds and does not fall clear of the work or which collects on the surfaces shall be blown off or otherwise removed. Rebound shall not be used in any portion of the work and no payment will be made for rebound or other concrete losses.

The nozzle shall be held at such distance and position that the stream of flowing material will impinge at approximately right angles to the surface being covered. Any portion of the placed concrete which tends to sag or which shows soft or sandy pockets or is otherwise unsatisfactory, shall be cut out and replaced with new concrete. Reinforcement damaged or destroyed by such repairs shall be replaced by trimming the concrete back and properly lapping and tying additional steel as may be required by the Engineer.

Reinforcement shall be firmly supported in the position shown on the plans. Mortar blocks, metal chairs, clips, or spacers with wire ties or other acceptable means shall be used to anchor and place the reinforcement properly.

Where material is placed on overhead surfaces the amount of water used shall be so adjusted that approximately three-fourths (3/4) inch of the placed material shall adhere without support. The limit of thickness shall be considered to have been exceeded when the material begins to sag or slough.

B) Forms and Ground Wires - The forms shall be built in accordance with applicable provisions of these specifications, except all forms shall be built so as to permit the escape of air and rebound.

Ground wires shall be installed in such a manner that they accurately outline the finished surface as indicated on the plans. They shall be located at intervals sufficient to insure proper thickness throughout. Wires shall be stretched tight and shall not be removed prior to application of the finish coat.

Headers will be required where the plans indicate a formed edge and at plan joints.

C) Joints - Construction joints shall be sloped off at an angle of approximately forty-five (45) degrees to the surface to which the concrete is being applied. Before applying concrete in the adjacent sections the sloped portion shall be thoroughly cleaned and wetted by means of air and water blast. The plan joints shall be formed in accordance with and placed in the locations designated on the plans.

D) Finish - Upon reaching the thickness and shape outlined by forms and ground wire, the surface shall be rodded off to true lines. Any low spots or depressions shall be brought up to proper grade by placing additional concrete. Ground wires shall then be removed, and unless otherwise specified, the surface shall then be broom finished to secure a uniform surface texture. Rodding and working with a wood float shall be held to a minimum. Rebound or accumulated loose sand shall be thoroughly cleaned up and disposed of by the Contractor. In no case shall it be floated into the surface of the work.

When a nozzle finish is specified on the plans, ground wires shall not be used, and the surface shall be left as uniform as possible without rodding. Nozzle finishes will not be permitted where the underlay has been floated. Concrete shall not be applied to a surface containing frost or ice. Where standing or running water is encountered it shall be removed before applying the concrete. No

work shall be done without the permission of the Engineer when the temperature is lower than forty (40) degrees F. After placing, the concrete shall be protected from freezing or quick drying.

E) Curing - Pneumatically placed concrete shall be cured in accordance with Section 403, "Concrete Structures".

F) Workmen - Only experienced foremen, gunmen, nozzlemen, and rodmen shall be employed and satisfactory written evidence of such experience shall be furnished the Engineer or his representative upon demand.

407.06 – METHOD OF MEASUREMENT

Measurement for pneumatically placed concrete will be made by the square foot in place. For encasement of structural steel members and covering portions of structures, the actual contact area shall be the basis for measurement.

Pneumatically placed concrete, measured as provided above, will be paid for at the unit price bid per square foot for "Pneumatically Placed Concrete", of the type specified. The unit price bid per square foot shall be full compensation for all cement, sand, water, reinforcement, furnishing and driving all steel drive pins, for mixing and placing pneumatically placed concrete, and for all labor, tools, equipment, and incidentals necessary to complete the work. Excavation for channel and canal lining will be paid for in accordance with Section 200-04. Shaping and fine grading of channel or canal slopes and floors are not to be paid for directly but shall be included in the unit price bid for "Pneumatically Placed Concrete".

407.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

PNEUMATICALLY PLACED CONCRETE	S.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 408 – STEEL STRUCTURES

408.01 – DESCRIPTION

This section covers the fabrication and erection of structural steel and other metals, except reinforcing steel, which are used for steel structures or steel portions of structures.

408.02 – MATERIALS

408.02.01 – GENERAL

The metal used for the various portions of the structure shall be as specified and shall conform to the requirements of the applicable sections of Parts 1 through 12 of the ASTM Specifications.

408.02.02 – SHOP DRAWINGS

Unless otherwise provided on the plans, the Contractor shall prepare and submit detailed shop drawings for each detail of the general plans requiring the use of structural steel, forgings, wrought iron, castings, or bearings. Camber and erection diagrams will be required. The drawings shall be prepared on sheets twenty-four (24) inches by thirty-six (36) inches. Or as designated by the City Engineer.

All shop drawings shall be checked by the fabricator before being submitted for approval by the Engineer. The Contractor shall furnish to the City as many prints of the drawings as are necessary for carrying out the work. The Contractor shall be responsible for the correctness and completeness of the drawings and for shop fit and field connections, although the drawings have been approved by the Engineer.

408.02.03 – STORING MATERIALS

All materials shall be handled in such manner that no injury will result. Material to be stored shall be placed on skids above the ground and shall be kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members, such as columns, shall be supported on skids placed closely enough to prevent excessive deflection.

408.03 – EQUIPMENT

Before starting work, the Contractor shall inform the Engineer fully as to the method of erection he proposes. Follow and as to the amount and character of the equipment he proposes to use; the adequacy of which shall be subject to the approval of the Engineer. The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety or adequacy of his methods or equipment or from carrying out the work in full accordance with the plans and specifications. No work shall be done without the sanction of the Engineer.

The Contractor shall prepare and submit erection plans for the erection of plate girders (riveted, bolted, or welded), trusses, and for all railroad underpass structures. Field erection plans for I-beam units will not be required unless specified on the plans. The plans shall be complete in all details of procedure, sequence of work, equipment to be used, etc., so that a check can be made of the adequacy of the proposed erection procedure.

Spot welding for the purpose of eliminating field erection bolts or for holding steel parts together while riveting will not be permitted.

The Contractor shall provide the falsework and all tools, machinery and appliances, including drift pins and fitting-up bolts, necessary for the expeditious handling of the work. Drift pins sufficient to fill at least one-fourth (1/4) of the field holes for main connections shall be provided.

408.04 – CONSTRUCTION METHODS

408.04.01 – WORKMANSHIP

Workmanship and finish shall be equal to the best general practice in modern steel fabricating shops.

Rolling tolerances for rolled shapes, plates, and bars shall conform to the requirements of ASTM Designation A-6.

Before being laid out or worked, rolled material shall be straight. If straightening is necessary, it shall be done by methods approved by the Engineer. Kinks and bends in the material will be cause for rejection. Heat shrinking of low alloy structural steels will not be permitted.

If straightening is necessary in the field, only methods approved by the Engineer shall be used.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

Portions of the work exposed to view shall be finished neatly. Shearing, flame cutting, and chipping will be done carefully and accurately. Undercut gusset plates will not be accepted. All sharp corners and edges, and edges that are marred, cut, or roughened in handling or erection, shall be slightly rounded by grinding or other suitable means.

408.04.02 – RIVETED AND BOLTED STRUCTURES

Unless prohibited by the plans, high strength bolts may be used where rivets are designated. In these specifications where reference is made to pitch, edge distance, preparation of holes, etc., for rivets, the same criteria shall govern for high strength bolts. Pitch and edge distance not shown on the plans shall be in accordance with AASHTO Standard Specifications for Highway Bridges.

Unless otherwise specified or shown on the plans, fabrication of riveted structures shall conform to the current edition of AASHTO Standard Specifications for Highway Bridges.

408.04.03 – HOLES FOR BOLTS OR RIVETS

Holes shall be either punched full size, punched and reamed, or drilled. The finished hole shall be one-sixteenth (1/16) inch larger than the nominal diameter of the rivet.

Holes punched full size shall have all burrs and sharp edges removed. The diameter of the die shall not exceed that of the punch by more than three thirty- seconds (3/32) inch.

A) Holes for Shop Rivets shall be subpunched, or subdrilled at the fabricator's option, one-fourth (1/4) inch less in diameter than that of the finished holes and shall be reamed to size with the parts assembled, with the following exceptions:

   1) Holes in material thicker than seven-eighths (7/8) inch shall not be punched; however, at the fabricator's option, they may be subdrilled to the diameter specified for subpunching or may be drilled full size with the parts assembled, provided that the parts are adequately bolted or clamped together.

   2) Holes in rolled beams and plate girders, including stiffeners and active fillers at bearing points, may be subpunched one-eighth (1/8) inch less in diameter than that of the finished holes and reamed to size (after assembly) in material not thicker than the nominal diameter of the rivet less one-eighth (1/8) inch.

   3) Holes in material not more than seven-eighths (7/8) inch thick, for rivets which do not transfer stress caused by external vertical loading, may be punched full size or, at the fabricator's option, may be subpunched one-eighth (1/8) inch less in diameter than the finished holes and reamed to size after assembly. This applies to holes for stitch rivets, lateral, longitudinal or sway bracing and their connecting material, lacing, stay plates, diaphragms which do not transfer shear or stress, inactive fillers, and stiffeners not at bearing points. However, holes through assembled material shall not pass through both reamed plies and plies punched full size unless the reamed holes have been subpunched for the fabricator's convenience, or the assembled material is not over five (5) plies thick, of which the main material consists of not more than three (3) plies.

B) Holes for Field Rivets shall be subpunched or subdrilled at the fabricator's option, one-fourth (1/4) inch less in diameter than that of the finished holes, and shall be reamed to size through steel templates with hardened steel bushings, with the following exceptions:

   1) Field splices in plate girders and in the chords of trusses shall be reamed with the members assembled. Other field connections may be reamed with the members assembled, at the fabricator's option. Chord splices or truss members shall, in all cases, be reamed or drilled with at least three (3) abutting sections assembled and with milled ends of compression chords in full bearing.

   2) Assemblies such as floor systems to girders, complete trusses, rolled beam spans connected by diaphragms, and portals to trusses shall be reamed with the members assembled if so indicated on the plans, and otherwise at the fabricator's option.

   3) Field connections of lateral, longitudinal, or sway bracing shall conform to the requirements of holes for shop rivets.

   4) Holes in material thicker than seven-eighths (7/8) inch shall not be punched but shall be subdrilled to the diameter specified for subpunching, or drilled full size with parts assembled.

      The accuracy of the punching shall be such that for any group of holes when assembled, seventy-five (75) percent shall admit a rod equal to the diameter of the cold rivet at right angles to the plane of the connection. Otherwise the holes shall be reamed. When the extent of the reaming is such that the holes cannot be properly filled or accurately adjusted after reaming, the faulty member shall be discarded and replaced.

      Mispunched members shall not be corrected by welding without the approval of the Engineer.

408.04.04 – REAMED WORK

Reaming shall be done after the pieces forming a built-up member are assembled and so firmly bolted together that the surfaces are in close contact. Burrs and sharp edges of each reamed hole under both rivet heads shall be removed with a countersinking tool making one-sixteenth (1/16) inch fillets. The pieces shall be taken apart before riveting, if necessary, and any shavings removed. If it is necessary to take the members apart for shipping or handling, the pieces reamed together shall be so marked that they may be reassembled in the same position. Reamed parts shall not be interchanged.

408.04.05 – DRILLED HOLES

Drilled holes shall be one-sixteenth (1/16) inch larger than the nominal diameter of the rivet. Burrs and sharp edges of each drilled hole under both rivet heads shall be removed with a countersinking tool making a one-sixteenth (1/16) inch fillet. Burrs on the outside surfaces shall be removed. If members are drilled while assembled, the parts shall be held securely together while the drilling is being done.

Drilled holes shall be drilled to finish size while all of the thicknesses of metal are assembled or subdrilled and reamed as required for punched and reamed holes.

Holes shall be clean cut, without torn or ragged edges. Holes that must be enlarged to admit rivets shall be reamed. Drilling shall be done accurately.

408.04.06 – ASSEMBLING STEEL

Steel parts shall be assembled in the shop or in the field in accordance with the following:

A) Shop Work - At the time of assembling and riveting, bolting, or welding, steel surfaces in contact for shop or field connection shall be thoroughly cleaned of rust, loose mill scale, dirt, grease, or other material foreign to the steel. No paint shall be applied to contact surfaces prior to riveting, bolting, or welding.

   Riveted or bolted trusses, continuous plate girder and I-beam spans, skew portals, skew connections, rigid frames, bents, and towers, shall be completely assembled in the shop and accurately adjusted to line and camber and holes for field connections and shall be drilled or reamed while assembled. Holes for other field connections, except those in lateral, longitudinal, and sway bracing, shall be drilled or reamed in the shop with the connecting parts assembled or drilled or reamed to a metal template with hardened bushings, without assembling.

   Long span truss work shall be assembled in lengths of not less than three (3) abutting panels, the members adjusted for line and camber, and holes for field connections drilled or reamed while assembled.

   Field riveted or bolted joints for girders shall be completely assembled, the members adjusted for line and camber, and holes for field connections drilled or reamed while assembled.

   Field butt joints for welded girders shall be completely assembled with the members adjusted for line and camber and prepared to fit for welding.

   All machinery shall be completely assembled. All bearings shall be fitted to the specified clearances and alignment. Gear reductions and all line gears shall have gear center distances set and the gears properly matchmarked.

B) Field Work - The parts shall be accurately assembled as shown on the plans and all matchmarks shall be followed. The material shall be carefully handled so that no parts will be bent, broken, or otherwise damaged. Hammering which will injure or distort the members shall not be permitted. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled. Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are fully riveted or bolted and all other truss connections pinned and bolted. Rivets or bolts in splices of butt joints of compression members and rivets or bolts in railings shall not be driven or torqued until the span has been erected in place, temporarily bolted, and the member is

supporting its own weight.

Splices and field connections shall have one-half (1/2) of the holes filled with bolts and cylindrical erection pins (half bolts and half pins) before riveting or bolting. Splices and connections carrying traffic during erection shall have three-fourths (3/4) of the holes so filled. Fitting-up bolts shall be of the same nominal diameter as the rivets, and cylindrical erection pins shall be one thirty-second (1/32) inch larger.

The drifting done during assembling shall be only such as to bring the parts into position and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit the rivets, they shall be reamed.

Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be matchmarked and a diagram showing such marks shall be furnished to the Engineer.

408.04.07 – RIVETING

Shop and field riveting shall conform with the following provisions:

A) Shop Work - Rivets shall be heated uniformly to a light cherry red color and shall be driven while hot. Rivets, when heated and ready for driving, shall be free from slag, scale, and other adhering matter. When driven they shall completely fill the holes. The heads shall be of approved shape, full size, neatly formed, concentric with the shank, free from fins, and in full contact with the surface of the member.

Loose, burned, or otherwise defective rivets shall be replaced. In removing rivets care shall be taken not to injure the adjacent metal. Caulking or recupping will not be permitted.

Rivets shall be driven by direct acting riveters where practicable. If rivets are driven with a pneumatic hammer, a pneumatic bucker shall be used if practicable.

B) Field Work - Pneumatic hammers shall be used for field riveting. Connections shall be accurately and securely fitted up before the rivets are driven. Drifting shall be only such as to draw the parts into position and not sufficient to enlarge he holes or distort the metal. Unfair holes shall be reamed or drilled. Rivets shall be heated uniformly to a light cherry red color and shall be driven while hot. They shall not be overheated or burned. Rivet heads shall be full and symmetrical, concentric with the shank, and shall have full bearing all around. They shall not be smaller than the heads of the shop rivets. Rivets shall be tight and shall grip the connected parts securely together. Cup faced dollies fitting the head closely to insure good bearing shall be used. Sufficient air capacity shall be maintained to keep the air pressure at one hundred (100) pounds per square inch at the hammers. Caulking or recupping will not be permitted. In removing the rivets the surrounding metal shall not be injured. The removal of loose or defective rivets by flame cutting will not be permitted, except upon written permission of the Engineer.

408.04.08 – BOLTED CONNECTIONS

When high strength bolts are required or permitted, the bolts shall be in conformance with ASTM A-325-81 and ASTM A-194.

408.04.09 – JOINTS AND CONNECTIONS

A) Edge Planing - Sheared edges of plates more than five-eighths (5/8) inch in thickness and carrying calculated stress shall be planed to a depth of one-fourth (1/4) inch.

B) Facing of Bearing Surfaces - Surfaces of bearing and base plates and other metal bearing surfaces that are to come in contact with each other, with ground concrete surfaces, or with asbestos sheet packing shall be machined flat to within one thirty-second (1/32) inch tolerance in twelve (12) inches and to within one-sixteenth (1/16) inch tolerance overall. Surfaces of bearing and base plates and other metal bearing surfaces that are to come in contact with preformed fabric pads, elastomeric and elastic bearing pads, or Portland Cement grout shall be machined flat to within one-eighth (1/8) inch tolerance in twelve (12) inches and to within three-sixteenths (3/16) inch tolerance overall.

At the option of the Contractor, steel slabs, where not in contact with other metal bearing surfaces, may be heat straightened in lieu of machining, provided the above tolerances are met.

C) Abutting Joints - When shown on the plans abutting joints shall be faced and brought to an even bearing. Where joints are not faced the opening shall not exceed one-fourth (1/4) inch.

D) End Connection Angles - Floor beams, stringers, and girders having end connection angles shall be built to exact length back-to-back of connection angles. If end connections are faced, the finished thickness of the angle shall not be less than that shown on the detail drawings.

E) Web Plates - In girders having no cover plates and which are not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than one-eighth (1/8) inch below at any point.

F) Fit of Stiffeners - End stiffener angles of girders and stiffener angles intended as supports for concentrated loads shall be milled or ground to secure an even bearing against the flange angles. All fillers under stiffener angles shall fit sufficiently tight to exclude water after being painted.

G) Pin and Bolted Connections - Pilot and driving nuts shall be used in driving pins. Pins shall be so driven that the members will take full bearing on them. In field assembling, the pin nuts on pin connections and the bolts on bolted connections shall be screwed up tight and the threads, except when high strength bolts are used, burred at the face of the nuts with a pointed tool.

H) Pins and Rollers - Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws. The final surface shall be produced by a finishing cut.

Pins and rollers more than seven (7) inches in diameter shall be forged and annealed.

In pins larger than nine (9) inches in diameter, the forging shall be permitted to cool to a temperature below the critical range cooling and a hole not less than two (2) inches in diameter shall be bored full length along the axis of the pin before being annealed.

Pin holes in structural members shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other unless otherwise required. The final surface shall be produced by a finishing cut.

The distance outside to outside of holes in tension members and inside to inside of holes in compression members shall not vary from that specified more than one thirty-second (1/32) inch. Holes in built-up members shall be bored after riveting, bolting, or welding is completed.

The diameter of the pin hole shall not exceed that of the pin by more than one- fiftieth (1/50) inch for pins five (5) inches or less in diameter, or one thirty- second (1/32) inch for larger pins.

I) Screw Threads - Screw threads shall make close fits in the nuts and shall be Unified Standard Series conforming to USASI B1.1-1960.

408.04.10 – BEARINGS AND ANCHORAGE

Anchor bolts shall be either headed bolts, installed with or without pipe sleeves, or swedge bolts installed in drilled holes as detailed on the plans. The anchor bolts shall be carefully installed to permit true positioning of the bearing assemblies.

When anchor bolts are installed in pipe sleeves, the pipes shall be completely filled with grout at the time the grout pads are constructed or at the time the bearing assemblies or masonry plates are placed. Swedge bolts installed in holes shall be either sulphured in or grouted in as shown on the plans.

All bearing assemblies shall be set level and to the elevations shown on the plans. Adjustments in the horizontal positions of bearing assemblies shall be made for temperature as directed by the Engineer.

In conformance with the details shown on the plans, masonry plates and the bearing plates of bearing assemblies shall be set on ground concrete surfaces, on preformed fabric pads, or on grout pads.

Grout to be placed below masonry plates or bearing plates of the bearing assemblies and in anchor bolt sleeves shall consist by volume of one (1) part Portland Cement and three (3) parts clean concrete sand. Concrete areas to be in contact with the grout shall be cleaned of all loose or foreign matter that would in any way prevent bond between the mortar and the concrete surfaces and shall be kept thoroughly saturated with water for a period of not less than twenty-four (24) hours immediately prior to placing the grout. The grout shall contain only sufficient moisture to permit packing and shaping. The grout shall completely fill the anchor bolt sleeves and shall be tightly packed under the masonry or bearing plates to provide full bearing. After placing all exposed surfaces of the grout pads shall be kept covered with a heavy thickness of burlap saturated with water for a period of three (3) days. All improperly cured or otherwise defective grout shall be removed and replaced at the Contractor's expense.

408.04.11 – EXPANSION AND ROTATION ASSEMBLIES

Before leaving the shop or foundry the rockers or roller nests shall be completely assembled with the bearing plates for checking and approval by the Engineer.

408.04.12 – WELDING

All shop and field welding shall be arc welding and shall be done in accordance with the current specifications of AWS Structural Welding Code as modified by AASHTO Standard Specifications for Highway Bridges.

Radiographic and Magnetic Particle Inspection of welds will be paid for by the City as part of the structural steel inspection.

Unless otherwise shown on the plans or specified, bearing assemblies that are to be machined after welding shall be stress relieved by heat treatment before machining in accordance with AWS Specifications.

Portions of members in bearing assemblies or in direct bearing shall be straightened, planed, or otherwise corrected after fabrication as necessary to provide full bearing on bearing assemblies or bearing areas on level bearing plates.

Where the end of a stiffener plate is shown "tight-fit" on the plans, the end of the plate shall be so fitted that it bears on the beam flange with at least point bearing. Local clearances between the end of the plate and the flange shall not exceed one-sixteenth (1/16) inch.

Unless otherwise shown on the plans or specified, erection bolts required for welded splices or welded connections may be left in place and the ends of all such erection bolts which project beyond the nut shall be burned off flush with the face of the nut. Where the bolt does not project, the end of the bolt and nut shall be tack welded to prevent loosening of the nut. Burning off projecting bolt ends and tack welding shall be performed prior to painting.

408.04.13 – PAINTING

The painting of metal structures shall include, unless otherwise provided in the contract, the cleaning and preparation of the metal surfaces; the application, protection and drying of the paint coatings; and the supplying of all tools, tackle, scaffolding, labor and materials necessary for the entire work. In the event no particular paint system is specified, any of those listed in Section 984 suitable for the structure indicated may be used. However, paints will be applied only as a complete and compatible system and once selected will be used throughout the project.

Shop painting, field painting, and maintenance painting are covered under these specifications. The prime coat shall be applied as soon as possible after cleaning and before deterioration of the surface occurs.

A) Cleaning - Cleaning shall remove all dirt, rust, scale, loose rust, loose mill scale, welding flux and slag, oil, grease, corrosive chemicals, and other detrimental foreign matter which may impair the adhesion of the coating to be applied.

Unless cleaning is to be done by blast cleaning, all weld areas, before cleaning is begun, shall be neutralized with a proper chemical after which it shall be thoroughly rinsed with water. Five methods of cleaning, including Solvent Cleaning, Hand and Power Tool Cleaning, Flame Cleaning, Commercial Blast Cleaning, and Near White Blast Cleaning or combinations of these methods are permitted. All new structural steel or painting requiring removal to the base metal shall be cleaned by the Commercial Blast Cleaning method unless otherwise specified.

Regardless of the method specified or used, the cleaned surface shall be primed or prepared as soon as possible and before any detrimental corrosion or recontamination occurs. Surfaces not intended to be painted shall be suitably protected from the effects of cleaning and painting operations.

1) Solvent Cleaning is a procedure for removing foreign matter such as oil, grease, soil, drawing and cutting compounds and other contaminants from steel surfaces by the use of solvents, emulsions, cleaning compounds, steam cleaning or similar materials and methods which involve a solvent or cleaning action.

2) Hand and Power Tool Cleaning is a method of preparing metal surfaces for painting using power impact tools, power sanders, power grinders, hand tools or a combination of this equipment to remove all detrimental foreign matter as defined above. All tools shall be operated in such a manner that no burrs or sharp ridges are left on the surface and no sharp cuts are made into the steel.

3) Flame Cleaning is a method of preparing metal surfaces for painting using oxyacetylene torches with power or hand operated steel brushes to remove detrimental foreign matter as defined above. When this method is used all metal, except the inside of boxed members and other surfaces which will be inaccessible to the Flame Cleaning operation after the member is assembled, shall be Flame Cleaned in accordance with the following operations:

   i) Oil, grease and similar adherent matter shall be removed by washing with a suitable solvent. Excess solvent shall be wiped from the work before proceeding with subsequent operations.

   ii) The surfaces to be painted shall be cleaned and dehydrated (freed of occluded moisture) by the passage of oxyacetylene flames which have an oxygen to acetylene ratio of at least one (1). The inner cones of these flames shall have a ratio of length to port diameter of at least eight (8) and shall be not more than 0.15 inch center to center. The oxyacetylene flames shall be traversed over the surfaces of the steel in such manner and at such speed that the surfaces are dehydrated and dirt, rust, loose scale, scale in the form of blisters or scabs, and similar foreign matter are freed by the rapid, intense heating by the flames. The flames shall not be traversed so slowly that loose scale or other foreign matter is fused to the surface of the steel or the temperature of the steel raised above three hundred (400) degrees F. The number, arrangement and manipulation of the flames shall be such that all parts of the surfaces to be painted are adequately cleaned and dehydrated.

   iii) Promptly after the application of the flames, the surfaces of the steel shall be wire brushed, hand scraped wherever necessary, and then swept and dusted to remove all free material and foreign particles. Compressed air shall not be used for this operation.

   iv) Paint shall be applied promptly after the steel has been cleaned and while the temperature of the steel is still above that of the surrounding atmosphere so that there will be no recondensation of moisture on the cleaned surfaces.

   Unless otherwise provided, the inside surfaces of boxed members and other surfaces which will be inaccessible to the flame cleaning operation after the member is assembled shall be cleaned by Hand Cleaning. If Flame Cleaning of such surfaces is required, it shall be so stated in the special provisions and the following will apply:

The inside surfaces of boxed cleaning operation after the member is assembled shall be cleaned as specified in paragraphs 1 and 2 above and wire brushed but not painted before the member is boxed or assembled. After all fabrication of the member is completed, its inside surfaces shall be hand wire brushed or hand scraped wherever necessary in order to remove dirt and other foreign substances which may have accumulated after the surfaces were originally cleaned. The outside surfaces of the members shall then be cleaned and dehydrated, wire brushed, and hand scraped wherever necessary. All surfaces shall then be swept and dusted to remove free material and foreign particles and the member completely painted.

4) Commercial Blast Cleaning is a method by which all steel shall be cleaned by either the centrifugal wheel or the air blast method. The cleaning shall remove all mill scale and other substances down to the bare metal except for slight shadows, streaks or discolorations caused by rust stains, mill scale oxides or, if the surface is pitted, slight residues of rust in the bottom of the pits. At least two-thirds (2/3) of each square inch of surface area shall be free of all visible residues and the remainder shall be limited to light discoloration, slight staining or light residues mentioned above.

   The maximum size of sand, crushed grit or shot shall be no larger than that passing the No. 16 sieve.

   The height of the profile of the anchor pattern produced on the surface shall be limited to a maximum height that will not be detrimental to the life of the paint film. The maximum particle sizes specified may produce an anchor pattern that is too high or too rough for the paint systems used. In such cases, the abrasive sizes should be reduced. If the application of the second coat of paint is deferred, an adequate reduction in anchor pattern height shall be made (reduction in abrasive size).

   Special attention shall be given to the cleaning of the corners and reentrant angles. Before painting, all metallic shot and grit or sand shall be removed from the surfaces. The cleaning shall be approved by the Engineer prior to painting.

5) Near White Blast Cleaning will be done with the same methods and procedures outlined in Commercial Blast Cleaning except for the degree of cleaning. Near White Blast cleaned surface finish is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint and other foreign matter have been completely removed from the surface except for very light shadows, very slight streaks, or slight discolorations caused by rust stains or mill scale oxides. At least ninety-five (95) percent of each square inch of surface area shall be free of visible residues, and the remainder shall be limited to the light discoloration mentioned above.

B) Storage of Paint - All paint and thinner shall be stored in an area that is well ventilated and protected from sparks, flames, direct rays of the sun and from excessive heat. Paint susceptible to damage by low temperatures shall be kept in a heated storage space when necessary.

C) Mixing - The paint shall be mixed in a manner which will insure breaking up of all lumps, complete dispersion of settled pigments, and a uniform composition. Paint shall be carefully examined for uniformity after mixing.

   All pigmented paint shall be strained after mixing except where application equipment is provided with adequate strainers. Strainers shall remove only skins and undesirable matter but will not remove the pigment.

   Thinner shall not be added to the paint unless necessary for proper applications without approval of the Engineer. Paints to be sprayed, if not specifically formulated for spraying, may require thinning when proper adjustment of spray equipment and air pressure does not result in satisfactory paint application. In no case shall more than one (1) part thinner to eight (8) parts paint be added unless paint is intentionally formulated for greater thinning. The type of thinner shall comply with the paint

consistency during the mixing process.

D) Application of Paint - Paint may be applied by brushing, air spraying, airless spraying, or hot spraying or a combination of these methods. Daubers or sheepskin may be used when no other method is practicable for proper application in places of difficult access.

Paint shall not be applied when temperatures of the steel or paint are below forty (40) degrees F Paint shall not be applied when the surface temperature is expected to drop below thirty-two (32) degrees F before the paint has dried, or when steel temperature is below the dew point resulting in condensation of moisture. Paint shall not be applied to frosted or ice coated surfaces. Paint shall not be applied to steel which is at a temperature that will cause blistering or porosity or otherwise be detrimental to the life of the paint.

A coat of paint shall not be applied until the preceding coat has dried. The paint shall be considered dry for recoating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats.

Paint shall not be force dried under conditions which will cause checking, wrinkling, blistering, formation of pores, or detrimentally affect the condition of the paint.

Driers shall not be added to paint on the job unless specifically called for in the specification for the paint.

If stripe painting is specified, all edges, corners, crevices, rivets, bolts, weld and sharp edges shall be stripe painted with the priming paint before the steel receives its full prime coat of paint. Such striping shall extend for at least an inch from the edge. When practicable, this stripe coat shall be permitted to dry before the prime coat is applied; otherwise, the prime coat shall set to touch before the full prime coat is applied. However, the stripe coat shall not be permitted to dry for a period long enough to allow rusting of the unprimed steel.

Shop and field paint shall be applied to the minimum dry mil film thickness specified for the paint system to be applied. The dry mil thickness will be measured in place with a calibrated magnetic film thickness gauge and repainting will be required for areas deficient in thickness.

Paint shall be worked into all crevices and corners possible.

Any runs or sags shall be immediately brushed out or after setting the paint shall be removed and the surface repainted in a manner approved by the Engineer.

When using the brush method, the brushes shall be of a style and quality that will enable proper application of the paint. Uniform brushing shall be done so that a smooth coat as nearly uniform in thickness as possible is obtained. There shall be a minimum of brush marks left in the applied paint.

The equipment used for all spray applications of paint whether air spray, airless, or hot spray, shall be suitable for the intended purpose. Any solvents left in the equipment shall be completely removed before applying paint to the surface to be painted.

Blind sides of all rivets, bolts and all other areas inaccessible to the spray gun shall be painted by brush, daubers or sheepskins. Brushes shall be used to work paint into cracks, crevices and blind spots which are not adequately painted by spray.

Areas of steel surfaces to be in direct contact with the concrete, paving or footing or encased or embedded in concrete or coated with concrete shall not be painted.

Contact surfaces of members to be joined by high strength bolts in friction type connections shall be left unpainted unless specifically authorized and shall be free of oil and grease coatings.

Shop contact surfaces shall not be painted, but any resulting crevices shall be sealed off in the paint application.

Steel shall not be painted within two (2) inches of edges to be welded.

Steel surfaces to be in contact only after field erection shall be painted except where the paint will interfere with assembly.

Steel surfaces not in direct bonded contact but inaccessible after assembly shall receive the full specified paint system before assembly.

Machine finished surfaces shall be coated with white lead or tallow, or an approved protective lubricant, before shipment or before rusting can occur.

1) Shop Painting - The number of coats and the type of paint shall be as specified. Unless otherwise specified, all structural steel shall be painted with at least one (1) coat of primer in the shop where fabrication is done. If the shop coat is damaged in fabrication, it shall be repaired before leaving the shop. Erection marks and weight marks shall be copied on areas that have been previously painted with the shop coat.

2) Field Painting - Shop coated steel members shall preferably be field painted after erection of such members is completed. Steel members may be field painted on the ground before erection providing such painting where damaged is touched up with the same number of coats and kind of paint after erection and provided the final complete coat of paint is applied after erection.

   Steel which has been shop coated shall be touched up with the same type of paint as the shop coat. This touch up shall include cleaning and painting of field connections, welds or rivets, and all damaged or defective paint and rusted areas. For areas requiring rust removal or paint repair the degree of surface preparation shall be at least equal to that required for structural steel under these specifications. The Contractor may at his option clean and apply one (1) overall coat in place of touch up or spot painting.

   The final field coat shall not be applied until all concrete work is finished. All concrete spatter and drippings shall be removed before application of paint. If concreting or other operations damage any paint, the damaged surface shall be cleaned and repainted.

   All dirt, sand, drift, and other foreign material shall be removed from the bridge seats before applying paint to the shoes, bearing plates and other steel parts of the structure to be painted in the immediate vicinity of bearing areas. Cleaning and painting shall be so programmed that detrimental amounts of dust or other contaminants do not fall on wet, newly painted surfaces.

3) Painting of Existing Structures - Only loose, cracked, brittle or nonadherent paint, loose mill scale, and loose rust shall be removed unless otherwise specified. All exposed edges shall be feathered and spot cleaned. Rust spots shall be thoroughly cleaned and the edges of all old paint shall be scraped back to sound materials.

   The Contractor shall at all times adequately protect traffic, the bridge floor and concrete surfaces from paint spray or splashes. Any paint spilled or sprayed on vehicles, curbs, bridge seats or bridge floors shall be removed by the Contractor at his expense.

   Empty paint cans, paper, or cloth which have come into contact with paint, and paint spilled on the vegetation, shall not be left in the channel or right-of-way or adjacent private property, but shall be removed from the work.

   The Contractor will be responsible at all times for safeguarding both public and private property from all hazards and damage resulting from the work.

408.04.14 – FALSEWORK

The falsework shall be properly designed for the loads to be supported and shall be constructed substantially and maintained. The Contractor shall prepare and submit plans for falsework to the Engineer for approval.

The falsework plans shall be complete in all details of members, connections, equipment, etc., so that a structural check can be made of the falsework.

Approval of the Contractor's plans shall not be considered as relieving the Contractor of any responsibility.

408.04.15 – GRADING DECK ON CONTINUOUS UNITS

Forms shall not be erected or concrete placed until after all welding, bolting, or riveting is complete, the unit positioned, and bearings properly set.

An accurate measurement shall be made of the elevations of girder or beam flanges at all grading control points as shown on the plans.

Subsequent grading of forms and placing and finishing of concrete shall be governed by these measurements only, taking into account the dead load deflection of the slab and rail as shown on the dead load deflection diagram.

408.04.16 – MISFITS

Corrections of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets will be considered a legitimate part of the operation. Any error in shop work which prevents the proper assembling and fitting up of parts by the moderate use of drift pins or a moderate amount of reaming and slight chipping or cutting shall be reported immediately to the Engineer, and his approval of the method of correction shall be obtained. The correction shall be made in the presence of the Engineer who will check the material. Such work is to be done at the entire expense of the Contractor.

408.06 – METHOD OF MEASUREMENT

No direct compensation will be made for "Steel Structures". Measurement and payment for quantities of structural metal, concrete, reinforcement, railing, and other proposal items which constitute the completed and accepted structures will be made in accordance with the provisions of pertinent specifications. When identified in the bid items, the steel structures shall be paid by structural steel in pounds.

408.07 – BASIS OF PAYMENT

Structural Steel, measured as provided above, will be paid for at the contract unit price for:

STRUCTURAL STEEL LBS.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

SECTION 409 – CONCRETE BRIDGE FLOORS

409.01 – DESCRIPTION

This section covers the construction of concrete bridge floors in accordance with these specifications and in reasonably close conformity with the lines, grades and dimensions shown on the plans or established by the Engineer.

409.02 – MATERIALS

Materials shall meet the requirements specified in the following Materials:

Portland Cement Concrete	932
Joint Fillers and Sealers	932
Reinforcing Steel	941
Curing Materials	932

409.04 – CONSTRUCTION METHODS

A) Construction Joints - Construction joints shall be made only where located on the plans, shown in the concrete placing schedule, or as directed by the Engineer. Shear keys or inclined

reinforcement shall be used where necessary to transmit shear and/or bond the two (2) sections together.

B) Forms - All forms shall conform to the requirements of Section 404.04 (C).

C) Placing Reinforcing Steel - All reinforcing steel shall be placed in accordance with Section 411.

D) Expansion Devices - Expansion devices shall be those shown on the plans. They will be carefully checked for line, grade, and crown.

E) Placing and Finishing Concrete - An Approved self-propelled finishing machine shall be used on all bridge decks. Supports for the finishing machine shall be parallel to the centerline of the structure, firmly fastened in place and set to correct line and grade with proper allowances for dead load deflections. A transverse finish shall be provided throughout the entire bridge length unless otherwise approved in writing by the Engineer.

Concrete bridge floors shall not be struck off longitudinally unless approved by the engineer. In such case the templates shall be supported on header boards cut to the crown of the roadway. The header boards shall be surfaced with steel plates unless otherwise approved by the Engineer. These templates shall be of sufficient weight and rigidity or trussed so that the desired finish camber is obtained longitudinally.

Before placing floor concrete, the forms shall be thoroughly wetted. The concrete shall be placed slightly higher than the finished surface of the floor. Immediately after the concrete has been placed and compacted as specified under Section 404.04 (D), it shall be carefully struck off to proper crown and finished to a smooth, even surface.

While the concrete is still plastic, the surface of the concrete shall be tested for trueness with a ten (10) foot straightedge. Any depressions found shall be filled immediately with freshly mixed concrete, and any high areas shall be cut down. The surface shall be struck off, consolidated and refinished. Special attention shall be given to insure that the surface across joints fully meet the requirements for smoothness. Final finish shall be uniformly textured by transverse brooming or other methods approved by the Engineer unless otherwise specified on the plans.

The Contractor shall furnish enough work bridges, a minimum of two (2), to enable his workmen to satisfactorily perform the floating, straight-edging, curing and final finishing at the proper times. The surface shall be given a further test for trueness using a ten (10) foot straightedge or other specified device before final acceptance. Areas showing high spots of more than one-eighth (1/8) inch shall be marked and immediately ground down with an approved grinding tool to tolerance requirements. The skid resistant surface shall then be restored in all ground down areas in a manner approved by the Engineer.

Tops of curbs shall be finished with a wooden float. Chamfer strips on curbs shall be set to established line and grade after the floor is placed.

Transverse Groove Final Finish for Overlays. Do not tine finish overlays within 2 inches of a construction joint.

High Density Concrete. After completing the finishing and before applying the transverse groove final finish, seal all vertical joints with adjacent concrete by painting with thinned grout. After joint painting, apply the transverse groove final finish. Grooving passes shall not be overlapped but shall be within 1 inch of the preceding pass.

Latex Modified Concrete. After completing the finishing, apply the transverse groove final finish. Grooving passes shall not be overlapped but shall be within 1 inch of the preceding pass. This must be done before the plastic film forms on the surface, approximately 25 minutes in hot, dry weather. Separate screed rails and construction dams from the newly placed material by passing a point trowel along their inside face. Exercise care to insure that this trowel cut is made for the entire depth and length of rails or dams after the concrete has stiffened sufficiently to not flow back.

F) Curing Floors and Parapets - Floors, curbs and parapets shall be cured in accordance with Section 403.04.10. with approved materials immediately after the finishing operations have been completed and marring of the concrete will not occur. The curing shall be maintained for a period of seven (7) days. Materials shall meet the requirements of Section 932.

If a penetrating sealer is called for in the plans, application shall be made following the minimum curing period.

G) Removing Forms - The side curb and parapet forms shall be removed in warm weather within twenty-four (24) hours after the concrete is placed and in cool weather within forty-eight (48) hours or at least as soon as they may be removed without damaging the curb. All wires shall be cut one-fourth (1/4) inch back of the surface of the concrete and the holes shall be filled with stiff cement mortar at once.

Forms supporting concrete floors placed on truss or I-beams, plate girder or Pre-stressed girder spans shall be left in place at least fourteen (14) days. In unfavorable weather, the specified time shall be increased at the discretion of the Engineer,

The above specified time may be decreased in case test beams or test cylinders made, cured and tested in accordance with Section 932 meet the specified minimum requirements.

In no case shall the forms supporting concrete floors on truss or I-beams or girder spans be removed in less than five (5) days after the concrete is poured.

H) Load on Floors - Loads shall not be placed on floor slabs for a period of seven (7) days or until forms are removed. Pneumatic-tired concrete carts or "buggies" holding not more than six (6) cubic feet of concrete per tire and holding not more than twenty-one (21) cubic feet of concrete per cart or "buggy", may pass over the floor after forty-eight (48) hours have elapsed after the completion of the placement. Plank runways of three (3) inch minimum thickness placed on a sand cushion having a depth of not less than four (4) inches must be provided for the carts or "buggies". If High Early Strength Concrete is used, the carts or "buggies" may pass over the floor after twenty-four (24) hours on runways with sand cushion as provided above. In no case shall a mixer be operated on concrete bridge floors without prior approval of the Engineer. Stockpiles of material placed on concrete floors shall not exceed sixty-four (64) pounds per square foot.

I) Opening to Traffic - Concrete bridge floors on I-beams, girders and trusses may be opened to traffic after a period of twenty-one (21) days has elapsed since the last concrete was placed in the floor.

The above specified time may be decreased if test beams or test cylinders are cast at the time the last concrete was placed in the floor. Test beams and test cylinders shall be made, cured and tested in accordance with Section 932. The bridge may be opened to traffic when the test beams meet strength requirements as provided in Section 932 or when test cylinders have a minimum compressive strength of three thousand (3000) psi. In no case shall bridge floors on I-beams, plate girders, Pre-stressed concrete girders, and trusses be opened to traffic in less than seven (7) days after the last concrete is placed in the floor.

When unusually low temperatures prevail during the curing period, the time of opening to traffic may be extended beyond the limits designated above, if required by the Engineer.

When the use of High Early Strength Concrete is approved by the Engineer in bridge floors, the time of opening to traffic will be governed by Section 406.

409.06 – METHOD OF MEASUREMENT

The accepted quantities which constitute the completed floor will be measured by the cubic yard of concrete according to the plans. Additional concrete required to take care of deflection will be included under this item, unless otherwise shown on the plans.

409.07 – BASIS OF PAYMENT

Concrete bridge floors, measured as provided above, will be paid for at the contract unit price for Section 404.07 Structural Concrete which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

SECTION 410 – PORTLAND CEMENT CONCRETE OVERLAY OF BRIDGE FLOORS

410.01 – DESCRIPTION

A) **Repair.** Repair of bridge decks consists of removing loose, delaminated, spalled, or deteriorated concrete from the existing surface, replacing with new high density concrete, or latex modified concrete and other necessary work as specified in the contract documents. When the bridge deck is to be overlaid, the replacement material for Class A and Class B repair shall be the same as the overlay material.

The Engineer will make a field inspection of all bridge decks and determine the areas of concrete deck to be repaired. These areas will be marked by the Engineer and repaired by the Contractor. The lower limit for Class A and Class B bridge deck repair shall be to suitable existing concrete, as determined by the Engineer. Bridge deck repair shall be classified as follows:

a. *Class A Bridge Deck Repair.* Class A bridge deck repair consists of:

i. Removing unsound concrete down to the top mat of reinforcing steel;

ii. Disposing of concrete removed;

iii. Replacing the excavated volume of concrete with high density concrete or latex modified concrete.

b. *Class B Bridge Deck Repair.* Class B bridge deck repair consists of:

i. Removing unsound concrete below the top mat of reinforcing steel;

ii. Cleaning existing concrete from the top mat of reinforcing steel in the repair area;

iii. Disposing of concrete removed;

iv. Replacing the excavated volume of concrete with high density concrete or latex modified concrete.

c. *Class C Bridge Deck Repair.* Class C bridge deck repair consists of:

i. Removing all unsound concrete for the full depth of the deck;

ii. Cleaning existing concrete from both mats of reinforcing steel in the repair area;

iii. Disposing of concrete removed;

iv. Replacing the excavated volume of concrete with Class AA concrete.

B) **Overlays.** Overlay of bridge decks consists of deck preparation and overlaying with either high density concrete or latex modified concrete, and other necessary work as specified in the contract documents. Unless otherwise specified, the overlay shall raise the roadway surface and shall cover the entire concrete deck. Deck preparation and overlaying consist of:

a. Sandblasting and/or chipping the concrete to a depth as necessary to remove rust, oil, and other foreign matter leaving a clean etched concrete surface free of any laitance; (Where the original deck concrete was cured by linseed oil emulsion, the entire deck shall be scarified to a depth of ¼ inch (6mm) below the original surface.)

b. Disposing of concrete removed;

c. Overlaying with the specified overlay concrete to the depth designated in the contract

documents.

Thickness of the concrete overlay shall be measured from the level of the original surface to the specified final raised surface as shown on the Plans. When the deck is to receive Class A or Class B repairs, the replacement material may be placed monolithically with the overlay course or separately prior to the overlay.

410.02 – MATERIALS

Use materials conforming to the following Sections:

High Density Concrete	932
Latex Modified Concrete	932

For repairs and overlays, use either high density concrete or latex modified concrete as specified in the contract documents. Limit the maximum concrete temperature to 85°F (30°C).

410.03 – EQUIPMENT

Provide all equipment with suitable traps, filters, drip-pans, or other devices to prevent oil or other deleterious matter from being deposited on the deck.

A) **Surface Preparation Equipment.** Use the following types of surface preparation equipment:

a. *Sawing Equipment.* Use sawing equipment capable of sawing concrete to the specified depth.

b. S*andblasting Equipment.* Use sandblasting equipment capable of removing rust and old concrete from the exposed reinforcement.

c. *Power Driven Hand Tool*s. Power driven hand tools for removal of concrete will be permitted with the following restrictions:

i. Limit the nominal size class of jack hammers to a maximum of 30 pounds (125n).

ii. Operate jack hammers or mechanical chipping tools at an angle less than 45° measured from the surface of the slab.

iii. For removing concrete from beneath any reinforcing bar, limit the nominal size class of chipping hammers to a maximum of 15 pounds (65N).

iv. *Scarifying equipment.* Use a scarifier for preparing an existing deck for an overlay. Use a power-operated mechanical scarifier capable of uniformly scarifying or removing the old surface to the depths required.

B) Proportioning and Mixing Equipment.

a. *For High Density Concrete.* Use proportioning and mixing equipment meeting the requirements of Section 932 for high density concrete. Use a construction or stationary concrete mixer of the rotating-paddle type, or a continuous mixer used in conjunction with volumetric proportioning.

b. *For Latex Modified Concrete.* Use proportioning and mixing equipment of a self-contained, mobile, continuous-mixing type meeting the following requirements:

i. The mixer shall be self-propelled and shall be capable of carrying sufficient unmixed, dry, bulk cement, sand, coarse aggregate, latex modifier, and water to produce on the site not less than 5 cubic yards ($5m^3$) of concrete.

ii. The mixer shall be capable of positive measurement of cement being introduced into the mix. The recording meter visible at all times and equipped with a ticket printout shall indicate this quantity.

iii. The mixer shall provide positive control of the flow of water and latex emulsion

into the mixing chamber. Water flow shall be indicated by a flowmeter and shall be readily adjustable to provide for minor variations in aggregate moisture.

iv. The mixer shall be capable of being calibrated to automatically proportion and blend all components of indicated composition on a continuous or intermittent basis as required by the finishing operation, and shall discharge mixed material through a conventional chute directly in front of the finishing machine. Sufficient mixing capacity of mixers shall be provided to permit the intended placement of the mixed material without interruption.

C) Placing and Finishing Equipment.

a. *Placing Equipment.* For placing and rough finishing, use adequate hand tools for placement of stiff plastic concrete to approximately the strike off level of the screed.

b. Finishing Machines.

i. *Repairs.* For deck repairs, use a vibrating screed to finish the deck surface.

ii. O*verlays.* Place and finish overlays with an approved finishing machine meeting the following requirements.

Use a finishing machine capable of screeding concrete within 12 inches (300mm) of the face of the existing curb or parapet wall. Make the screed sufficiently long to extend at least 6 inches (150mm) beyond the sides of the placement section, overlapping previously placed courses, overlay forms, and existing and planned sawcut edges. Provide each screed with positive control of the vertical position, the angle of tilt, and the shape of the crown.

Power and gear the finishing machine to maintain smooth finishing operations under all conditions in forward and reverse. Make provisions for raising the screeds to clear the screeded surface for traveling in reverse.

Use a finishing machine capable of final screeding within 10 minutes of depositing the concrete on the deck under normal operating conditions.

Support the finishing machine on rails that are fully adjustable, not shimmed, to obtain the correct profile.

When placing concrete in a lane abutting a previously completed lane, equip the finishing machine to travel on the completed lane without marring or damaging its surface.

For high density concrete overlays, use a mechanical strike-off to provide a uniform thickness of concrete in front of the oscillating screed. Equip the oscillating screed(s) to consolidate the concrete to 98% of the unit weight determined by AASHTO T 121. Install identical vibrators along the screed length on 5 foot maximum centers. Make the bottom face of this screed at least 5 inches wide with a turned up or rounded leading edge to minimize tearing of the surface of the plastic high density concrete.

For latex modified overlays, use a finishing machine equipped with not less than two finishing devices:

- A vibrating screed designed to consolidate the modified composition to 98% of the rodded unit weight, and one of the following,
- A vibrating oscillating screed, or
- A finishing device consisting of one or more rotating cylindrical drums not exceeding 4 feet in length.

Equip the vibrating screed(s) for latex modified concrete with positive control of vibration so that vibration frequency can be varied between 3000 and 6000 vibrations per minute.

Make the bottom face of the screed at least 4 inches wide.

410.04 – CONSTRUCTION METHODS

A) General. Comply the requirements of Section 403 unless otherwise specified.

B) Work Plan. Before starting the work, submit a work plan to the Engineer and obtain approval. Allow 14 days for the Engineer's review. Include descriptions of the material, equipment, and forms to be used, and the labor requirements.

C) Preparation of Surfaces.

a. *General Requirement for Repairs.* Remove all unsound deck concrete as specified. Repair areas will be enlarged, reduced, or reclassified as directed by the Engineer, based upon inspection. Do not revise the size of a repair area without permission.

Provide a saw-cut vertical edge around the perimeter of the repair areas. Make the saw cut at least 1 inch (25mm) deep measured from the original surface of the deck. Avoid cutting, stretching, or damaging any exposed reinforcing steel. Blast clean reinforcing steel to remove all concrete. Replace damaged reinforcing steel, lapping new and old reinforcing as directed.

After removing all unsound concrete, clean and dry the repair area using sandblasting and filtered air blast. Remove all rust, oil, and other foreign matter to provide a clean, dry, etched concrete surface.

b. *Class A Bridge Deck Repair.* For Class A repair, remove unsound concrete by chipping with power hand tools. In Class A repair areas, notify the Engineer before removal below the top mat. Where removal of material beneath the top mat of reinforcing steel is directed, the repair will be classified as Class B repair.

c. *Class B Bridge Deck Repair.* For most Class B repair, remove unsound concrete by the methods used for Class A repair. If removing unsound concrete deeper than 50% of the original deck thickness, use 15 pound (65N) chipping hammers or hand tools to prevent damage to remaining concrete. In Class B repair areas, notify the Engineer before removing concrete below the mid-depth level. Remove concrete at least 1 inch (25mm) below the top mat. If the depth of the bottom mat is reached, remove the full depth of the deck. Full depth removal will be classified as Class C repair.

d. *Class C Bridge Deck Repair.* For Class C repair, remove the concrete for full depth of the deck, leaving the reinforcing steel intact. Provide forms enable placement of new concrete in the full-depth opening. For areas of one square yard or greater, support forms from the existing superstructure. For smaller areas, the forms may be suspended from existing reinforcing bars by wire ties. Remove all forms when completed. Show typical forming details in the work plan submittal.

e. *Overlays.* Clean the entire existing concrete deck area uniformly using sandblasting alone or chipping followed by sandblasting. Sandblast that portion of the curb or parapet wall against which new concrete is to be placed. Remove all rust, oil, and other foreign matter to provide a clean, etched concrete surface free of laitance. If the original deck concrete was cured with linseed oil emulsion, scarify to a depth of $1/4$ inch (6mm) below the original deck before cleaning. Place expansion joints as shown on the contract drawings. The longitudinal and transverse profile and the elevation of all expansion joints will be established by the Engineer.

D) Mixing.

a. *High Density Concrete.* Mix high density concrete at the project site in accordance with Section 932.

b. *Latex Modified Concrete.* Comply with the following requirements for the proportioning

and mixing latex modified concrete materials:

i. *Measurement of Materials.* Accurately proportion all materials for the specified mixture using a mobile continuous mixer. Calibrate the proportioning equipment for each material in the presence of the inspector. Operate the proportioning equipment at the manufacturer recommended speed during calibration, checks, and normal operation. Make yield checks as needed.

ii. *Mixing of Materials.* Mix materials in accordance with the specified requirements for the equipment used. The mixture, as discharged from the mixer, shall be uniform in composition and consistency. Mixing capability shall be such that finishing operations can proceed at a steady pace with final finishing completed before the formation of the plastic surface film.

c. *Class AA Concrete.* Comply with Section 932.

E) Placing and Finishing Concrete for Repairs.

a. *General.* Concrete for repairs may be placed either monolithically with overlays or separately. In addition to the surface screed vibration, vibrate the fresh concrete internally if the concrete thickness is 3 inches (75mm) or more.

If to be overlaid, leave the repair rough textured. If not to be overlaid, match the surface texture of the repair with the existing deck. Unless part of an overlay, place concrete to the level to the existing deck.

b. Surface Preparation Immediately before Concreting

i. G*routing for High Density Concrete.* Before placing high density concrete, scrub a thin coating of bonding grout into the dry, prepared surface. Exercise care to insure that all parts receive a thorough, even coating and excessive grout does not collect in pockets. Limit the application rate of grout to insure the grout does not dry before concrete placement. Since grout will dry on a vertical surface more rapidly than the flat deck surface, give special attention to maintaining the grout in the required condition.

ii. *Surface Wetting for Latex Modified Concrete.* Before placing latex modified concrete, clean the repair areas with air blast followed by flushing with water. Keep the surfaces wet for an hour or more before placing latex modified concrete. Remove puddles of free water before concrete placement.

F) Placing and Finishing Concrete for Overlays.

a. *Dimensions.* Make high density overlays 2 inches (50mm) ± ¼ inch (6mm) thick and latex modified overlays 1 ½ inches (38mm) ± ¼ inch (6mm) thick. Limit the width of each overlay pass to a maximum of 26 feet (8m).

b. Joints.

i. H*igh Density Concrete.* Saw the previously placed high density concrete overlay course to have straight and vertical edges at transverse and longitudinal joints, before placing the adjacent overlay course. Remove all slurry produced by wet sawing of concrete joints from prepared areas before placing new concrete.

ii. *Latex Modified Concrete.* Install transverse bulkheads, equal in depth to the thickness of the latex modified concrete, to the required grade and profile before placing concrete. 3. *Finishing Machine Setup.* Adjust the finishing machine to provide the required overlay profile. Place finishing machine rails outside the area to be concreted. Positively anchor the rails to provide horizontal and vertical stability for the rails. Do not use a hold-down device shot into the concrete unless the concrete is to be subsequently resurfaced. Submit working drawings for

anchoring support rails for approval.

c. Before concrete is placed, make a dry run with the finishing machine to check anticipated overlay thickness. Attach a filler block having a thickness 1/8 inch (3mm) less than overlay thickness to the bottom of the screed. With screed guides in place, pass the screed over the area to be concreted. Correct, in an approved manner, those areas not having the required clearance.

d. *Surface Preparation Immediately before Concreting.* Prepare the surface to be overlaid in the manner specified for repairs using like concrete type.

e. *Placement.* Place concrete in a continuous operation throughout the pour. In case of a long delay in latex modified concrete placement, install a transverse bulkhead. During shorter delays of less than one hour, protect the end of the placement from drying with several layers of wet burlap.

Place and mechanically strike off the new concrete overlay slightly above the final grade. Mechanically consolidate to 98% of the unit weight, determined by AASHTO T 121, and screed to final grade. In addition to the surface screed vibration, vibrate fresh concrete internally if 3 inches (75mm) or more in thickness. Hand finish with a wood float as required to produce a tight, uniform surface.

f. *Work Bridges.* Keep a minimum of two movable work bridges on hand at all times during concrete placement. Use one of the work bridges for nuclear density measurements and surface finishing and texturing. Use the other work bridge to apply the curing.

g. *Evaporation Control and Curing.* Control evaporation of moisture from the fresh overlay concrete and cure. Cracking or other damage caused by improper curing will be cause for rejection of the work.

h. *Ambient Temperature Limitations.* Do not place concrete when the air or deck temperature is cooler than 45°F or the deck temperature is hotter than 85°F.

i. The Engineer may require placing concrete during the nighttime hours during hot weather. The Engineer will inform the Contractor, in writing, if night placing becomes necessary.

G) Straightedge Testing and Surface Tolerance. Immediately after completing the surface of either a repair or overlay and before final finishing, test the surface for trueness with a 10-foot (3m) straightedge. When the straightedge is laid on the repaired pavement or overlay in a direction parallel to the centerline, the surface shall not vary more than 1/8 inch (3mm) from the lower edge of the straightedge. The transverse slope of the pavement shall be uniform to a degree such that no depression greater than 1/8 inch is present when tested with the 10-foot straight edge laid in a direction transverse to the centerline and extending from edge to edge in a traffic lane.

After completing curing, retest the surface and grind any high areas in excess of the specified tolerances. Groove the ground surfaces to have a texture equal to the surrounding surfaces.

H) Transverse Groove Final Finish for Overlays. Do not tine finish overlays within 2 inches (50mm) of a construction joint.

a. *High Density Concrete.* After completing the finishing and before applying the transverse groove final finish, seal all vertical joints with adjacent concrete by painting with thinned grout.

After joint painting, apply the transverse groove final finish.

b. *Latex Modified Concrete.* After completing the finishing, apply the transverse groove final finish. This must be done before the plastic film forms on the surface, approximately 25 minutes in hot, dry weather. Separate screed rails and construction dams from the newly

placed material by passing a point trowel along their inside face. Exercise care to insure that this trowel cut is made for the entire depth and length of rails or dams after the concrete has stiffened sufficiently to not flow back.

i. Limitation of Operations.

1. *Traffic Control.* During the construction period of the project, provide such traffic controls as required by the contract documents.

2. *Loading.* After removing old concrete and before placing new concrete, restrict loading on bridge decks to approved construction equipment. Limit the wheel and axle loads of construction vehicles to 8000 pounds (35kN) and 16,000 pounds respectively. Any combination of axles spaced closer than 4 feet center-to-center of axles will be considered as one axle. Unless otherwise specified, keep traffic off the finished surface during the specified curing period. Do not perform preparation work in the adjacent lane on areas adjoining new concrete during the specified curing period.

410.06 – METHOD OF MEASUREMENT

Class A Bridge Deck Repair, Class B Bridge Deck Repair, And Class C Bridge Deck Repair will be computed in square yards from measurements of the areas so repaired. All classes of bridge deck repair will be measured prior to the actual placement of the concrete. Bridge deck overlay will be measured in square yards from measurements of the areas so overlaid.

410.07 – BASIS OF PAYMENT.

The accepted quantities, measured as specified in this Section, will be paid at the contract price per unit of measurement for the pay items listed below that are shown in the Plan bid schedule. Payment will be full compensation for the respective work prescribed in this Section. Payment will be made under:

CLASS A BRIDGE DECK REPAIR	S.Y.
CLASS B BRIDGE DECK REPAIR	S.Y.
CLASS C BRIDGE DECK REPAIR	S.Y.
BRIDGE DECK OVERLAY	S.Y.

SECTION 411 – REINFORCING STEEL

411.01 – DESCRIPTION

This section shall cover the furnishing and placing of reinforcing steel in accordance with these specifications and in conformity with the plans.

All reinforcement shall consist of deformed bars or wire mesh as specified.

Deformed bars shall be of an approved deformed type such that a mechanical bond will be provided between the concrete and steel at frequent intervals. Square twisted bars shall not be used. The size shall be such that the minimum net sectional area of the bar shall be equal to the section of a plain bar of the nominal size indicated.

411.02 – MATERIALS

Materials shall meet the requirements of Section 941.

Bar List - The bar list and bending schedule are made for the purpose of arriving at an estimate of quantities. The Contractor shall verify the quantity, size and shape of the bar reinforcement against the structure drawings and make the necessary corrections, if any, before ordering. Errors in the bar list and bending schedule shall not be cause for adjustment of contract unit price.

411.04 – CONSTRUCTION METHODS

Reinforcing steel shall be protected at all times from damage. When placed in the work the reinforcing steel shall be substantially free from dirt, detrimental scale, paint, oil or other foreign substance. Thin powdery rust and tight rust that does not reduce the effective cross section is not considered detrimental and need not be removed.

Unless otherwise permitted, all reinforcing bars shall be bent cold. Bars partially embedded in concrete shall not be field bent except as shown on the plans and in a manner approved by the Engineer. Should the Engineer approve the application of the heat for field bending reinforcing bars, precautions shall be taken to assure that the physical properties of the steel will not be materially altered.

All reinforcing steel shall be accurately placed within the tolerances specified herein. During the placing of concrete, reinforcing steel shall be firmly held by approved supports in the position shown on the plans. Reinforcing bars shall be fastened at alternate intersections with wire ties unless this results in ties being more than twelve (12) inches apart in which case each intersection shall be tied. Spot welding of reinforcing steel will not be permitted. Spacing of parallel bars is shown center to center. Bar bends are out to out and distance from face of concrete to reinforcing steel is clear distance. In the plane of the steel parallel to the nearest surface of concrete, individual bar spacing shall not vary from plan placement by more than one-sixth (1/6) of the spacing between bars, and the average over ten (10) spaces shall not vary more than one-twentieth (1/20) of the specified spacing. Perpendicular to the nearest surface of concrete, bars shall not vary from plan placement by more than one-fourth (1/4) inch in slabs and walls up to and including eight (8) inches in total thickness, the bars shall not vary more than one-half (1/2) inch from plan placement. The placement of deck reinforcement in bridge floors shall not deviate more than one-fourth (1/4) inch from plan placement in the vertical direction.

Approved metal bar supports of adequate strength, of proper depth and in sufficient number shall be used for supporting the bars in slabs, beams, and girders. Both low and high approved metal chairs shall be used in I-Beam, truss and girder floors.

The placing, wiring and supporting reinforcement in each section of the work shall be approved by the Engineer before any concrete is deposited in the section.

All reinforcement shall be furnished in the full lengths indicated on the plans. Splicing of bars, except where shown on the plans, will not be permitted without written approval of the Engineer. Splices shall be staggered as far as possible.

Unless otherwise shown on the plans, bar splices in the bottom of beams and girders, and in walls, columns and haunches shall be lapped as given in the table below for 'other bars'. Bar splices near the top of beams and girders having more than twelve (12) inches of concrete under the bars shall be lapped as given in the following table for 'top bars':

TABLE 411.02.01 – Required Length of Lap in Inches

Size (No.)	4	5	6	7	8	9	10	11
Top Bar	15	19	24	32	45	54	68	83
Other Bars	12	13	17	23	40	48	59	60

The required length for lap splices given in the table is based on Grade 40 Reinforcing Steel. If Grade 60 Reinforcing Steel is specified the required length for lap splices shall be increased by fifty (50) percent. No more than one-half (1/2) of the bars should be lap spliced within a required lap length.

Bars larger than No. 11 bars shall not be lap spliced but shall be weld spliced in accordance with current AWS Specifications or spliced with other positive mechanical methods. The splice methods or devices shall be approved by the Engineer prior to use.

The minimum spacing center to center of parallel bars shall be two and one-half (2 1/2) times the diameter, but in no case shall the clear distance between the bars be less than one and one-half (1 1/2) times the maximum size of the coarse aggregate.

The minimum covering measured from the surface of the concrete to the face of any reinforcing bar shall be not less than two (2) inches or as otherwise shown on the plans. In the footings of abutments and retaining walls and in piers the minimum covering shall be three (3) inches.

411.06 – METHOD OF MEASUREMENT

Reinforcing steel and wire mesh will be measured by the pound based on the theoretical number of pounds complete in place as shown on the plans or placed as ordered.

The quantities of materials furnished and placed shall be based upon the calculated weights of the reinforcing steel actually placed in accordance with these specifications. The weights calculated shall be based upon the following table:

TABLE 411.04.01 – Reinforcing Steel Weights

Bar Designation Number	Nominal lb/ft	Weight kg/m
¼	0.167	0.249
3	0.376	0.560
4	0.688	0.994
5	1.043	1.552
6	1.502	2.235
7	2.044	3.042
8	2.670	3.973
9	3.400	4.960
10	4.303	6.403
11	5.313	7.906
14S	7.650	11.384
18S	13.600	20.239

No allowance will be made for clips, metal spacers, ties, etc., wire or other material used for fastening or holding reinforcement or forms in place, except that wire hoops used in reinforced concrete columns and encased I-beams or similar construction, when included in the bar list shown on the plans, will be classed as reinforcing steel and will be paid for at the contract unit price per pound for reinforcing steel.

411.07 – BASIS OF PAYMENT

The accepted quantities of reinforcing steel and wire mesh (unless wire mesh is included in other items) will be paid for at the contract unit price per pound for:

REINFORCING STEEL LBS.

which shall be full compensation for furnishing all material, equipment, labor and incidentals required to complete the work as specified.

SECTION 412 – PENETRATING SEALER FOR CONCRETE SURFACES

412.01 – DESCRIPTION

This section covers the furnishing and placing of a penetrating sealer system in reasonably close conformity with the requirements specified herein and as shown on the plans.

412.02 – MATERIALS

The material shall be a penetrating sealer for Portland Cement Concrete. The penetrating sealer shall be as called for in the plans. If the type is not called for, the sealer shall be equal to or better than Chemical Products Corporation's CP-5003.

412.04 – CONSTRUCTION METHODS

A) Weather Limitation - The materials shall not be applied when the air or surface temperature is less than forty (40) degrees F or while the surface is wet.

B) Surface Preparation - The surface shall be swept and/or washed to remove laitance, dirt, asphalt, and other foreign materials, exposing a surface of sound concrete. Equipment shall be fitted with suitable traps, filters, drip pans, or other devices to prevent oil or other deleterious matter from being deposited.

C) Application of Penetrating Sealer - The penetrating sealer shall consist of application to be applied at the rate recommended by the manufacturer.

412.06 – METHOD OF MEASUREMENTS

The penetrating sealer system will be measured by the square yard in place.

412.07 – BASIS OF PAYMENT

The accepted quantities of penetrating sealer system will be paid for at the contract unit price per square yard for:

PENETRATING SEALER S.Y.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.

SECTION 450 – STORM SEWER CONSTRUCTION

SECTION 450 – CONSTRUCTION REQUIREMENTS FOR STORM SEWERS

450.01 – DESCRIPTION

This section covers general construction requirements of storm sewers and sewer appurtenances as described herein.

450.01.01 – PREQUALIFICATION

As a minimum, all Contractors and Bidders shall meet the prequalification requirements of the City's Prequalification Board, and be prequalified to perform work in the "Storm Sewer Construction" Category. Prequalification for additional categories of work, when required may be specified in the Special Provisions.

450.01.02 – TEMPORARY SEWER AND DRAIN CONNECTIONS

When existing sewers have to be taken up or removed, the Contractor at his own expense, shall provide and maintain temporary outlets and connections for all private or public drains, sewers or sewer inlets. the Contractor shall also take care of all sewage and drainage which will be received from these drains, sewers and sewer inlets; and for this purpose the Contractor shall provide and maintain at his own expense, adequate pumping facilities and temporary outlets or diversions. The Contractor shall construct such trough, pipe or other structures necessary and be prepared at all times to dispose of drainage and sewage received from these temporary connections until such time as the permanent connections are built and in service. The existing sewers and connections shall be kept in service and maintained under the contract, save where specified or ordered to be abandoned by the Engineer. All water or sewage shall be disposed of in a satisfactory manner so that no nuisance is created and that the work under construction will be adequately protected.

450.01.03 – CLEANUP

After installation of each section of drainage facility, the Contractor shall remove all spills resulting from work, debris, construction materials and equipment from the site of work, grade, smooth over surfaces and leave the right-of-way in a clean, neat, and serviceable condition prior to sodding.

450.02 – MATERIALS

450.02.01 – SUBMITTALS

Drawings, specifications, schedules, and other data showing complete details of the fabrication and construction of pipe and fittings, together with complete data covering all materials proposed for use, shall be submitted. The drawings and data shall include, but shall not be limited, to the following for each size of pipe.

A) Data on reinforcement
B) Details of joints
C) Details of fittings and specials
D) Test reports
E) Laying schedule
F) Type "A" Certification for pipe and protective lining
G) Type "D" Certification and sample of Elastomeric O-ring gasket
H) Documentation of an ongoing manufacturer's quality control program

All material furnished under certification shall be tagged, stenciled, stamped or otherwise marked with a lot number, heat number, order number, or other appropriate identification which can be readily recognized and checked against the certification. The Contractor shall submit six (6) copies of all submittals requested in this specification.

450.02.02 – GENERAL

Unless otherwise specified, all materials used in the manufacture of pipe, fittings, and accessories shall conform to ASTM C-76 or as modified herein.

A) Fine Aggregate - Fine aggregate shall conform to the requirements of ASTM C-33, and shall be clean natural sand. Artificial or manufactured sand will not be acceptable.

B) Cement - Cement shall conform to the requirements of ASTM C-145, containing not more than five (5) percent tricalcium aluminate.

C) Gaskets - Gaskets shall conform to requirements of ASTM C-361, Section 6.9.1, except minimum tensile strength shall be fifteen hundred (1,500) pounds per square inch, Shore A, hardness shall be forty (40). Polymer used in the manufacture of gaskets shall be synthetic rubber. Natural rubber will not be acceptable.

D) Rubber Joint Filler - Rubber joint filler shall be synthetic.

E) Hardness - Hardness shall be forty (40) plus or minus (±) five (5) when measured in accordance with ASTM D-2240, Type A durometer.

Tensile Strength - Tensile strength shall be twelve hundred (1,200) pounds per square inch minimum.

450.06 – METHOD OF MEASUREMENT

Storm sewer will be measured by the linear foot in accordance with the dimensions shown on the plans or directed by the Engineer. Storm sewer, complete with all necessary appurtenances as described in this section, shall be measured by the unit complete and in place.

450.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(TYPE) STORM SEWER (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 451 – CORRUGATED METAL PIPE, OTHER PIPE

451.01 – DESCRIPTION

This section covers the requirements, method of measurement and payment of corrugated metal pipe or other pipe as designated by the Engineer.

451.02 – MATERIALS

All corrugated materials shall be aluminized as designated by the Engineer. All other pipe materials shall be designated by the Engineer and plans.

SECTION 452 – PRE-CAST BOX CULVERTS

452.01 – DESCRIPTION

This section covers the requirements, method of measurement and payment of pre-cast reinforced concrete box sections.

452.02 – MATERIALS

All materials shall conform to Section 450.02

452.04 – CONSTRUCTION METHODS

Requirements - Must be in accordance with ASTM C-789-79 or AASHTO M-259 and ASTM C-850-79 or AASHTO M-273.

452.06 – METHOD OF MEASUREMENT

Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

452.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

PRE-CAST BOX CULVERT L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 453 – REINFORCED CONCRETE PIPE (RCP)

453.01 – DESCRIPTION

This section covers bar-cage reinforced concrete pipe and fittings with O-ring rubber gasketed joints intended to be used for conveyance of storm water run-off. Pipes shall be supplied in nominal diameters eighteen inches (18”) and larger.

453.02 – MATERIALS

453.02.01 – GENERAL

All materials shall conform to Section 647.

453.04 – CONSTUCTION METHODS

The City retains the right to inspect the pipe, specials and fittings, all work performed and materials furnished at the manufacturer's plant and at the project site and to independently monitor the fabrication of the pipe, specials and fittings. Such inspection shall not relieve the Contractor or the manufacturer of their responsibility to furnish material and perform the work in accordance with these specifications.

453.06 – METHOD OF MEASUREMENT

Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

453.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REINFORCED CONCRETE PIPE (SIZE)	L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 454 – MANHOLES

454.01 – DESCRIPTION

This section covers construction of manholes. Manholes used in Storm Sewer construction shall be Pre-cast Reinforced Concrete.

454.02 – MATERIALS

All materials shall conform to Section 626.02.

454.04 – CONSTUCTION METHODS

The City retains the right to inspect the pipe, specials and fittings, all work performed and materials furnished at the manufacturer's plant and at the project site and to independently monitor the fabrication of the pipe, specials and fittings. Such inspection shall not relieve the Contractor or the manufacturer of their responsibility to furnish material and perform the work in accordance with these specifications.

454.05 – TESTING

After manhole construction has been completed, the manhole shall be visually inspected by the Engineer for acceptability. Visual inspection shall be done to check for leaks, thin spots, honey combs, voids, pinholes and conformance with these specifications.

454.06 – METHOD OF MEASUREMENT

Payment for Manhole shall be made at the unit price bid per each. Sanitary Sewer Manholes over 6 feet deep will be paid for in vertical feet measured from finished grade to 6 feet from the invert. The price established shall be full compensation for excavation, backfill, crushed rock foundation, inverts and benches, walls and cones, manhole inserts when specified, ring and cover, protective coating, outside waterproofing when specified, removal of existing manhole when necessary or specified or called for on the plans, brick masonry or pre-cast grade ring and all labor, materials, tools, equipment and incidentals necessary to complete this item of work.

454.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(TYPE) MANHOLE (SIZE)	EA.
MANHOLE ADDED DEPTH	V.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 455 – MANHOLE DROP CONNECTION

455.01 – DESCRIPTION

This section covers construction of drop connections for sewer pipes entering a manhole at twenty-four

(24) inches or more above the manhole invert.

455.02 – MATERIALS

Acceptable pipe materials and fittings shall meet the requirements of these specifications.

455.04 – CONSTRUCTION METHODS

Each drop manhole connection shall consist of providing one (1) sewer tee branch, one (1) ninety (90) degree curve or two (2) forty-five (45) degree curves (as required), necessary pipe or portions of pipe to complete the upper and drop connections and necessary concrete for encasement. Additionally, work shall be accomplished in accordance with "Standard Detail for Manhole Drop Connection".

455.06 – METHOD OF MEASUREMENT

Measurement for manhole drop connection shall be from the invert of the entering pipe to the invert of the manhole. Measurement shall be in vertical feet.

455.07 – BASIS OF PAYMENT

Payment for "Manhole Drop Connection" shall be made at the unit price bid per vertical foot for each size.

MANHOLE DROP CONNECTION (SIZE)	V.F.

The price established shall be full compensation for all material including pipe and fittings, concrete, labor, tools, equipment, and incidentals necessary to complete this item of work. Where drop manhole connections are connected to existing manholes, necessary removal and replacement of brick (or concrete) shall be included.

SECTION 456 – ABANDONING/REMOVING MANHOLE

456.01 – DESCRIPTION

This section covers abandoning or removing existing manholes when called for on the plans or specified. This work shall be accomplished following abandoning and plugging existing sewer lines.

456.04 – CONSTRUCTION METHODS

A) Abandoning Manhole - This work shall be accomplished in accordance with the Standard Detail for Abandoning Manholes. The manhole shall be broken down to a point two (2) feet below proposed or existing grade.

B) Removing Manhole - This work shall be accomplished in accordance with the "Standard Detail for Abandoning Manhole" except the manhole shall be broken down to a point two (2) feet below any proposed construction or totally removed when directed by the Engineer.

C) Construction - Manhole shall be filled with sand backfill and shall be compacted to remove all voids in material.

456.06 – METHOD OF MEASUREMENT

Measurement for "Abandoning Manhole" shall be made at the unit bid price per each. Measurement for "Removing Manhole" shall be made at the unit price bid per each when specified as an item of work

456.07 – BASIS OF PAYMENT

Payment for "Manhole Drop Connection" shall be made at the unit price bid per vertical foot for each size.

ABANDONDING MANHOLE (SIZE)	EA.
REMOVING MANHOLE	EA.

Payment for "Abandoning Manhole" shall be made at the unit bid price per each. The price established shall be full compensation for all materials including sand backfill, labor, tools, equipment and incidentals necessary to complete this item of work. The price established for "Removing Manhole" shall be full compensation for all materials including sand backfill, labor, tools, equipment and incidentals necessary to complete this item of work. In the absence of the bid item, the price shall be included in the cost of Manhole construction.

SECTION 457 – RAISING MANHOLE

457.01 – DESCRIPTION

This section covers raising a manhole.

457.04 – CONSTRUCTION METHODS

A) General - All work shall comply with the requirements of these specifications.

B) Type I: Raising Manhole less than or equal to one (1) foot - When called for on the plans or directed by the Engineer, the manhole shall be raised by using pre-cast concrete grade rings or courses of brick masonry. In no case however, shall the chimney be greater than one (1) foot in height.

C) Type II: Raising Manhole greater than one (1) foot - When called for on the plans or directed by the Engineer, the manhole shall be raised by initially removing the existing corbel or cone. Pre-cast manhole shall then be rebuilt in conformity with the size and shape of requirements for new manholes. Brick or cast-in-place manholes shall then be rebuilt in conformity with the "Standard Detail for Rebuilding Manholes".

D) Resetting Existing Ring and Cover - Once the appropriate raising has been accomplished the existing ring and cover shall be reset to the new grade.

457.06 – METHOD OF MEASUREMENT

Measurement for payment shall be made from the finish grade to the limit of plan removal unless otherwise directed by the Engineer.

457.07 – BASIS OF PAYMENT

Payment for "Raising Manhole (Type I)" shall be made at the unit price bid per each.

Payment for "Raising Manhole (Type II)" shall be made at the unit price bid per vertical foot.

RAISING MANHOLE (TYPE I)	EA.
RAISING MANHOLE (TYPE II)	V.F.

The price established shall be full compensation for all materials including excavation, backfill, resetting of existing ring and cover, resurfacing, tools, labor, equipment and incidentals necessary to complete this item of work.

SECTION 458 – LOWERING MANHOLE

458.01 – DESCRIPTION

This section covers lowering manhole to a specified elevation.

458.04 – CONSTRUCTION METHODS

A) General - All work shall comply with the requirements of these specifications.

B) Type I - Manhole shall be lowered by removing pre-cast grade rings or courses of brick masonry, such that the frame maintains a minimum of two (2) inches of seat support.

C) Type II - When the minimum seat support is not available, the corbel, cone, or wall shall be

removed to an elevation which will accommodate installation of a pre-cast cone, grade rings, or brick masonry and the ring and cover. The manhole shall be rebuilt in conformance with the "Standard Detail for Rebuilding Manholes".

D) Resetting Existing Ring and Cover - Once the appropriate lowering has been accomplished the existing ring and cover shall be reset to the new grade.

458.06 - MEASUREMENT

Measurement for payment shall be made from the finish grade to the limit of plan removal unless otherwise directed by the Engineer.

458.07 – BASIS OF PAYMENT

Payment for "Lowering Manhole (Type I)" shall be made at the unit price bid per each. Payment for "Lowering Manhole (Type II)" shall be made at the unit price bid per vertical foot, (VF).

LOWERING MANHOLE (TYPE I)	EA.
LOWERING MANHOLE (TYPE II)	V.F.

The price established shall be full compensation for all materials including removing existing portions of the manhole, excavation, backfill, resetting existing ring and cover, resurfacing, tools, labor, equipment and incidentals necessary to complete this item of work.

SECTION 459 – RESETTING EXISTING MANHOLE RING AND COVER

459.01 – DESCRIPTION

This section covers the resetting of existing manhole ring and cover. When called for on the plans or specified, or directed by the Engineer, the existing ring and cover shall be reset to the existing grade (elevation) by using pre-cast concrete grade rings or brick masonry.

459.04 – CONSTRUCTION METHODS

All adjustments shall be made in accordance with Section 626.

459.06 – METHOD OF MEASUREMENT

Measurement for "Resetting Existing Manhole Ring and Cover" shall be made at the unit price bid per each.

459.07 – BASIS OF PAYMENT

Payment for "Resetting Existing Manhole Ring and Cover" shall be made at the unit price bid per each.

RESETTING EXISTING MANHOLE RING AND COVER	EA.

The price established shall be full compensation for all materials, excavation and backfill, resurfacing, tools, labor, equipment, and incidentals necessary to complete this item of work.

SECTION 460 – SETTING NEW MANHOLE RING AND COVER

460.01 – DESCRIPTION

This section covers setting of new manhole ring and cover. When cast iron fittings are unsound or misshapen or when directed by the Engineer a new ring and cover shall be set to the existing elevation (grade) by use of pre-cast concrete grade rings or brick masonry.

460.04 – CONSTRUCTION METHODS

All adjustments shall be made in accordance with Section 626.

460.06 – METHOD OF MEASUREMENT

Measurement for "Setting New Manhole Ring and Cover" shall be made at the unit price bid per each

460.07 – BASIS OF PAYMENT

Payment for "Setting New Manhole Ring and Cover" shall be made at the unit price bid per each.

SETTING NEW MANHOLE RING AND COVER EA.

The price established shall be full compensation for all materials including ring and cover, excavation and backfill, resurfacing, tools, labor, equipment, and incidentals necessary to complete this item of work.

SECTION 461 – RAISING MANHOLE LID

461.01 – DESCRIPTION

This section covers raising manhole lids. Where manhole lids are to be adjusted to a higher street or surface elevation, pavement work or other surface disturbance may be avoided by inserting an expandable manhole riser ring.

461.02 – MATERIAL

Manhole riser ring skirting and linkage shall be of stainless or galvanized steel and designed for use in storm sewer applications. Skirting shall be formed to produce a radial tension against the sides of the manhole frame when expanded and linkage shall be designed to produce no built in moments in ring. Ring shall contract and expand without twisting, bending, or binding. Riser ring shall be removable and reusable with no protruding parts that hinder entry into manhole or limit use of equipment. Expandable manhole riser ring shall be as manufactured by American Highway Prod's of Bolivar, Ohio, or an approved equal.

461.04 – CONSTRUCTION METHODS

Existing manhole frame must be in good condition and have a minimum one and one quarter (1 1/4) inch deck to accommodate riser ring. Loose rust and debris shall be removed with a wire brush from existing frame prior to installation. Manhole riser shall be installed as directed by the manufacturer while verifying proper height and adjustment has been obtained.

In locations where an asphalt surface is not to be placed around the ring, a bead of bituminous or epoxy sealant shall be placed around the exterior circumference where the ring meets the frame before completing surface restoration.

461.06 – METHOD OF MEASUREMENT

Measurement for "Raising Manhole Lid" shall be made at the unit price bid per each ring.

461.07 – BASIS OF PAYMENT

Payment for "Raising Manhole Lid" shall be made at the unit price bid per each ring.

RAISING MANHOLE LID EA.

Payment is regardless of riser height and shall be full compensation for all materials, resurfacing and/or surface restoration, tools, labor, and incidentals necessary to complete this item of work.

SECTION 490 – STRUCTURES AND STORM SEWER CONSTRUCTION STANDARD BID ITEMS

490.01 – DESCRIPTION

This section covers Standard Bid Items used in the contract documents for the construction of structures and storm sewers. Additional bid items may be called out in the Special Provisions, other sections of the Standard Specifications, or as directed by the Engineer for additional work covered and change orders.

SECTION	CODE	DESCRIPTION	UNIT
401	401-00	STRUCTURAL EXCAVATION	C.Y.
402	402-01	DRILLED SHAFT (DIAMETER)	L.F.
402	402-02	BELL FOOTING	C.Y.
402	402-03	TEST HOLE	EA.
402	402-04	TEST BELL	EA.
404	404-00	STRUCTURAL CONCRETE	C.Y.
405	405-00	PRE-STRESSED CONCRETE BEAM (TYPE)	L.F.
406	406-00	HIGH EARLY STRENGTH CONCRETE	C.Y.
407	407-00	PNEUMATICALLY PLACED CONCRETE	S.F.
408	408-00	STRUCTURAL STEEL	LBS.
410	410-00	CLASS A BRIDGE DECK REPAIR	S.Y.
410	410-00	CLASS B BRIDGE DECK REPAIR	S.Y.
410	410-00	CLASS C BRIDGE DECK REPAIR	S.Y.
410	410-00	BRIDGE DECK OVERLAY	S.Y.
411	411-00	REINFORCING STEEL	LBS.
412	412-00	PENETRATING SEALER	S.Y.
450	450-00	(TYPE) STORM SEWER (SIZE)	L.F.
452	452-00	PRE-CAST BOX CULVERT	L.F.
453	453-00	REINFORCED CONCRETE PIPE (SIZE)	L.F.
454	454-01	(TYPE) MANHOLE (SIZE)	EA.
454	454-02	MANHOLE ADDED DEPTH	V.F.
455	455-00	MANHOLE DROP CONNECTION (SIZE)	V.F.
456	456-00	ABANDONING MANHOLE (SIZE)	EA.
456	456-00	REMOVING MANHOLE	EA.
457	457-00	RAISING MANHOLE (TYPE I)	EA.
457	457-00	RAISING MANHOLE (TYPE II)	V.F.
458	458-00	LOWERING MANHOLE (TYPE I)	EA.
458	458-00	LOWERING MANHOLE (TYPE II)	V.F.
459	459-00	RESETTING EXISTING MANHOLE RING AND COVER	EA.
460	460-00	SETTING NEW MANHOLE RING AND COVER	EA.
461	461-00	RAISING MANHOLE LID	EA.

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SECTION 500

SECTION 500 - WATER

SECTION 500 – CONSTRUCTION REQUIREMENTS

500.01 – DESCRIPTION

This section covers general construction requirements of water lines and appurtenances as described herein.

500.02 – PREQUALIFICATION

For this Water Project, the bidder shall be pre-qualified as Class “A” or “B” to perform all Water Construction Work as required by the ORDINANCE NO.20, 815, passed by the Council of the City of Oklahoma City on May 27, 1997. The Contractor must obtain all permits required by the City of Oklahoma City, State and federal regulations and laws.

500.03 – CONSTRUCTION OUTSIDE CITY LIMITS

The Contractor performing work outside the corporate limits of Oklahoma City shall comply with all ordinances, regulations, and policies of the county and city wherein the work is located. He shall obtain any permits, provide barricades and lights, and make repairs as required by the responsible authorities.

500.04 – TEST HOLES

Test hole information, when shown on the plans or included in the specifications, shall only represent subsurface characteristics to the extent indicated, and only for the point location of the test hole.

Each bidder shall make his own interpretation of the character and condition of the materials that will be encountered between test hole locations. Each prospective Bidder may, at his own expense, make additional surveys and investigations as he may deem necessary to determine conditions which will affect performance of the work.

500.05 – ORDER OF CONSTRUCTION

The Contractor shall start at enough different locations to complete the entire contract within the time limit specified. Water Line appurtenances shall be constructed as soon as the Water Line that they serve is constructed to their locations. Postponing the construction of appurtenances until the Water Line has been completed, or the building of appurtenances in advance of the construction of the Water Line, will not be permitted.

A) The construction of Water Lines for more than six hundred feet (600') in advance of appurtenances which are incomplete or the construction of which has not been started, will not be permitted.

B) Unless otherwise directed by the Engineer, the Contractor shall leave no more than six hundred feet (600') between backfilling operations and the complete restoration of paving, paving cut and permanent repairs, driveway permanent repairs, fencing, sodding, etc.

C) When Temporary Surfacing is provided for in the contract documents, the Contractor shall complete temporary paving repair immediately before backfill is completed.

D) Temporary Surfacing shall be done in accordance to Section 824.02. Materials shall be asphalt in accordance to Section 824.02 Part A.

E) All water lines that are to be abandoned in place shall be cut to the nearest connections and either capped or plugged as required to provide a tight connection. The Contractor shall be responsible for providing the appropriate plug or cap for the job. When an existing valve is abandoned in a grassy area the box is to be pulled and the top nut removed from the valve. The cost of this work is considered incidental.

500.06 – DELIVERY OF MATERIALS

Construction materials shall not be delivered to the site of the work more than three (3) days in advance of their anticipated use nor shall the quantity of pipe or other materials on hand at the site of the work at any time be in excess of the amount required to complete six hundred (600') feet of Water Line unless with special permission of the Engineer.

500.07 – SURFACE DRAINAGE STRUCTURES

When not called for on the plans or specified as a separate bid item, all surface drainage structures and appurtenances shall be removed and replaced in a condition equal to or better than the original installation when required. No additional compensation shall be made for this work and the cost of same shall be included in the other pay items.

500.08 – CONCRETE AND STEEL REINFORCEMENT

Unless otherwise specified, all concrete used in construction of waterlines and their appurtenances shall be High Early Strength Concrete and have a minimum three (3) day compressive strength of three thousand five hundred (3,500 psi) pounds per square inch and shall conform with the applicable requirements of Section 932. All steel reinforcement used shall be grade sixty (60) with a minimum yield strength of sixty thousand (60,000 psi) pounds per square inch and meet the applicable material requirements of Section 900. All steel reinforcement shall be coated with epoxy coatings and conform to ASTM A 775 standards.

500.09 – DEPTH OF COVER

Where not otherwise indicated on plans, the pipe shall be laid at an elevation that will provide after completion, a minimum depth of cover over the top of pipe shall be 4 feet (4') below the surface.

500.10 – STANDARD DESIGN CONDITIONS

A) **Standard Design Pressures** - Unless otherwise specified, all pipes and fittings shall be designed for the following minimum pressure conditions:

Pipe Nominal Size (inches)	Minimum Internal Pressure (psi)		
	Working	Surge	Design
< 48	150	100	250
? 48	200	200	400

B) **Live Loading** - Unless otherwise specified or called for on the plans, minimum pipe design corresponding to the specified design pressure shall be for highway live loading condition and where waterline is crossing or running parallel to the railroad, corresponding minimum pipe design for railroad live loading condition shall govern (with or without casing).

C) **Section Line Pipes** – Unless otherwise specified all section line mains and pipes shall be greater than twelve (> 12") inches in diameter and ductile iron pipe. The ductile iron pipe shall be installed as per Section 524.

D) **All Pipes** – Pipe materials with allowable sizes shall be in accordance with the following table.

Pipe Material	Size
Pre-stressed Concrete Embedded Cylinder Pipe (PCECP)	? 48”
Polyvinyl Chloride (PVC) Pipe	? 12”
Steel Pipe	? 48”
Ductile Iron Pipe (DIP)	? 64”

500.11 – CLEAN-UP

A) Water main installation procedures require clean-up operations to follow excavation and construction a distance not to exceed three hundred feet.

B) Sodding, seeding, sprigging, and fertilizing operations will be accomplished following completion of water main installation. Sod will be preserved and replace in areas where heavy sod existed prior to construction.

C) Compaction of trench backfill to 90% standard proctor density will be required. Test will be performed to assure density. The cost of this work shall be included in the cost per linear foot. High traffic areas shall be compacted to 95% standard proctor density.

SECTION 505 – PIPE AND FITTINGS INSTALLATION

505.01 – DESCRIPTION

This section covers installation of pipes in open-cuts, in conformity with the lines, grades, and dimensions and as provided in applicable sections of these specifications.

505.02 – MATERIALS

505.02.01 – PIPE AND FITTINGS

Acceptable pipe materials and fittings shall meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Rigid	Pre-stressed Concrete Embedded Cylinder Pipe (PCECP)	526
Flexible	Polyvinyl Chloride (PVC) Pipe	525
	Steel Pipe	527
	Ductile Iron Pipe (DIP)	524

505.02.02 – EMBEDMENT

A) **General** - Embedment material shall meet the requirements of Section 215. Prior to delivery, the Contractor shall submit laboratory tests for materials to be used for embedment, and backfill. Materials shall be approved by the Engineer prior to placement.

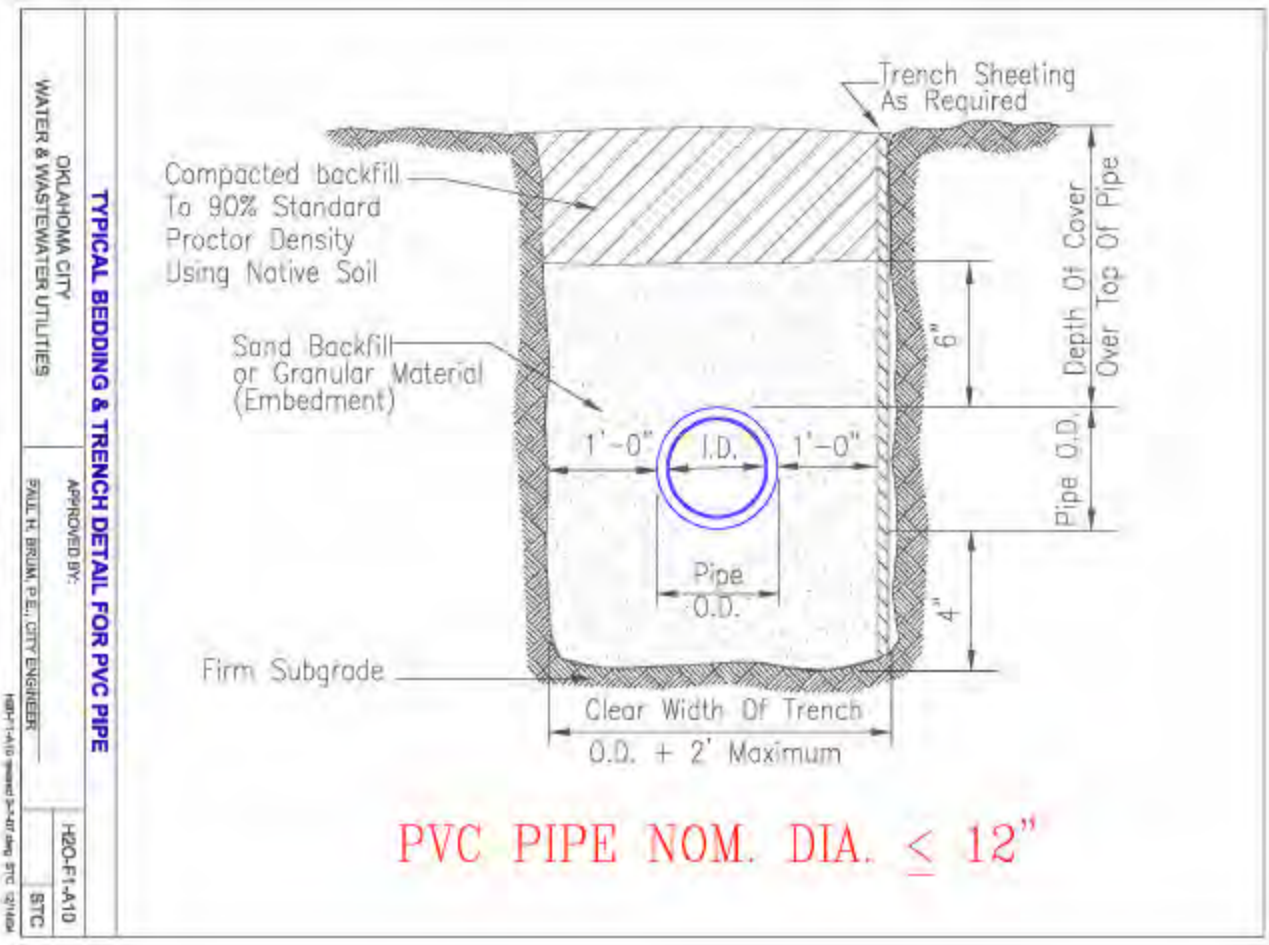
B) **Invoices** - The Contractor shall submit invoices for the purpose of complying with the minimum quantities necessary to complete installation pursuant to the appropriate standard details and the minimum dimensions specified.

505.04 – CONSTRUCTION METHODS

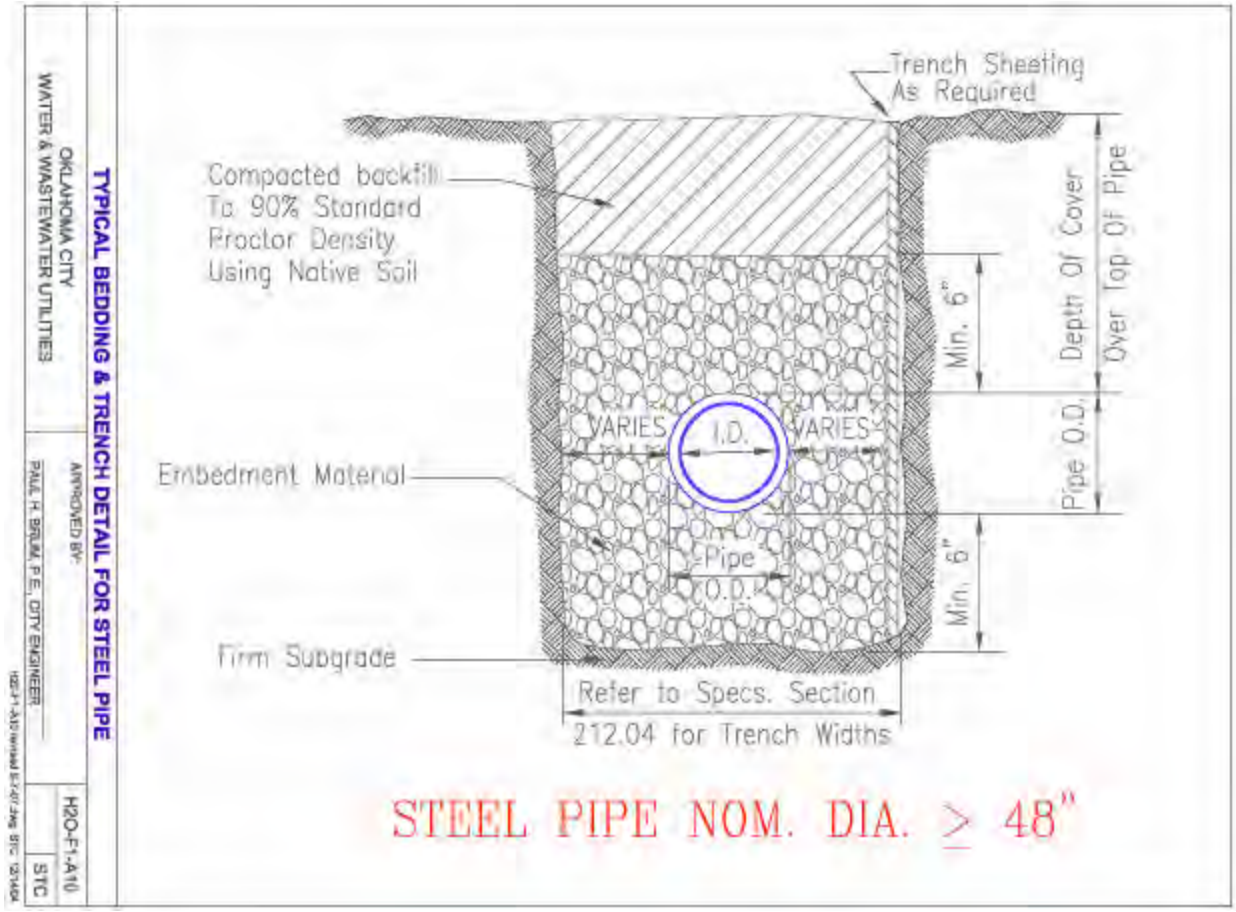
505.04.01 – BEDDING AND HAUNCHING

A) **Rigid Pipe** - All rigid pipes greater than or equal to forty-eight inches (?48") shall be embedded in accordance with AWWA Manual M9, "Concrete Pressure Pipe", Type "4" Bedding and in accordance with the dimensions and lines shown on the Drawings and meeting the requirements of Section 526.

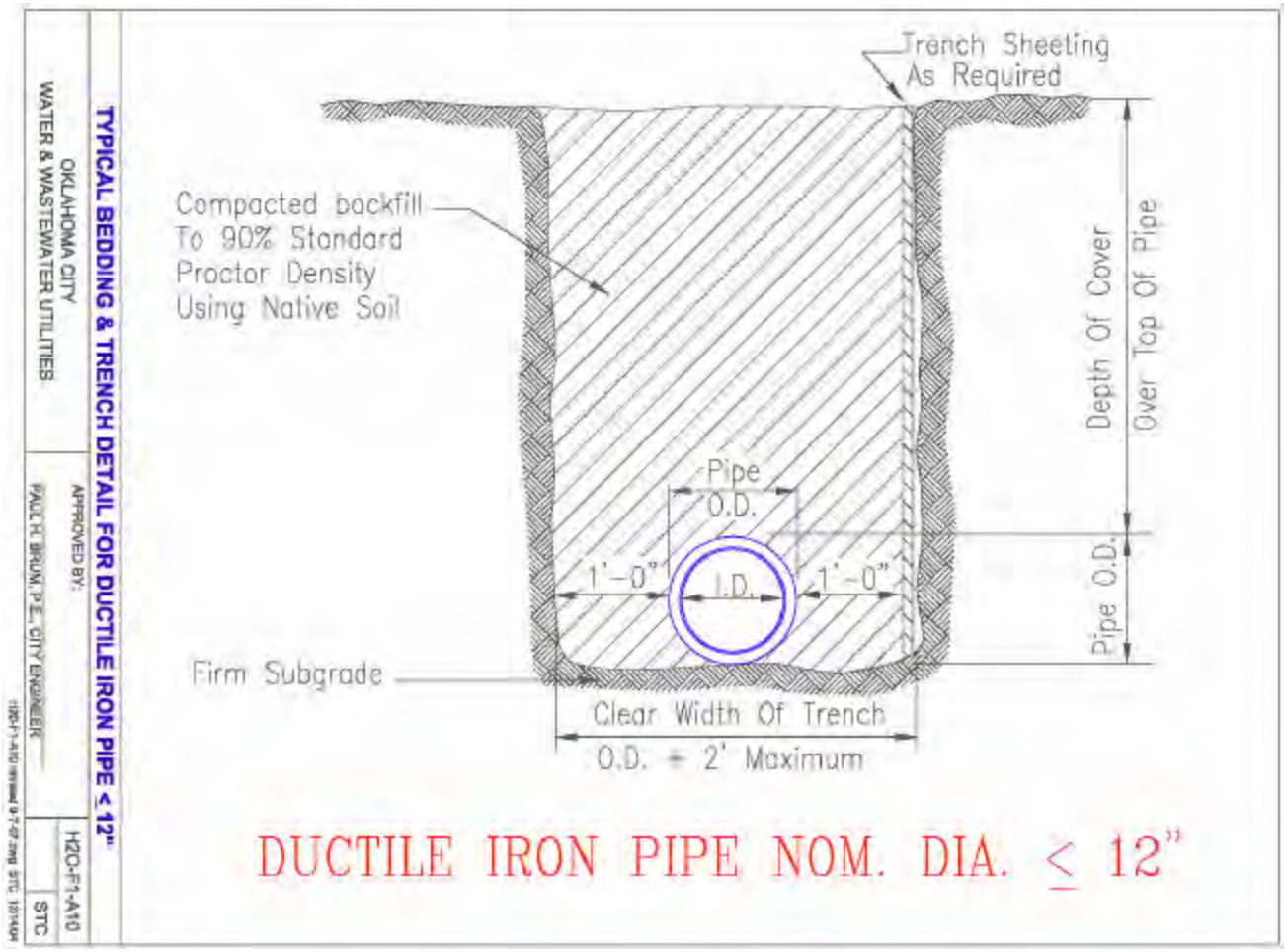
B) **Polyvinyl Chloride (PVC) Pipe**– All PVC pipe less than or equal to 12 inches (? 12")shall be embedded in accordance with ASTM D-2774, "Standard Recommended Practice for Underground installation of Thermoplastic Pressure Piping", and ASTM D-2321, "Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe", and as shown on the Standard Detail "Typical Bedding and Trench Detail for PVC Pipe" and meeting the requirements of Section 525 .



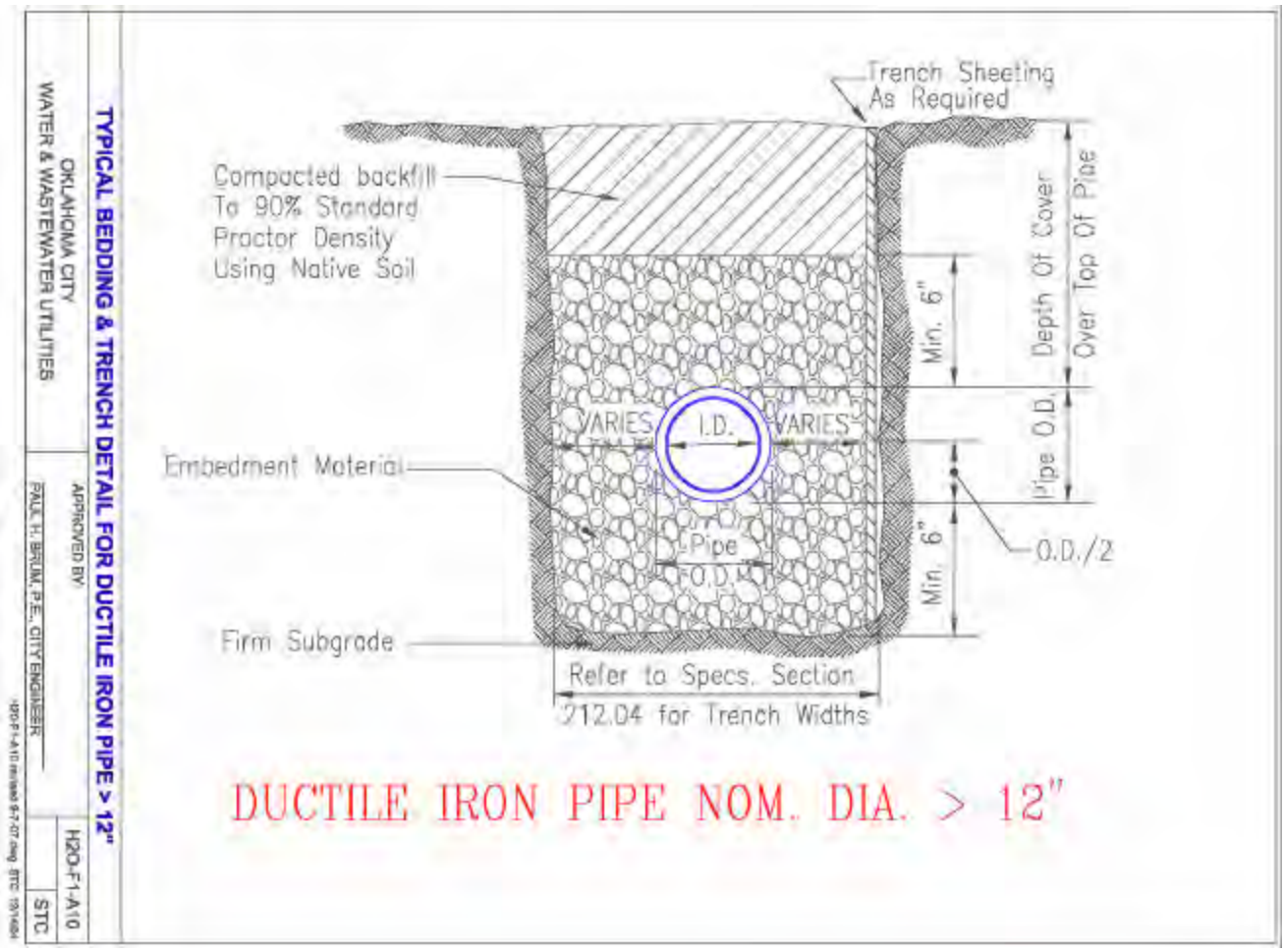
C) **Steel Pipe** – All steel pipes shall be embedded as shown on the Standard Detail ”Typical Bedding and Trench Detail for Steel Pipe” and meeting the requirements of Section 527.



D) **Ductile Iron Pipe (DIP)** – All ductile iron pipe less than or equal to twelve inches (12”) in diameter shall be embedded in accordance with the requirements of Section 524 and as shown on the Standard Detail “Typical Bedding and Trench Detail for Ductile Iron Pipe ? 12””.



All ductile iron pipes greater than twelve (12”) inches in diameter shall be embedded in accordance with AWWA C-150, Type 4 or Type 5 Laying Condition as modified in the Standard Detail “Typical Bedding and Trench Detail for Ductile Iron Pipe > 12”” and meeting the requirements of Section 524.



505.04.02 – INSTALLATION REQUIREMENTS

A) **Shipping, Handling and Storage -** Pipe shall be transported from the plant, where it is manufactured, to the job site employing special methods of packaging to prevent damage to the pipe. After the pipe is received at the job site, it shall be carefully inspected for any damage that may have occurred in transit. The pipe shall be handled at all times with care using padded slings or hooks. The pipe shall not be dropped, skidded or rolled against pipe already on the ground. If any damage occurs to pipe, the pipe shall be rejected. All pipe and accessories shall be stored on flat, level ground with no rocks or other objects under the pipe. Gaskets for push-on joints and pipe shall be stored in cool location out of direct sunlight in accordance with the manufacturer's recommendations.

B) **Pipe Foundation -** No waterline shall be laid unless the foundation is in a condition satisfactory to the Engineer. Where trenches are excavated in soft, unsuitable, or rock, trench bottom shall be stabilized in accordance with Section 215 when directed by the Engineer.

C) **Laying Requirements -** All pipes, specials, fittings and other appurtenances shall be examined carefully for damage and other defects before installation. The City retains the right to reject damaged and defective materials.

The pipe ends shall be free of all lumps, blisters and they shall be wiped clean of foreign materials such as dirt and sand before installation.

Pipe shall be laid with the bell ends facing in the direction of laying unless directed otherwise by the Engineer. Where pipe is laid on a slope of ten (10%) percent or greater laying shall start at the bottom and proceed up the slope.

When laying pipe is not in progress during the noon hour or overnight, the open ends of the pipe shall be closed by watertight plugs. If water is in the trench the plugs shall be left in place until the trench is pumped dry.

Bell holes for bell-and-spigot pipe shall be excavated at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper installation of pipe. Bell holes shall not be excavated more than ten (10) joints ahead of pipe laying. Filling and ramming earth or other material beneath the pipe to raise it to grade shall not be permitted.

The Contractor shall use every precaution at all times during construction of the pipeline. All pipe, specials, fittings, and other appurtenances shall be lowered carefully into the trench with suitable equipment, to prevent damage to the waterline materials. In rock trenches, plywood shields or other approved means shall be used to prevent the cradled pipe from swinging against the sides of the trench.

All joint preparation and joining operations shall comply with the instructions and recommendations of the pipe manufacturer and meet the joint requirements in the appropriate material section. For PCECP, the position of the rubber gasket shall be checked with a feeler after each joint is completed. Additionally, when laying PCECP, the maximum joint opening shall not exceed three-eighths inch (? "). Rubber gaskets shall be positioned on the joint in accordance with the manufacturer's recommendations. Immediately before joints are pushed together, all joint surfaces shall be coated with the lubricant furnished with the pipe.

Any damage to the pipe, from any cause during installation of the pipeline shall be cause for replacement, as directed by the Engineer, and at the expense of the Contractor.

After a section of pipe is properly installed and approved for backfill, the trench shall be backfilled and compacted as per Section 212.

505.06 – METHOD OF MEASUREMENT

Payment for "Waterline Pipe" shall be made at the unit price bid per lineal foot of pipe installed for each size. The price established shall be full compensation for all materials including pipe, short pieces and specials, embedment material, labor, tools, equipment and incidentals necessary to complete this item of work. "Waterline Pipe" shall be measured along the pipe, through fittings and valves.

For pipes less than or equal to sixteen inches (16”) in diameter, payment for fitting shall be paid for by pounds. For pipes greater than sixteen inches (16”) payment for fittings shall be made at price bid for each fitting type. The price established shall be full compensation for all materials including fittings, embedment material, concrete thrust blocks, labor, tools, equipment and incidentals necessary to complete this item of work.

505.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) (TYPE) WATERLINE PIPE (JOINT TYPE)(NOM WALL THICK)	L.F.
FITTINGS (SIZE AND TYPE)	LBS.
FITTINGS (SIZE AND TYPE)	EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 510 – WATER SERVICE LINE CONNECTIONS

510.01 – DESCRIPTION

510.01.01 – GENERAL

This section covers water service line connections in sizes five-eighths inch (5/8") through two inches (2") for use in buried service lines from the main to the meter valve or meter setting appurtenance in accordance with ANSI/AWWA C-800 Standard for Underground Service Line Valves and Fittings or as modified herein. All water service lines shall be connected as per city ordinances.

510.01.02 – DEFINITIONS

The following definitions shall apply:

A) **Adapter** - A fitting used to connect pipe, tubing, or other fittings with differing characteristics such as sizes, diameters, or material type.

B) **Chamfer** - A bevel made on the end of a thread to facilitate thread engagement.

C) **Corporation valve (stop)** - A valve attached to the water main to start a service connection, which is used to interrupt flow during installation or maintenance of the service line.

D) **Coupling** - A fitting for connecting two pipes or tubing sections together.

E) **Curb valve** - A valve installed in the water service line and accessible for operation from the surface of the ground for routinely interrupting flow through the service line.

F) **Driving thread** - A thread installed on the outlet end of corporation valves and used to hold the valve during installation.

G) **Dry seal** - A type of pipe thread covered by ANSI/ASME B1.20.3. Dryseal pipe threads are based on the USA (American) pipe thread. They differ from the USA (American) pipe thread in that they are designed to seal pressure-tight joints without the need for sealing compounds.

H) **Fitting** - A part used to connect piping or tubing.

I) **Inlet** - The opening in a valve or fitting through which flow from the water main enters the valve or fitting.

J) **N.P.T.** - National Pipe Thread as specified in ANSI/ASME B1.20.1.

K) **Outlet** - The opening in a valve or fitting through which flow from the water main leaves the valve or fitting.

L) **Service line check valve (backflow preventers)** - A check valve used to minimize backflow and reduce the potential for contamination of water in the main line if pressure in the main is reduced or service pressure is increased.

M) **Tapping saddle** - A fitting that attaches circumferentially to a pipe to provide for attachment of a corporation valve.

510.02 – MATERIALS

Castings - Materials in contact with potable water shall be made from copper alloy No. C83600, in accordance with the chemical and mechanical requirements of ASTM B-62 or ASTM B-584. The alloy shall contain nominally eighty-five (85%) percent copper and five (5%) percent each tin, lead, and zinc, or approved equal.

Component Parts - Component parts such as fasteners, seals, and packing may be of other materials selected for adequate endurance, corrosion resistance, and strength.

510.02.01 – DESIGN OF VALVES AND FITTINGS

General - Valves, fittings, and parts thereof shall be machined to the sizes and tolerances defined in AWWA C-800. End connections may be threaded, brazed, compression, or flared as appropriate.

Pressure Rating - Service line valves and fittings shall be suitable for use with water at one hundred (100?) degree F and one hundred fifty (150 psi) pounds per square inch pressure.

510.02.02 – DETAILED DESIGN OF VALVES AND FITTINGS

Dimensions of Corporation Valves:

A) **General** - Corporation valves shall be installed with drilling or tapping machines. Unless otherwise specified, the minimum inside diameter of the waterway through a corporation valve shall be large enough to accommodate the maximum drill sizes herein. Maximum drill sizes for installation of corporation valves and service clamps or saddles with a driving machine shall be as shown below.

Corporation Valve Size (inches)	Maximum Drill Size (inches)	
	Corporation Valve with AWWA Thread Inlet	Corporation Valve with N.P.T. Thread inlet
?	9/16	.....
¾	11/16	11/16
1	15/16	?
1¼	1 3/16	1?
1½	1 7/16	1 7/16
2	1?	1¾

B) **Overall Body Dimensions** - For corporation valves to be installed by a tapping machine, overall body dimensions shall conform with the dimensions listed below.

Corporation Valve Size (inches)	Maximum Radius (inches)	Maximum Length (less nut) (inches)
?	1.50	4?
¾	1.50	4?
1	1.50	4?
1¼	2.50	9 1/16
1½	2.50	9 1/16
2	2.50	9 1/16

C) **Tapping Saddles -** Tapping Saddles shall conform to the requirements of Section 533.

D) **Service Line Fittings**

a. **General** - The fittings used in service lines shall be designed for connection to the service line by threads, brazing compression, and/or flaring. Small waterways and abrupt corners causing water turbulence and pressure drop shall be minimized.

b. **Solder for service line fittings** - When solder is used with fittings, it shall be "lead free" with a maximum lead content of no more than two-tenths (0.2%) percent as defined in

the 1986 amendments to the SDWA.

E) **Service Line Check Valve** - Check valves may be of an angle design or straight-through design, with good fluid-flow characteristics. The spring shall be strong enough to resist opening with a one (1 psi) pounds per square inch pressure in the direction of flow. The check valve shall be field repairable without removing the valve body from the service line.

510.02.03 – END CONNECTIONS

End connections shall be in conformance with AWWA C-800.

510.04 – CONSTRUCTION METHODS

510.04.01 – GENERAL

The following are general connection requirements only. Additional plumbing code and other requirements may be applicable, which are not included herein.

A) Single taps shall be made at forty-five (45?) degree angles from crown of distribution main. When two (2) or more taps are to be made, they shall be a minimum of thirty-six (36") inches apart and alternate from forty-five (45?) degrees to thirty (30?) degrees from crown of distribution main.

B) Back/reverse tap may be allowed only under adverse conditions and as directed by the Engineer.

C) No tap shall be allowed on fire hydrant leads except under adverse conditions and when approved by the Engineer.

D) Corporation valves (stops) shall be a minimum of one inch (1") for new installations. Existing connections may be replaced with the original size.

E) When tapping dedicated firelines, the tap shall be on the main side of the pit and shall have a gate valve on the outlet side of the double detector check.

F) Direct taps shall be allowed into mains up to twenty (20") inches in diameter. Taps into mains greater than twenty (20") inches shall require a main extension of a size not less than six (6") inches in diameter.

G) Tapping saddles equal to JCM Product No. 406 "Coated Service Saddle with Double Stainless Steel Straps" may be used for three quarter (¾") to two (2") inch service line connections on mains two (2") to twenty (20") inch diameter. Tapping saddle shall also conform with the requirement of Section 533. All other taps shall be accomplished using tapping sleeves in accordance with Section 532.

H) When tapping saddles are installed and approved test shall be performed. Saddles shall hold a minimum of eighty (80 psi) pounds of pressure for thirty (30) minutes.

I) When reconnecting to existing three (3") inch services, reducing of tapping saddles shall only be allowed for a three (3") inch service. A four (4") inch tap shall be allowed with a four (4") inch by three (3") inch reducer from the tapping saddle. No other reductions of the tapping saddles shall be allowed.

J) Service connections two (2") inches and smaller shall be by corporation valve (stop) of the same size as the service line and meter to be installed. Corporation valves shall be as specified in Section 510.02. Service connections to the main for service lines larger than two (2") inches shall be a branch connection, and shall comply with these specifications.

K) Service connections to all ferrous mains shall be electrically insulated by means of an approved insulating fitting. Care shall be taken to properly install corporation valves and provide enough

slack in service lines to protect against pullout.

L) Under no circumstances is a machined-over-all (MOA) asbestos-cement pipe to receive a corporation valve. Machined-over-all (MOA) polyvinyl chloride pipe may receive a corporation valve.

M) When tapping mains where it is necessary to remove part of the polyethylene wrapping, the polyethylene wrap shall be repaired or replaced in such a manner as to protect both the pipe and corporation valve. Any bedding material removed during excavation shall be replaced in kind and compacted.

N) No tees shall be connected to existing water service lines three inches (3") and smaller in diameter providing water to a single meter of the same size.

510.04.02 – AFFIDAVIT OF COMPLIANCE

When requested, the Contractor shall provide an affidavit of compliance that valves and fittings furnished comply with all provisions of these specifications.

510.05 – TESTING

Any valves or fittings found defective shall be replaced with new valves or fittings at the Contractor's expense.

510.07 – BASIS OF PAYMENT

The items as provided above will be paid for at the contract unit price bid:

WATER SERVICE LINE CONNECTION (SIZE) EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 511 – WATER SERVICE LINES

511.01 – DESCRIPTION

511.01.01 – GENERAL

This section covers water service lines intended to be used from the connection to the meter valve for meter setting appurtenance in accordance with AWWA G-800 Standard for Underground Service Line Valve and Fitting or as modified herein. All water service lines shall be connected as per city ordinances.

511.01.02 – TYPES

A short service line is a line not in excess of ten (10') feet. All services in excess of ten (10') feet shall be considered long service lines. Extra long services are used for special circumstances and shall be noted on the plans. Service lines shall be single service unless otherwise directed by the Engineer.

511.02 – MATERIALS

All service lines shall be seamless copper tubing of the designation, "Type K". All fittings shall be brass or copper. Substitutions such as plastic or PVC pipe shall not be accepted. For three-quarter (¾") inch to one inch (1") service lines meter tailpieces shall be "Type K" copper in composition and twenty-four (24") inches in length. A brass male or female union shall be required for the last fitting on the City side of the water service. Said union shall not include plastic or galvanized fittings.

511.04 – CONSTRUCTION METHODS

The following are general construction requirements only. Additional plumbing code and other

requirements may be applicable, which are not included herein.

A) General - Service lines shall be a minimum of one inch (1") for new installations. Existing service lines may be replaced with the original size. Service lines three-quarter (¾") inch to one inch (1") and dead ends shall not be split.

Joints in water lines less than one and one-half (1½") inch in diameter shall not be soldered. No unnecessary unions shall be permitted. A one and one-half (1½") inch diameter service line may be split with two (2) three-quarter (¾") inch or one inch (1") service line only. A two (2") inch diameter service line may be split with six (6) three-quarter inch (¾) inch or two (2) one inch (1") service lines only. No service lines less than one and one-half (1½") inches in diameter shall be split.

B) Boring –

a. Copper lines under street pavement shall not be spliced
b. Street bores shall be a minimum of thirty (30") inches below the bottom of the street.
c. Bores for service lines three-quarter (¾") and one inch (1") in diameter shall not be larger than the service.
d. Bores for service lines one and one-half (1½") inches and two (2") inches in diameter shall not be larger than the service, except when encased with steel pipe.
e. Encasement pipe shall be welded with continuous weld and extend twelve (12") inches past curb lines.
f. Service line bores shall be level and at the same depth as the main.

511.06 – METHOD OF MEASUREMENT

The price established shall be full compensation for all materials including copper service lines, boring, fittings and when required service line check valve, connections to meter, labor, tools, equipment, and incidentals necessary to complete this item of work.

511.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

DOUBLE SERVICE (SIZE) EA.
SINGLE SHORT SERVICE (SIZE)EA.
SINGLE LONG SERVICE (SIZE) EA.
SINGLE EXTRA LONG SERVICE (SIZE) EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 512 – METER RELOCATION

512.01 – DESCRIPTION

This section covers meter relocation as called for on the plans and specifications or as directed by the Engineer.

512.02 – MATERIALS

A) General

a. Meters that are three inches (3") and larger in diameter shall be compound meters or turbine meters.

b. Elbows, tees and wyes shall not be allowed on the City side of meters larger than two (2") inches. Wyes and tees shall be allowed only for service splits of one and one-half (1½") inch and two (2") inch services.

c. Isolation valves shall be a minimum of five (5) pipe diameters on the City side of meter, and two (2) pipe diameters on the customer side of meter.

d. Throttling valves, check valves, backflow preventers and pressure-regulating devices shall be no closer than twenty (20) pipe diameters outside of the meter on the customer side. Under no circumstance will these valves be allowed in the same pit with the meter.

e. One and one-half (1½") inch and larger meters shall be set on blocks a minimum of twelve (12") inches above the floor of the pit and shall be centered in pit and shall have a minimum of eighteen (18") inch clearance between the outside of the meter and the inside of the pit wall.

f. Pits for meters three inches (3") and larger shall have a minimum unobstructed pipe length equal to five (5) and two (2) times the diameter of pipe on the City and customer side of meter, respectively.

B) Strainers

a. Two (2") inch compound meters shall be set with strainers. All three (3") inch and larger meters, whether compound or turbine, shall be set with strainers.

b. Strainers on all meters from two (2") inches to six (6") inches shall be bronze. Strainers on all meters eight (8") inches or larger shall be cast iron.

c. Backflow Preventers

i. Backflow preventers shall be required for all service connections in conjunction with fire or lawn sprinkler systems or swimming pools.

ii. Services supplying water that could be chemically treated in-line or within the system shall require backflow preventers. Water connection and services with frost-free spigots, shall require backflow preventers.

iii. Meters shall not be installed until backflow preventer has been installed.

iv. Backflow prevention devices shall be installed on the customer's side of the meter.

v. Backflow prevention devices shall meet the standards set forth in the BOCA National Plumbing Code, and comply with the requirements of AWWA M-14.

C) Fireline with Domestic Meters – Double detector check and backflow preventers shall be installed between the customer's fireline and the customer's domestic facilities. No single service shall be permitted for fireline and domestic facilities without separate meter and cutoff.

512.04 – CONSTRUCTION METHODS

The following are general installation requirements only. Additional plumbing code and other requirements may be applicable, which are not included herein.

A) Meters

a. Meters shall not be installed unless the foundation of the structure is complete. Meters shall not be installed unless the private house line is in place in accordance with the most recent Plumbing Code set forth or incorporated in the Oklahoma City Municipal Code.

b. After the service and the private line are installed and meter is set, and before service is backfilled, the corporation connection shall be turned on to check for leaks in the service line, corporation valve and meter.

c. An approved backflow prevention device shall be installed before sprinkler meters are

set. Sprinkler meters shall have a service separate from the private line or acceptable service split and separate meter pit or tile. Any meter that services a fire sprinkler, irrigation for landscaping, or directly services a swimming pool, is considered a "sprinkler meter" and requires the same installation procedures as a domestic meter with the exception that a backflow prevention device shall be present between the meter and the sprinkler system before the meter can be set.

d. For three-quarter (¾") inch to one inch (1") service lines, the top of curb valve (stop) shall be eighteen (18") inches to twenty-four (24") inches below inside top of meter box.

e. All meters and meter pits shall be installed on City property, easement or right-of-way.

f. When water service cannot be interrupted for the purpose of meter relocation, a bypass around the meter shall be installed.

B) Meter Boxes

a. Meter boxes shall be Carson 2200 or approved equal. Meter boxes shall be set on firm unpaved surfaces and away from sidewalks and drives. Meter boxes shall be accessible to meter readers. Meter boxes shall be used only for one and one half (1 ½") inch and two (2") inch meters

b. The top of meter box shall be set at grade level. If the ground is not to final grade at the time of the installation of the meter box and tile, then the installing contractor shall raise or lower the meter box when the final grade is established.

c. In pedestrian and vehicular traffic areas or areas surrounded by pavement or concrete, a poured-in-place meter pit or MSBCF-XL box/cover or equal shall be installed. Under no circumstances are corrugated steel meter boxes to be used.

d. A "W" must be chiseled/cut in the curb on the City side of meter location.

C) Pits

a. Pits for meters of three inches (3") and larger in diameter shall comply with the Standard Detail for Meter Pits.

b. The pit wall through which the inlet/outlet pipe passes shall be properly sealed with bituminous material.

512.06 – METHOD OF MEASUREMENT

Payment for "Meter Relocation" shall be made at the unit price bid per each, for each size. The price established shall be full compensation for all materials including valves, fittings, meter lock, meter pit, labor, tools, equipment, and incidentals necessary to complete this item of work.

512.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

METER RELOCATION (SIZE) EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 513 - WET CONNECTIONS

513.01 – DESCRIPTION

This section covers wet connections for tie-in to existing mains. The connections shall be either a cross or tee as called for on the plans where tapping is not allowed.

513.04 – CONSTRUCTION METHODS

The wet connection shall begin with isolating the point of tie-in by closing of valves. The existing main shall then be cut where wet connection is to be made and the line drained.

513.06 – METHOD OF MEASUREMENT

Payment for "Wet Connection" shall be made at the unit price bid per each for each size. The price established shall be full compensation for cutting of the line, dewatering or draining of the main, labor, tools, equipment and incidentals necessary to complete this item of work. The cost of furnishing and installation of required fittings shall be paid for separately pursuant to Section 505.

513.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

WET CONNECTION (SIZE) EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 514 – TAPPING CONNECTIONS

514.01 – DESCRIPTION

This section covers water main tapping for main connections for sizes four (4") inch to forty-eight (48") inch in diameter.

514.02 – MATERIALS

The following materials shall be used and meet the requirements of the appropriate Sections listed below.

Tapping Mechanism	Section
Tapping Sleeves	532
Tapping Valves	520.02.02

514.04 – CONSTRUCTION METHODS

A) Description - A tap is the cutting of a coupon, utilizing a tapping sleeve or saddle with tapping valve for a connection.

B) Methods

a. Direct taps - Direct taps shall be made when the main to be tapped is on the same horizontal plane as the branch. The cutting operation is to be done with a sharp shell-cutter tool, which shall be lubricated with the manufacturer's recommended cutting tool lubricant.

b. Swing Ties - Swing ties shall be made when the main to be tapped is either above or below the branch when called for on the plans or specified. A swing tie may consist of

i. Waterline pipe
ii. Tapping sleeve as necessary;
iii. Tapping valve and Box;
iv. Tap;
v. Solid sleeve;
vi. Ninety degree (90?) bends.

514.06 – METHOD OF MEASUREMENT

Payment for "Tap" shall be made at the unit price bid per each for each size of the following: Tapping

Sleeve, Tapping Valve and Box, and Tap. The price established shall be full compensation for all material, labor, tools, equipment, and incidentals necessary to complete this item of work. Fittings and valves shall be paid for under other items of work.

514.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) TAP EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 515 – FIRELINES

515.01 – DESCRIPTION

This section covers construction of firelines and installation of associated appurtenances as described herein.

A fireline shall be considered any waterline, which exclusively serves fire hydrants, located on private or public property or which serves fire sprinkler or fire standpipe systems located on private property, in addition to a possible domestic service.

Construction of firelines and associated appurtenances shall comply with the applicable requirements of Oklahoma City Code for Fire Prevention and Protection and International Plumbing Code, as amended.

A double detector check valve of a type and manufacture as described herein shall be used to detect the possible leakage or misuse of water and provide a positive separation between the City's domestic water system and automatic fire sprinkler systems. The double detector check valve with bypass meter, with a check valve in the bypass, shall be used as the service inlet to all firelines.

515.02 – MATERIALS

Double detector check valves shall be iron body, bronze seat or disk ring, designed for a bypass meter, flanged or mechanical joint ends, and shall be approved by Underwriter's Laboratories, Inc., or Factory Mutual Laboratories. Double detector check valves shall be approved by the American Society of Sanitation Engineering (ASSE). Upon request of the Engineer, the manufacture shall furnish a certificate of compliance and acceptance by ASSE.

515.02.01 – FIRE HYDRANTS

Fire hydrants shall conform to the requirements of Section 516 and the appropriate Standard Details.

515.02.02 – BYPASS METER

Double detector check valves serving fire lines, regardless of the type of system they serve, shall be equipped with a bypass meter located in the building as the fireline enters the building, or located in an approved pit. The double detector check valve and bypass meter shall be installed in the system prior to any other appurtenances, in an accessible location for periodic inspections by the Fire Department. Bypass meters shall conform to the latest ASSE Standard #1048 and ASSE Standard #1047.

515.02.03 – ISOLATION VALVE

Isolation valves shall be gate valves conforming to the requirements of Section 520. Isolation valves shall be installed on all fire system lines serving fire sprinkler or fire standpipe systems and shall be located on public right-of-way.

515.02.04 – FIRE STANDPIPE

Fire standpipes shall be installed pursuant to the requirements of the applicable sections of the Oklahoma City Code for Fire Prevention and Protection.

515.02.05 – METER PIT

Meter pits shall be constructed to the dimensions shown on the appropriate Standard Details for Meter Pit Construction.

515.04 – CONSTRUCTION METHODS

Construction of firelines and their appurtenances shall conform to the appropriate Standard Detail for Fireline Construction.

515.07 – BASIS OF PAYMENT

Payment for firelines shall be pursuant to the Bid Items as established in the Contract Documents.

SECTION 516 – FIRE HYDRANTS

516.01 – DESCRIPTION

This section covers fire hydrants intended to be used for fire protection when specified or called for on the plans. The hydrant shall be located and positioned in such a way as to be accessible and protected from traffic.

516.02 – MATERIALS

516.02.01 – GENERAL

All fire hydrants furnished shall conform to AWWA C-502, as amended, or as modified herein. No hydrant manufacturer shall be considered which has not regularly manufactured hydrants continuously for a period of at least ten (10) years. No hydrant model shall be considered which has not regularly been in service for a period of at least two (2) years. Fire hydrants shall be the products of the following companies or approved equal.

Hydrants shall conform to AWWA Standard C502, latest revision. Hydrants shall be

Company Name	Product Identification
American Darling	Model 5¼" B-84-B
Mueller	Centurion 200 Model A-423
M & H	Reliant Model 129
U.S.	Metropolitan
Clow	Medallion

516.02.02 – SUBMITTALS

The Contractor shall provide eight (8) copies of all submittals for fire hydrants. The submittal shall clearly identify the make, model, design, and metal characteristics for approval by the Engineer prior to installation.

Drawings shall show principal dimensions, metal thickness, construction details, materials used in all parts of the fire hydrant with ASTM designation and structural properties. Net assembled weight of hydrants shall be shown.

Specifications shall include comprehensive parts list with sufficient drawings or details to clearly identify

parts.

516.02.03 – AFFIDAVIT OF COMPLIANCE

The Contractor shall provide an Affidavit of Compliance that fire hydrants furnished comply with all provisions of these specifications.

516.02.04 – TYPE OF SHUT-OFF

Type of shut-off shall be of the compression type with the flow.

516.02.05 – DELIVERY CLASSIFICATION

All hydrants shall be equipped with two (2) hose nozzles and one (1) steamer nozzle. Leaded in nozzles shall not be acceptable.

516.02.06 – INLET CONNECTION

Unless otherwise specified, the inlet connection shall be a mechanical joint hub complete with all joint accessories. All mechanical joint gland bolts shall be high strength, low alloy, corrosion resistant material, such as Cor-Ten or equal, as specified in ASTM A-252. The inlet valve opening shall be five and one-quarter (5¼") inches net.

516.02.07 – OUTLET CONNECTIONS

The outlet connections shall be two (2) hose nozzles, two and one-half (2½") inches in nominal I.D. and one (1) pumper nozzle five (5") inches in nominal I.D. Nozzle threads shall be Oklahoma City Standard, six (6) threads to the inch for two and one-half (2½") inch nozzles, and four (4) threads to the inch for five (5") inch nozzles pursuant to Standard Detail for Fire Hydrant Nozzle Threads.

516.02.08 – HARNESSING LUGS

Harnessing lugs shall be furnished when specified or called for on the plans.

516.02.09 – NOZZLE CAP GASKET

Gaskets shall be furnished on all nozzle caps. Gaskets shall be neoprene.

516.02.10 – DRAIN VALVE AND OUTLET

A positive operating drain valve or valves shall be provided.

516.02.11 – PAINT

Fire hydrants shall be painted with two (2) coats of high gloss International Orange enamel paint manufactured by Pittsburgh Paint or approved equal. Each coat of paint shall have a minimum dry thickness of two (2) mils.

516.02.12 – SHAPE AND SIZE OF OPERATING AND CAP NUTS

The operating and cap nuts shall be National Standard Pentagon nuts.

516.02.13 – BREAKABLE TYPE

Breakable type (traffic models) shall be furnished. A breakable type hydrant is one that requires no excavation and shall break at the design point.

516.02.14 – STAND PIPE, FLANGES, AND EXTENSIONS

Breakable parts of standpipe shall be located approximately three inches (3”) but not more than five (5") inches above the ground line. These parts shall be of the breakable flange type, breakable coupling or integral flange with sawed bolts. Breakable flanges screwed to the standpipe shall not be accepted. The flange on each end shall have at least eight (8) bolts, or other acceptable method to permit proper orientation of nozzles in forty-five (45?) degree increments and shall be designed so that a wrench can be used on nuts and bolts. Extension of hydrant shall be made by adding at the ground line flange a new coupling and stem section equal to the length of the extension. Stem extensions made by adding new section of stem to the threaded section of the stem at the top of the hydrant shall not be acceptable.

516.02.15 – STEM

Provisions shall be made in the design of the stem to disconnect the stem from the hydrant parts above the standpipe break point in the event of traffic accidents.

516.02.16 – COUPLINGS

If breakable or sleeve type couplings are used, they shall have sufficient torsional strength such that a torsional failure of the stem shall occur at some point other than coupling. Design of the coupling shall be such that when the coupling is broken, no parts shall come loose and fall into hydrant, and the break shall not occur through the pins or bolts holding the coupling to the stem.

516.02.17 – GROUND LINE GASKETS

Gaskets furnished for ground line flanges shall be full face, or flange shall be recessed.

516.02.18 – MAIN AND VALVE SEATS

Main valve seats on the hydrant shall be of such design that incorrect positioning is impossible and that the threads shall be adequately guided into position. Arrangements shall also be made to hold the main valve gasket in place during assembly. The main valve seat shall be made of bronze and threaded into a bronze retainer ring or it may be threaded into a heavy bronze bushing in the hydrant base. All bronze parts in constant contact with the water shall be of type "A", "D", or "E" bronze in accordance with Table 1, AWWA C-212.

516.02.19 – NOZZLE CAP CHAINS

All fire hydrants shall be equipped with nozzle cap chains.

516.02.20 – FLANGES

All flanges shall have a minimum thickness of seven-eighths (? ") inch. Bolt hole edge distance shall be sufficient to provide full support for the bolt heads and nuts.

516.02.21 – OPERATING STEMS

Operating stems shall be high grade bronze, wrought iron or steel. Stem nuts shall be bronze. Where passing through O-rings, iron or steel stems shall have a bronze, stainless steel, or other non-corrodible metal sleeve. Operating threads shall be sealed against contact with water regardless of open or closed position of the main valve. An internal lubricant chamber shall be provided as a part of the dry top construction. An external access for adding lubricant shall be provided

516.26 – O-RINGS

Fire hydrants shall be equipped with O-rings in lieu of stem packing.

516.27 – CAP NUTS

The hydrant shall have a cap nut to seal the bottom end of the stem threads against contact with water.

516.04 – CONSTRUCTION METHODS

516.04.01 – BURY LENGTH

Unless otherwise specified, hydrants shall be furnished with a four (4') foot six (6") inch depth of bury.

516.04.02 – TAPPING OF DRAIN OPENING

Tapping of drain opening shall not be required.

516.04.03 – DIRECTION OF OPENING

The direction of opening shall be to the left or Counter-Clockwise. An arrow and the word "OPEN" shall be cast in relief to be clearly visible on the top of the hydrant, to designate the direction of opening. A minimum number of turns to open shall be ten (10).

516.04.04 – INSTALLATION

The hydrant shall be inspected and cleaned prior to installation. It shall be placed on a concrete mat not less than four inches (4”) thick and sixteen (16") inches square. The rear side of the hydrant, opposite the pipe, shall be blocked with concrete between the hydrant and a vertical face of undisturbed earth. A minimum of seven (7) cubic feet of crushed rock shall be placed around and below the hydrant to allow the hydrant to properly drain. The hydrant shall be firmly supported prior to backfill.

516.05 – TESTING

Hydrostatic tests outlined in AWWA C-502 shall be complied with.

516.06 – METHOD OF MEASUREMENT

Payment for "Fire Hydrants" shall be made at the unit price bid per each. The price established shall be full compensation for furnishing and installing all materials including fire hydrants, extension pipe, riser pipe, and labor, tools, equipment and incidentals necessary to complete this item of work.

516.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

FIRE HYDRANT	EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 517 – REMOVAL OF FIRE HYDRANTS

517.01 – DESCRIPTION

This section covers removal of fire hydrant when called for on the plans or specified.

517.04 – CONSTRUCTION METHODS

Construction shall be in conformance with the Standard Detail for Removal of Fire Hydrants. Salvaged materials, including the fire hydrant, shall be disposed of by the Contractor.

Fire hydrants removed from an abandoned water line shall be capped as required to provide a tight connection.

Fire hydrants removed from a functional water line shall be plugged and restrained as required to

provide a tight connection.

517.06 – METHOD OF MEASUREMENT

Payment for "Removal of Fire Hydrant" shall be made at the unit price bid per each. The price established shall be full compensation for all material including solid sleeves, nipples, removal of existing fire hydrant and its appurtenances, labor, tools, equipment and incidentals necessary to complete this item of work.

Cap and or plugs necessary for this work shall be paid in accordance with Section 505.07.

517.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REMOVAL OF FIRE HYDRANT EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 518 – THRUST BLOCKS

518.01 – DESCRIPTION

This section covers thrust blocks intended to be used to transmit unbalanced thrust forces into undisturbed soil.

518.02 – MATERIALS

High Early Strength Concrete shall be used for thrust blocks. Compressive strength of concrete shall be minimum 3500 psi at three (3) days.

518.04 – CONSTRUCTION METHODS

All construction shall be in accordance with the Standard Details for Thrust Blocks.

518.06 – METHOD OF MEASUREMENT

Payment for "Thrust Blocks" shall be made at the unit price bid per cubic yard (CY) when identified on plans (neat cut dimensions); otherwise, considered incidental to construction of water line. The price established shall be full compensation for all materials including concrete, steel reinforcement, straps, labor, tools, equipment, and incidentals necessary to complete this item of work.

518.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

THRUST BLOCK CY.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 519 – BLOW-OFF CONNECTIONS

519.01 – DESCRIPTION

This section covers blow-off connections intended to be used to provide outlets for draining waterlines at low points in the profile and upstream of line valves located on a slope.

519.04 – CONSTRUCTION METHODS

Blow-off connections shall be constructed of the size, detail and location shown on the plans. Blow-offs shall be provided with a shut-off valve. Blow-offs shall be manufactured in accordance with AWWA C-208

Standard for Fabricated Steel Water Pipe Fittings. Blow off connections shall be constructed in accordance with standard details in contract.

519.06 – METHOD OF MEASUREMENT

Payment for "Blow-Off Connections" shall be made at the unit price bid per each for each size. The price established shall be full compensation for each installation, all materials, including fittings, labor, tools, equipment and incidentals necessary to complete this item of work.

519.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) BLOW-OFF CONNECTION EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 520 – WATER VALVES

520.01 – DESCRIPTION

This section covers water valves of size and type specified or called for on the plans. Unless otherwise specified, all valves twelve (12") inches or smaller in diameter shall be gate valves. Valves sixteen (16") inches and larger shall be butterfly valves. Valves specified shall be of the types shown in the following table:

Valve Type	Reference Standard	Size Range (inches)
Gate (Metal Seated)	AWWA C-500 & C-515	3" - 12"
Gate (Resilient Seated)	AWWA C-509 & C-515	3" - 12"
Tapping	AWWA C-500 & C-515	3" - 48"
Butterfly	AWWA C-504	16" - 72"
Check	AWWA C-506	½" - 10"
Check	AWWA C-508	2" - 24"
Air	.....	1" and Larger

520.02 – MATERIALS

The Contractor shall submit the following for approval prior to installation:

A) Valve make and model
B) Valve detail drawings
C) Type "A" and "B" Certifications.
D) Affidavit of Compliance with specifications

520.02.01 – GATE VALVES

A) General - Gate valves shall conform to the requirements of AWWA C-500, C-509, or C-515 and shall be, bronze mounted, outside screw and yolk, non-rising stem for buried installations and rising stem for unburied installations, open left, double disk (metal seated), parallel seat, "O-ring" for non-rising stem, and shall have standard operating nut.

B) Pressure Rating - Valves produced conforming to AWWA C-500, C-509, and C-515 shall have a design working pressure of two hundred (200 psi) pounds per square inch.

C) Acceptable Manufacturers - Gate valves shall be the product of the following manufacturers or an approved equal.

American Cast Iron Pipe Company
Mueller
US Pipe
Clow
Pratt
M & H

520.02.02 – TAPPING VALVES

A) General - Valves to be used with tapping sleeves shall have connecting flanges (Standard Class 125) with centering lip on the valve flange to fit recess or counterbore on the outlet tapping sleeve flange. The outlet end of the valve shall have a combination mechanical joint end and tapping machine flange.

B) Tapping Valves 4"-12" - Tapping valves shall conform to AWWA C-509 or C-515, except as modified for passage and clearance of tapping machine cutters. The opening through the valve shall be at least one-quarter (¼") inch larger than nominal valve diameter. The outlet end of the valve shall have the desired joint connection for the intended pipe.

Tapping valves shall allow full size cutters to be used. Seating of the disc gate shall not require any sliding or wedging to achieve a zero leakage. A maximum of three (3) internal moving parts shall be required for operation of the valve. The stem collar shall be protected from outside grit, sand, etc., by dual O-rings above stem collar. There shall be an O-ring below stem collar sealing off lubrication chamber from line fluid. Pressure energized O-rings may be used in place of flat gaskets on flanged joints in valve body/bonnet.

All interior and exterior ferrous surfaces shall be protected against corrosion by fusion-bonded epoxy coating. Coating shall be applied prior to assembly to insure coverage of all exposed areas, including boltholes.

C) Tapping Valves 16" and less than 24” - Tapping valves shall conform to AWWA C-500, covering gate valves except as modified for passage and clearance of tapping machines. The outlet end of the valve shall have the desired joint connection for the intended pipe. Valves shall be of the fully revolving, double disc, parallel seat design and have independent wedging action designed to spread the two discs against the seats in the valve body. Seats in the body shall be replaceable without removing valve from pipeline.

The two discs shall be interchangeable and field replaceable without removing valve from pipeline. Either disc shall be able to seat against line pressure. Wedging surface shall be protected by bronze, stainless steel, or other suitable material for corrosion purposes.

Valves twenty-four (24") inches and larger, to be installed with stem in horizontal position, shall be equipped with tracts and scrapers. Enclosed bevel gearing with two (2") inch square wrench nuts to be provided on sixteen (16") inch and larger horizontal stem valves. By-pass valves for equalization of line pressures on both sides of discs to be required for twenty-four (24") inch and larger valves.

All internal and external ferrous surfaces shall be coated with asphaltic varnish per Federal Specification TT-V-51, Military Specification MIL C-450, or equal.

D) Pressure Rating - Tapping valves manufactured conforming to AWWA C-500 and C-505 shall have the following pressure ratings:

Size (inches)	Working Pressure (psig)
? 12	200
? 16	150

E) Acceptable Manufacturers - Tapping valves shall be the product of the following manufacturers or an approved equal:

American Cast Iron Pipe Company
Mueller
US Pipe
Clow
Pratt
M & H

520.02.03 – BUTTERFLY VALVES

A) General - Butterfly valves shall be manufactured to all applicable sections of AWWA C-504 with modifications to permit a non-shock pressure rating of two hundred-fifty (250 psi) pounds per square inch. Unless otherwise shown on the plans, valves twenty (20") inches or smaller in diameter shall be Class 150-B. All valves twenty-four (24") inches and larger shall be equal to or better than specified below. Technical data shall be submitted to the Engineer for approval prior to installation.

B) Bodies - Bodies shall be cast-iron ASTM A-126, Class B, or ductile iron ASTM A-536, grade 65-45-12, heat-treated. Wall thickness shall be in accordance with AWWA C-504, Table 3, Class 150. Flanges shall be ANSI B16.1, Class 250.

C) Shafts - Shafts shall be stub or through shaft type of stainless steel conforming to ASTM A-564, Type 630, with one thousand one hundred fifty (1150?) degrees F. aging, and shall have diameters in accordance with Table 4, Class 150-B. If shafts are made of ASTM A-276 stainless steel, the diameter shall be increased by fifteen (15%) percent over Table 4, Class 150-B. The torsional shear stress shall not exceed fifty (50%) percent of the yield strength of the shaft material used at the maximum torque for the application.

D) Discs - Discs shall be of the double offset design so that the shaft centerline is offset both vertically and horizontally. The disc material shall be ductile iron ASTM A-536, Grade 65-45-12, heat treated or stainless steel ASTM A-296, Grade CF8M, or cast-iron ASTM A-48 or Ductile Iron ASTM A-546, Grade 65-45-12. Flow through or truss type disc shall not be acceptable.

E) Seats - Seats shall be synthetic rubber attached to the disc and held in place by retaining shoulders on both sides of the rubber seat ring and conform to ASTM A-276, Type 316 stainless steel retainer ring screws passing through the seat and retainer ring. The rubber seat ring shall seal against a ASTM A-276, Type 316 stainless steel body ring rolled and mechanically locked into the valve body. Valves twenty (20") inches and smaller shall have bonded seats. Bonded seats shall be simultaneously molded in, vulcanized and bonded to the body. Seat bond shall withstand seventy-five (75-lbs.) pounds pull when tested in accordance with ASTM D-529, Method B. Valve seats on twenty-four (24") inch diameter valves and larger shall be field adjustable and replaceable without dismantling operator, disc or shaft. Seats shall be retained

in the valve body by mechanical means without use of metal retainers or other devices located in the flow stream. The valve disc edge shall have a Type 316 stainless steel edge for mating with the rubber seat. Butterfly valves with rubber seats located on the disc shall not be allowed.

F) Bearings - The shaft shall be supported on both sides of the disc in sleeve type bearings with an area such as not to exceed one-fifth (1/5) of the compressive strength of the bearing or shaft material or the published design load for the bearing material with three hundred fifty (350 psi) pounds per square inch differential pressure across the disc.

G) Actuators - Actuators shall be of the traveling nut or link and lever type with mechanical stops in the open and closed position that are field adjustable and will withstand four hundred fifty (450) ft-lbs. of input torque against the open and shut stops without damage to the actuator.

H) Production Testing - Production testing shall be in accordance with Section 5.2 of AWWA C-504 for the seat leakage test in both directions using three hundred fifty (350 psi) pounds per square inch hydrostatic and Section 5.2.3 of AWWA C-504 for shell testing using five hundred (500 psi) pounds per square inch hydrostatic. Each valve shall be shop operated with the actuator in place for three (3) open-close cycles under no flow conditions as specified in Section 5.2 of AWWA C-214.

I) Proof-of-Design-Tests - Valve designs shall be tested in accordance with Section 5.2.4 of AWWA C-504 with five hundred (500 psi) pounds per square inch used for disc testing and three hundred fifty (350 psi) pounds per square inch used for cyclic testing.

J) Acceptable Manufacturers - Butterfly valves shall be the product of the following manufacturers or an approved equal:

American Cast Iron Pipe Company
Mueller
US Pipe
Clow
Pratt
M & H

520.02.04 – CHECK VALVES

A) General - Check valves shall conform to the requirement of AWWA C-506 Standard for Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types or AWWA C-508 Standard for Swing-Check Valves for Waterworks Service, two (2") inches through twenty-four (24") inches NPS.

B) Pressure Ratings - Check valves conforming to AWWA C-506 shall have a working pressure rating of one hundred fifty (150 psi) pounds per square inch. Valves conforming to AWWA C-508 shall have the following pressure ratings:

Size (inches)	Working Pressure (psig)
2 - 12	175
16 - 24	150

C) Acceptable Manufacturers - Check valves shall be the product of the following manufacturers or an approved equal:

American Cast Iron Pipe Company
Mueller
US Pipe
Clow
Pratt
M & H

520.02.05 – AIR VALVES

A) General - Two (2) types of air valves of size and type may be used to admit or vent air when specified or called for on the plans. The air valve may be as follows:

a. Air release valve

b. Air valve release and air vacuum combination

B) Materials - Unless otherwise specified or called for on the plans, air valves shall have a cast iron body and cover with bronze trim and stainless steel float. They shall be designed to withstand a minimum pressure of three hundred (300 psi) pounds per square inch without damage, and shall be consistent with the following specification:

Body and Cover	Cast Iron	ASTM A-48, Class 35
Float	Stainless Steel	ASTM A-240
Seat	Buna-N or Equal	.....
Retaining Screws	Stainless Steel	ASTM A-276
Guide Bushings	Stainless Steel	SAE 30303

C) Acceptable Manufacturers - Air valves shall be APCO as manufactured by the Valve and Primer Corporation or Valve and Primer Val-Matic or an approved equal.

520.04 – CONSTRUCTION METHODS

Gate valves shall be set with the stems plumb.

Check valves shall be set horizontally.

Tapping valves shall be installed in accordance with the recommendations of the pipe manufacturer being tapped.

Other types of valves shall be set in position shown on the plans or as directed by the Engineer.

At the site of the work and just prior to placing the valve in the trench, the valve shall be fully opened and closed and a record of the number of turns required for full operation shall be furnished to the Engineer. The inside of the valve shall be thoroughly cleaned before installation.

The valve shall be set on a firm base. Valves in PVC pipelines shall be supported by concrete independently of the pipe. The valve and the valve box shall be firmly supported and centered prior to backfill. Installation of valves shall also comply with the appropriate standard detail.

520.06 – METHOD OF MEASUREMENT

Payment for valves , valve boxes and valve vaultsshall be made at the unit price bid per each for each type and size of valve. The price established shall be full compensation for all material including valve, valve boxes, valve vaults, installation, labor, tools, equipment and incidentals necessary to complete this item of work.

520.07 – BASIS OF PAYMENT

Unless otherwise called out on plans, the item measured as provided above will be paid for at the contract unit price bid:

(SIZE) (TYPE) VALVE AND VALVE BOX	EA.
(SIZE) (TYPE) VALVE AND VAULT	EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 521 – VALVE BOXES AND VAULTS

521.01 – DESCRIPTION

This section covers valve boxes and vaults intended to provide means to operate the valve.

521.02 – MATERIALS

A) Valve Boxes - All valve boxes shall be three (3) piece cast iron of the extension type suitable for a depth of cover over the pipeline as required by the backfill requirements at each valve. Each valve box shall be provided with a suitable cast iron base and cover. All parts of valve boxes, bases, and covers shall be coated by dipping in hot bituminous base material.

B) Valve Vaults - Valve vaults shall be reinforced concrete structures constructed to size and dimensions shown on the appropriate standard details for valve vaults.

521.07 – BASIS OF PAYMENT

Payment for valve boxes and vaults shall be paid for as per Section 520.07.

SECTION 522 – HYDROSTATIC PRESSURE TESTING AND DISINFECTION

522. 01 – DESCRIPTION

This section covers hydrostatic pressure testing of installed water mains in accordance with the requirements specified herein.

Hydrostatic Pressure testing of all pipes shall be accomplished pursuant to Section 4 of AWWA C-600. The test pressure shall be not less than one and one-quarter (1.25) times the working pressure and not less than the testing pressures shown in the following table at the highest point along the test section. The allowable leakage in gallon per hour per one thousand (1000') feet of pipe shall not exceed the values shown in the table. The allowable leakage for welded steel pipes shall be zero (0).

Allowable Leakage Per 1000' of Pipe Line - (gph)
Table

Working* Pressure (psi)	Test Pressure (psi)	Nominal Pipe Size - (inches)									
		3	4	6	8	12	16	20	24	30	36
150	175	0.30	0.40	0.59	0.80	1.19	1.59	1.98	2.38	2.98	3.58
200	250	0.36	0.47	0.71	0.95	1.42	1.90	2.37	2.85	3.56	4.27
250	300	0.39	0.52	0.78	1.04	1.56	2.06	2.60	3.12	3.90	4.68

Allowable Leakage Per 1000' of Pipe Line - (gph)
Table (continued)

Working* Pressure (psi)	Test Pressure (psi)	Nominal Pipe Size - (inches)								
		42	48	54	60	64	66	72	78	84
150	175	4.17	4.77	5.36	5.96	6.36	6.55	7.15	7.75	8.34
200	250	4.99	5.70	6.41	7.12	7.60	7.83	8.55	9.26	9.97
250	300	5.46	6.24	7.02	7.80	8.32	8.58	9.36	10.14	10.93

*As a minimum, all pipe shall be tested at 150 psi working pressure. The test pressure shall be maintained for a minimum of two hours.

If any section of pipeline including specials, fitting and appurtenances are discovered to be damaged after the hydrostatic test, they shall be repaired or replaced with sound material and the test shall be repeated to the satisfaction of the Engineer. If any test of pipe installed indicates leakage greater than the allowable leakage, the contractor shall, at his own expense, locate and repair the source of leak in the pipeline until the leakage is within the specified allowance. All visible leaks are to be repaired regardless of the amount of leakage.

522.06 – METHOD OF MEASUREMENT

Payment for "Hydrostatic Pressure Testing and Disinfection" shall be made at the unit price bid lump sum. The price established shall be full compensation for all material, labor, tools, equipment and incidentals necessary to complete this item of work and disinfection as specified in Section 523.

522.07 – FIELD TESTING

HYDROSTATIC PRESSURE TESTING AND DISINFECTION LSUM

SECTION 523 – DISINFECTION

523.01 – DESCRIPTION

This section covers disinfection of water mains, water storage facilities, water treatment plants and wells.

523.04 – CONSTRUCTION METHODS

523.04.01 – GENERAL

A) Water Mains - All new water mains shall be disinfected before they are placed in service. All water mains taken out of service for inspecting, repairing, or other activity that might lead to contamination of water shall be disinfected before they are returned to service. All work shall

comply with AWWA C-651 Standard for Disinfecting Water Mains.

B) Water Storage Facilities - All new storage facilities shall be disinfected before they are placed in service. All storage facilities taken out of service for inspecting, repairing, painting, cleaning, or other activity that might lead to contamination of water shall be disinfected before they are returned to service. All work shall comply with AWWA C-652, Standard for Disinfection of Water Storage Facilities.

C) Water Treatment Plants - All new treatment facilities to be disinfected shall be chlorinated before they are placed in service. All treatment facilities taken out of service for inspecting, repairing, painting, cleaning, or other activity that might lead to contamination of water shall be disinfected before they are returned to service. All units that are downstream from the first point of application of disinfectant in the treatment process shall be disinfected. All work shall comply with AWWA C-653, Standard for Disinfection of Water Treatment Plants.

D) Water Wells - Disinfection and bacteriological testing of water wells shall be done prior to placing in domestic service, any well or any existing well that has received servicing or maintenance that might have caused foreign material or contamination to be introduced into the well. All work shall comply with AWWA C-654, Standard for Disinfection of Wells.

523.04.02 – FLUSHING

The Contractor shall perform preliminary flushing with potable water at a velocity of not less than two and one-half (2½-fps) feet per second. Flushing chlorinated water shall not be discharged into lakes, streams, storm drains or other bodies of water. All flushing water shall be dechlorinated in accordance with AWWA C-651 Section 4.5 prior to disposal. The site for flushing shall be selected with the approval of the Engineer and shall have adequate provision for drainage.

523.04.03 – DISINFECTION

The disinfection of the pipeline shall be performed by the Contractor and the bacteriologic and chemical tests shall be performed by the City. The Contractor shall furnish the necessary equipment and materials for disinfection and the City shall provide the necessary testing. The Contractor shall furnish labor to make the necessary connections and shall provide any temporary drainage measures for disposal of the wastewater.

523.06 – METHOD OF MEASUREMENT

Payment for "Disinfection" shall be as specified in Section 522.06. The price established shall be full compensation for all material including disinfectants, flushing, dechlorination, disinfection, hydrostatic pressure testing, labor, tools, equipment and incidentals necessary to complete this item of work. All necessary water for flushing shall be provided by the Contractor.

523.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for in accordance with Section 522.07.

SECTION 524 – DUCTILE IRON PIPE (DIP)

524.01 – DESCRIPTION

This section covers ductile iron pipe and fittings, for pressure applications, intended to be used for conveyance of raw or potable water, in sizes three inches (3") through sixty-four inches (64”). All Ductile Iron Pipe shall be polyethylene encased as per Section 524.02.08.

524.02 – MATERIALS

524.02.01 – GENERAL

All ductile iron pipe and fittings shall conform to the requirements of the following standards listed below or as modified herein.

A) ANSI/AWWA C-150/A 21.50, Thickness design of Ductile Iron Pipe
B) ANSI/AWWA C-151/A 21.51, Ductile Iron Pipe, Centrifugally Cast in Meal Molds or Sand-Lined Molds, for Water or Other Liquids.
C) ANSI/AWWA C-111/A 21.11, Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
D) ANSI/AWWA C-104/A 21.4, Cement Mortar Lining for Ductile Iron Pipe for Water.
E) ANSI/AWWA C-105/A 21.5, Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
F) ANSI/AWWA C-600, Installation of Ductile Iron Water Mains and Their Appurtenances.
G) ANSI/AWWA C-115/A 21.15, Flanged Ductile Iron Pipe with Threaded Flanges.
H) ANSI/AWWA C-116/A 21.16, Protective Fusion-Bonded Epoxy Coatings for Interior and Exterior surface of Ductile Iron and Gray Iron Fitting
I) ANSI/AWWA C-153/A 21.53, Ductile Iron Compact Fittings

524.02.02 – SUBMITTALS

When requested, the Contractor shall submit the following. No pipe, special sections and fittings shall be manufactured until shop drawings have been reviewed and approved by the Engineer.

Review and approval of the Contractor submittals, by the Engineer, shall not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities for manufacturing ductile iron pipe and fittings as described herein.

A) General - Detail drawings of pipes, specials, fittings, and joints.

B) Laying Schedule - Detail tabulated pipe-laying schedules corresponding to the numbers or identification painted on the pipes, specials and fittings.

C) Certification - Type "A" and "D" certification for pipe, specials, fittings, gaskets, and lining material pursuant to, but not limited to, applicable standards in Section 524. The affidavits of compliance and test reports shall be certified by a registered professional engineer.

D) Guides - The manufacturer's pipe installation guide, standard pipe material repair guide, and written quality control manual.

E) Copies - The Contractor shall provide eight (8) copies of all submittals requested herein.

524.02.03 – DESIGN BASIS

A) General - All ductile iron pipes are designed in accordance with AWWA C-150/ANSI 21.50. The designs are based on prism load of ordinary clay backfill with a unit weight of one hundred twenty (120 pcf) pound per cubic feet, maximum horizontal ring deflection of three (3%) percent, design factor safety of two (2), and for AASHTO HS-20 truck highway (HWY) or Cooper axle E-80 railroad (RR) live loading conditions.

B) Depth of Cover - The minimum design depth of cover shall be ten (10') feet. The assumed depth of cover for design purposes shall be fifteen (15') feet for burial depths of ten (10') to fifteen (15') feet, twenty (20') feet for burial depths of fifteen (15') to twenty (20') feet, twenty-five (25') for depth of twenty (20') to twenty-five (25') feet, thirty (30') feet for depth of twenty-five (25') to thirty (30') feet, and the actual cover for depths over thirty (30') feet. Pipe to be installed inside a casing shall be designed for full cover including live load (a single H-20 or Railroad E-80) neglecting the casing.

C) Deflection - The allowable deflection for the specified mortar lining system is three (3%) percent. Deflection calculation is in accordance with AWWA C-150.

D) Bending and Hoop Stresses - The bending and hoop stress requirements are met in accordance with AWWA C-150.

E) Buckling -

a. Buried Installations - The controlling load for buried pipes is determined from the greater of hydrostatic and earth loads plus vacuum or hydrostatic and earth load plus live load with a factor of safety of two (2.0) as determined in accordance with Section 6.3 of AWWA M-11. It is assumed that the groundwater level is equal to natural ground surface and the ground is fully saturated.

b. Unburied Installations - For unburied pipes, the internal collapsing vacuum pressure is used in determining the minimum wall thickness(es) in accordance with equation 4-2 of AWWA M-11 for a factor of safety of 1.5 against buckling. The Possion's ratio is 0.28 and modulus of elasticity is 52×10^6 psi.

c. Vacuum Pressure - For both buried and unburied installations, the internal collapsing vacuum pressure is taken as 14.7 psi.

524.02.04 – MINIMUM PIPE DESIGN FOR DUCTILE IRON PIPE

Unless otherwise specified, ductile iron pipe and fittings for buried and unburied installations, including boring, tunneling, and micro and small diameter tunneling, shall have the following minimum nominal thickness(es), in inches, shown below.

For boring, tunneling, and micro and small diameter tunneling installations, the minimum pipe design shall be equal to or greater than the minimum pipe design on either side of the installation.

Minimum Pipe Design for Ductile Iron Pipe		
Pipe Size (Inches)	**Nominal Push on Joint Wall Thickness Class 51 (Inches)**	**Flange Joints Class 53 (Inches)**
4”	0.26”	0.32”
6”	0.28”	0.34”
8”	0.30”	0.36”
12”	0.34”	0.40”
16”	0.37”	0.43”
18”	0.38”	0.44”
20”	0.39”	0.45”
24”	0.41”	0.47”
30”	0.43”	0.51”
36”	0.48”	0.58”
42”	0.53”	0.65”
48”	0.58”	0.72”
54”	0.65”	0.81”
60”	0.68”	0.83”
64”	0.72”	0.87”

524.02.06 – PIPE JOINTS AND FITTINGS

A) General - All specials and fittings may be used with push-on, mechanical, or flanged joints conforming to the requirements of AWWA/ANSI C-110/A 21.16. Fittings with push-on joints shall be installed with thrust blocks when necessary. Mechanical joints shall be adequately protected against unbalanced forces. Fittings with flanged joints shall be used with above ground installations. All joints shall have the same pressure rating as the pipe of which they are a part and shall meet the requirements of AWWA/ANSI C-111/A 21.11.

B) Push-on Joints - Push-on joints are a rubber gasket compression type joint meeting the requirements of AWWA C-111. Push-on joints shall have a deflection capability of three (3?) degrees.

C) Mechanical Joints - A mechanical joint is a bolted joint of the stuffing-box type. Each joint shall consist of a bell that is cast integrally with the pipe or fitting and provided with an exterior flange having bolt holes or slots, and a socket with annular recesses for the sealing gasket and the plain end of the pipe or fitting, a pipe or fitting plain end, a sealing gasket, a follower gland with bolt holes, and T-head and hexagonal nuts.

D) Flanged Joints - The flanged joints for ductile iron pipe shall be in accordance with AWWA C-111. Bolts, gaskets, and installation shall meet the requirements of AWWA C-115, Appendix A. The flanged joints for specials and fittings shall meet the requirements of AWWA C-110.

The flanges shall be rated for two hundred fifty (250 psi) pounds per square inch working pressure with bolt-hole drillings as for Class 125 flanges for service at temperatures ranging from twenty degrees (20?) to one hundred fifty degrees F (150?F) are pressure temperature rated for one hundred fifty (150) to two hundred pounds per square inch (200 psi) as shown in ANSI B 16.1. All flanged joints shall be made with single piece, red rubber gaskets one-eighth (? ") inch thick. Gaskets shall be full face for exposed installations and ring type or full faced for buried service meeting AWWA C-110, Appendix A requirements. As directed by the Engineer or shown on plans, flange joints meeting the requirements of ASME/ANSI B-16.1 may be used.

E) Restrained Joints - Restrained joints shall be as follows or approved equal. Retainer glands shall not be permitted.

Restrained Joints		
Company	**Size**	**Type**
American Cast Iron Pipe Co.	4” to 36”	Flex-Ring
	42” to 64”	Lok-Ring
Eba-Iron Sales Inc.	4” to 48”	Mega-Lug Series 1100
Ford Meter Box Co.	All	Uni-Flange
US Pipe and Foundry Co.	4” to 64”	TR-Flex

F) Sleeve Couplings - All sleeve couplings, except as noted on the plans or otherwise specified, shall be restrained with tie rods and shall be designed for the pipe design pressure and maximum allowable stress not to exceed sixty-five (65%) percent of minimum yield strength of steel used. Sleeve couplings shall be:

Dresser Style 38
Rockwell Steel Coupling 511
Smith Blair

Sleeve couplings for pipes three (3") to sixteen (16") inches shall be compact fittings meeting the requirements of AWWA C-153.

524.02.07 – COATING AND LINING

A) Exterior Coating - The exterior of ductile-iron pipe, specials and fittings shall be coated with the asphalt coating in accordance with AWWA C-151, Section 516. The coating shall have a minimum thickness of one (1) mil. The finished coating shall be smooth, continuous and strongly adherent to the pipe. Any damage to the outside coating during shipping, storage, handling and installation shall be field repaired with a fresh coating in accordance with the manufacturer's recommendations.

B) Interior Lining - Unless otherwise called for on the plans or specified, the interior of ductile-iron pipe, specials and fittings shall be cement mortar lined in the shop, with centrifugally spun lining in accordance with AWWA C-104. The Portland cement for cement mortar lining shall be in accordance with the requirements of ASTM C-150, Type I cement. Field repair of lining shall be made in accordance with AWWA C-104, Section 4-7.2.

The thickness of cement mortar lining shall be in accordance with the following table:

Pipe Nominal Size (inches)	Minimum Lining Thickness (inches)
6 - 12	1/16
14 - 24	3/32
30 - 64	?

524.02.08 – CORROSION PROTECTION

When specified or called for on the plans, all ductile-iron pipe, specials, fittings and other appurtenances shall be polyethylene encased in accordance with AWWA C-105/ANSI A 21.5. Exposure to sunlight of polyethylene wrapped pipe shall be kept to a minimum to prevent deterioration of polyethylene. Damage to polyethylene wrapping shall be prevented during backfilling operations. The minimum thickness for polyethylene is eight (8) mils.

524.05 – TESTING (PLANT TESTING)

524.05.01 – SOURCE QUALITY CONTROL

A) Hydrostatic Testing - Each length of pipe shall be shop tested hydrostatically to a pressure equal to two (2) times design pressure, but not less than five hundred (500 psi) pounds per square inch. The pipe shall be under the full test pressure for a minimum of ten seconds. The test shall be made before the application of cement mortar lining to the pipe. Any pipe that leaks or does not withstand the test pressure shall be rejected.

B) Pinhole Leak Testing - Pinhole leak testing of the ductile-iron pipe shall be done during the hydrostatic test as follows:

   a. During the day's production of pipe, the first five sections of pipe and subsequently one in every ten sections shall be tested for pinhole leaks.

   b. After testing the section of pipe hydrostatically to the pressure specified above in Part "A", the same section of pipe shall be tested hydrostatically to the working pressure and the pipe physically inspected for any pinhole leaks.

   c. Any pipe found to have pinhole leaks during the working pressure hydrostatic test shall be rejected, and the entire production for the day, shall be tested for leakage.

C) Joint Testing - Joints shall be tested and meet the performance requirements established in AWWA C-111/ANSI A 21.11, Section 11-9 and as modified herein. The working pressure rating of the joint shall be established by subjecting the joints to three (3%) percent of the pipe produced to hydrostatic pressure of twice the rated working pressure, but in no event less than twice the minimum working pressure rating shown below. At least two (2) joints shall be hydrostatically tested at a deflected angle of three (3?) degrees at the above specified pressure rating.

The minimum working pressure ratings for joints shall be as follows:

Joint Size (inches)	Pressure Rating (psi)
? 18	350
20	300
24	250
30 - 64	200

D) Test Reports - Test reports for the hydrostatic testing of ductile-iron pipe including the pinhole leak tests shall be submitted to the Engineer on a weekly basis during production.

E) Quality Control Tests - All quality control tests conducted by the manufacturer for each production run of pipe shall be submitted to the Engineer on a weekly basis during production.

F) Charpy Impact Test - Charpy impact test shall be performed in accordance with AWWA C-151. The absorbed energy (ft.-lb_f) requirements shall be 7 ft. lbs. at 70? F ± 10? F.

G) Mill Test Reports - Mill test reports of ductile iron used in the manufacture of pipe, specials, fittings and appurtenances shall be submitted to the Engineer.

H) Welding - All welding shall be done by qualified welders. The ductile-iron pipe manufacturer shall be responsible for quality control and testing of all welding done in the plant during fabrication of special fittings.

Inspection - The City retains the right to inspect the pipe, specials and fittings, all work performed and materials furnished, at the manufacturer's plant and at the project site and to independently monitor the fabrication of the pipe, specials and fittings. Such inspection shall not relieve the Contractor or the manufacturer of their responsibilities to furnish material and perform work in accordance with these specifications.

524.06 – METHOD OF MEASUREMENT

Payment shall be made pursuant to Section 505 for Ductile Iron Pipe. Polyethylene Encasement shall be measured along the pipe and fittings including all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

524.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) POLYETHYLENE ENCASEMENT L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 525 – POLYVINYL CHLORIDE (PVC) PIPE

525.01 – DESCRIPTION

This section covers polyvinyl chloride (PVC) pipe and fittings, for pressure applications, intended to be used for conveyance of raw or potable water, in sizes six (6") inch through twelve (12") inch diameter.

525.02 – MATERIALS

PVC pipe and fittings shall be produced by extrusion from Class 12454-A or 12454-B PVC compound providing a hydrostatic design basis (HDB) of four thousand (4,000 psi) pounds per square inch.

525.02.01 – GENERAL

All PVC pipe and fittings shall conform to the requirements of the following standards listed below or as modified herein.

AWWA C-900-PVC pressure pipe, 4 inch through 12 inch for water distribution.
AWWA C-905-PVC pressure pipe, 14 inch through 36 inch for water transmission.
AWWA M-23-PVC pipe-Design and Installation.
ASTM D-2774-Recommended Practice for Underground Installation of Thermoplastic Pressure Piping.
ASTM D-2827-Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
ASTM D-3139-Specifications for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
ASTM F-477-Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
NSF 14-Plastic Piping System Components and Related Materials.
PPI TR3-Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.

525.02.02 – SUBMITTALS

When requested, the contractor shall submit the following. No pipe, special sections and fittings shall be manufactured until shop drawings have been reviewed and approved by the Engineer.

Review and approval of the Contractor submittals, by the Engineer, shall not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities for manufacturing PVC pipe and fittings as described herein.

A) General - Detail drawings of pipes, specials, fittings, and joints. Submittals shall also include design calculations for fittings and specials.

B) Laying Schedule - Detail tabulated pipe-laying schedules corresponding to the numbers or identification painted on the pipes, specials and fittings.

C) Certification - Type "A" and "D" certification for pipe, specials, fittings, gaskets, and lining material. The affidavits of compliance and test reports shall be certified by a registered professional engineer.

D) Guides - The manufacturer's pipe installation guide, standard pipe material repair guide, and written quality control manual.

E) Mill Test Reports - Mill test reports of materials used in the fabrication of pipe, specials, fittings and appurtenances.

F) Copies - The Contractor shall provide eight (8) copies of all submittals requested.

525.02.03 – DESIGN BASIS

A) General - The PVC pipe is designed in accordance with AWWA M23, or as modified herein, and shall conform to minimum DR in Section 525.

B) Depth of Cover - The minimum design depth of cover shall be ten (10') feet. The assumed depth of cover for design purposes shall be fifteen (15') feet for burial depths of ten (10') to fifteen (15') feet, twenty (20') feet for burial depths of fifteen (15') to twenty (20') feet, twenty-five (25') for depth of twenty (20') to twenty-five (25') feet, thirty (30') feet for depth of twenty-five (25') to thirty (30') feet, and the actual cover for depths over thirty (30') feet. Pipe to be installed inside a casing shall be designed for full cover including live load (a single H-20 or Railroad E-80) neglecting the casing.

C) Allowable Stresses - For pipes six (6") inches through twelve (12") inches, the allowable design stress is sixteen hundred (1,600 psi) pounds per square inch and pipes sixteen (16") inch through thirty-six (36") inch, the allowable design stress is two thousand (2,000 psi) pounds per square inch, as established per AWWA C-900 and AWWA C-905, respectively.

D) Dimension Ratio (DR) - Minimum pipe DR is determined in accordance with equation A.4 or equation 2 of AWWA C-900 and AWWA C-905, respectively.

E) Deflection - The allowable deflection is five (5%) percent of the nominal diameter. Deflections are determined based on the following:

a. Deflection lag factor = 1.0

b. Bedding Constant = 0.10

c. Modulus of soil reaction, E' = 1000 psi

d. Earth load considered is the prism load of ordinary clay backfill with a unit weight of one hundred and twenty (120 pcf) pounds per cubic foot, compacted to 90% density (ASTM D-698).

e. A highway live loading of AASHTO HS-20 truck, or railroad live loading of Cooper Axle E-80.

525.02.04 – MINIMUM DIMENSION RATIO (DR)

Unless otherwise specified, PVC pipe and fittings for buried installations including boring, tunneling, and micro and small diameter tunneling, shall have the following minimum dimension ratios (DR).

For boring, tunneling, and micro and small diameter tunneling installations, the minimum dimension ratio shall be equal to or greater than the minimum dimension ratio on either side of the installation.

Pipe Nominal Size (inches)	Dimension Ratio (DR)
? 12	14
? 16	18

525.02.05 – DIMENSIONS

All PVC pipe shall have Cast-Iron-Pipe equivalent (C.I.) outside diameter (O.D.) dimensions.

525.02.06 – PIPE JOINTS AND FITTINGS

Unless otherwise specified, fittings for use with PVC pipe shall conform to provisions of AWWA C-110/A21.10 and shall be short-bodied style. Fittings shall be mechanical joint type. Pressure rating shall conform to the requirements of Section 524.02.06 for ductile iron pipes and fittings. The outside coating for fittings shall conform to the requirements of Section 524.02.07.

525.04 – CONSTRUCTION METHODS

The owner retains the right to inspect the pipe, specials and fittings, all work performed and materials furnished at the manufacturer's plant and at the project site and to independently monitor the fabrication of the pipe, specials and fittings. Such inspection shall not relieve the Contractor or the manufacturer of their responsibilities to furnish material and perform the work in accordance with these specifications.

525.05 – TESTING

Hydrostatic Pressure Testing and Disinfection shall be accomplished in accordance with Section 522.

525.07 – BASIS OF PAYMENT

Payment shall be made pursuant to Section 505.

SECTION 526 - PRE-STRESSED CONCRETE EMBEDDED CYLINDER PIPE (PCECP)

526.01 - DESCRIPTION

This section covers pre-stressed concrete cylinder pipe and fittings may be used for conveyance of raw or potable water in sizes forty-eight (48") inches and larger when specifically called out on the plans or in the special provisions.

526.02 – MATERIALS

526.02.01 – GENERAL

Except as herein modified, all PCECP and fittings shall be embedded steel cylinder type and shall conform to the requirements of AWWA C-301, and C-304.

526.02.02 – SUBMITTALS

The Contractor shall submit the following:

A) General - All engineering data for review and approval prior to pipe manufacture. Submittals shall include pipe design data, design curves, design computations, joint details, special pipe and fittings, and shop drawings. All pipe drawings shall show weld symbols and indicate manufacturing dimensions and tolerances. Design of pipe shall comply with the requirements and criteria established in Section 526.02.03.

   Review and approval of the Contractor submittals, by the Engineer, shall not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities for manufacturing PCECP and fittings as described herein.

B) Laying Schedule - Pipe laying schedules corresponding to the numbers or identification markings on the pipe, specials and fittings.

C) Samples - Representative samples of the steel cylinders, pre-stress wires, aggregate and cement to be used in the fabrication:

   a. Steel Cylinders - two (2) samples, approximately two (2') feet square, one to include a sample of the cylinder weld.

   b. Pre-stressing wires - two (2) samples, twenty-four (24") inches long.

   c. Coarse aggregate - one hundred (100) pounds

   d. Fine aggregate - fifty (50) pounds

   e. Cement - fifty (50) pounds in a sealed container.

D) Test Reports - Quality control and assurance test reports for pipes, specials, and fittings for each production run, including production welds, mill test reports, all steel plates, sheets and other materials used.

E) Concrete and Mortar Mix Designs - Proportions of materials for the mixtures shall be established on the basis of laboratory trial batches using the proposed materials and curing procedures. The following properties shall be measured and reported in accordance with the respective method.

Property	Method
Slump	ASTM C-153
Compressive Strength	ASTM C-39

The water-cement ratio shall be on the basis of aggregate in a saturated-surface dry condition. Proportions shall be established to obtain the required average compressive strength by the methods of ACI 214-77 at a slump of three to four (3 - 4") inches.

F) Materials Certification - Prior to Engineer's approval required in Part "A", the manufacturer shall submit certified material test reports for the following materials: aggregates, cement, admixtures, wire mesh, reinforcing rod, pre-stress wire, steel sheet, plate and shapes, joint rings, bolts, lugs and gaskets. Water for mortar and concrete mix shall be certified to be clear, clean and to have met the requirements of ASTM C-94. Certified reports shall show the actual results of all required chemical analyses, physical tests, examinations and heat treatments, including times and temperatures. The expense of performing all tests and for providing certified test reports required shall be borne by the Contractor.

G) Proof of Design and Cylinder Hydrostatic Test Reports - Test reports in accordance with Section 526.05.

H) Welders' Qualification Certificates - Certificate of qualifications issued by ASME. Welders shall meet the general requirements of Section 4.6 of AWWA C-301.

I) Affidavits of Compliance - Affidavits of compliance from the manufacturer for the following:

   a. Pre-stressed concrete cylinder pipes as required by AWWA C-301 and as modified herein.

   b. Specials and fittings as required by AWWA M-11 and as modified herein.

   c. The affidavits of compliance shall be certified by a registered professional engineer.

J) Guides - The manufacturer's pipe installation guide, standard pipe material repair guide and written quality control manual.

K) Copies - The Contractor shall provide eight (8) copies of all submittals requested herein.

526.02.03 – DESIGN BASIS

A) General - All pre-stressed concrete cylinder pipe shall be designed for the combination of internal pressure and external load outlined in the referenced AWWA standard (AWWA C-304) referred to in AWWA C-301, or as modified herein.

B) Depth of Cover - The minimum design depth of cover shall be ten (10') feet. The assumed depth of cover for design purposes shall be fifteen (15') feet for burial depths of ten (10') to fifteen (15') feet, twenty (20') feet for burial depths of fifteen (15') to twenty (20') feet, twenty-five (25') for depth of twenty (20') to twenty-five (25') feet, thirty (30') feet for depth of twenty-five (25') to thirty (30') feet, and the actual cover for depths over thirty (30') feet. Pipe to be installed inside a casing shall be designed for full cover including live load (a single H-20 or Railroad E-80) neglecting the casing.

C) Soil Unit Weight - Unless otherwise specified, the soil unit weight shall be taken as one hundred twenty (120 pcf) pounds per cubic foot.

D) Earth Load - Earth load shall be calculated based on a trench at the transition width using Marston equations.

E) Live Load - Unless otherwise specified, all pipes and fittings shall be designed for AASHTO HS-20 truck load or E-80 Cooper axle railroad conditions.

F) Bedding - The design bedding angle shall be taken as ninety (90?) degrees, pursuant to the

Standard Detail for installation of Rigid Pipes. Bedding shall be installed as per Section 505.

G) Core Concrete - The twenty-eight (28) day compressive strength shall be assumed to be no greater than five thousand (5,000 psi) pounds per square inch and no greater than six thousand (6,000 psi) pounds per square inch for vertically cast cores, and centrifugal or radial compaction, respectively.

H) Elastic Limit Pressure - The elastic limit pressure shall be not less than 1.4 times the design pressure.

I) Burst Pressure - The burst pressure shall be at least three (3) times the working pressure.

J) Trenchless Installations - For boring, tunneling, and micro and small diameter tunneling installations, the minimum pipe design shall be equal to or greater than the minimum pipe design on either side of the installation.

526.02.04 – MODIFICATIONS TO AWWA C-301

The following sections of AWWA C-301 are modified as follows:

A) Marking - The manufacturer's control number or work order number pertaining to any given section of pipe shall be stamped legibly and indelibly on the interior of the spigot joint ring following curing. All inspection reports shall show the work control number. Piece designation corresponding to laying position in lay schedule shall be marked on the outside of the pipe.

Each piece of straight and special pipe and each fitting shall be indelibly stenciled on the inside concrete surface at the pipe end with the following information: inside diameter, class, unique control number, cast date, wrapping date, wire diameter, wire class, wire spacing.

B) Inspection and Testing by Purchaser - The Engineer shall have the right to inspect and review all materials, processes, procedures and records related to the manufacture and repair of pipe. The manufacturer shall provide the Engineer with copies of all written quality control procedures and tests and reports as may be employed by the manufacturer during the production of the pipe. Such information shall be kept confidential when so requested by the manufacturer.

C) Cement - Cement used for the core, slurry, mortar coating, and authorized repairs shall conform to the requirements of ASTM C-150 "Specifications for Portland Cement" Type II. No cement replacement materials or mineral admixtures shall be used without prior approval from the Engineer.

D) Fine Aggregate and Course Aggregate - Acceptance of coarse and fine aggregate failing to meet the requirements for grading and quality as defined in ASTM C-33 "Standard Specification for Concrete Aggregates" shall be based on comparative laboratory test data demonstrating at least equal performance with respect to compressive strength and shrinkage for both concrete and mortar. The coarse aggregate shall be sampled in accordance with Federal Specification CRD-C-119 for thin or elongated pieces, the maximum dimension of which exceeds five times the minimum, shall not be in excess of ten (10%) percent of the coarse aggregate by weight.

E) Water - Clear, clean water in compliance with ASTM C-94 shall be used in all concrete and mortar. The use of recycled or wash water shall not be permitted.

F) Admixtures - No admixture shall be used without prior approval of the Engineer. Test data and compositional analysis of admixtures shall be submitted for acceptance prior to use.

G) Steel for Cylinders and Fittings, Steel sheets and coils - Steel sheets and coils for cylinders shall be hot rolled grade C conforming to the requirements of AWWA C-301.

H) Steel Reinforcement, Pre-stressed Wire - The pre-stressing wire for circumferential reinforcement shall conform to ASTM A 648 "Specification for Steel Wire Hard-Drawn for Pre-stressing Concrete Pipe" except that the following shall be added under the specification paragraphs as noted below:

Section Numbers referred to are those in ASTM-A648

7. Physical Requirements

7.1.5 Reduction of area shall conform to thirty-five (35%) percent minimum for size one-quarter (0.250) inch and larger wire.

7.2 Torsion Test

7.2.2 One test specimen suitable for a twelve (12") inch span shall be taken for each coil.

10. Inspection - The wire supplier's certification that the wire was manufactured and tested in accordance with the specifications, as herein modified, together with a report of the test result shall be furnished to the engineer prior to acceptance of the finished pipe. Such reports shall clearly reference the lot or heat involved and the reference number, code or other designation shall be identifiable on each coil as delivered.

The pipe design shall be based on the minimum tensile strengths of the wire class used. Wire other than Class I, II, or III shall not be used.

I) General Requirements

Core and Coating Tolerances - The minimum thickness of the core for embedded cylinder pipe shall be as shown in the following table.

Diameter (inches)	Core Thickness (inches)
48	4
54	4
60	4½
66	5
72	5½
78	6
84	6½
90	6½
96	6½
102	6½
120	8
126	8½

For embedded cylinder pipe, the thickness of the inner concrete lining shall not vary from the nominal dimension by more than the values shown in the table below:

Diameter (inches)	Inner Concrete Lining Thickness Variance (inches)
48	?
54 – 72	3/16
> 72	¼

The thickness of the mortar coating shall be such as to provide a minimum clear cover of four (4) times the nominal wire diameter over the exterior portion of the wire, but shall not exceed one and one-quarter (1¼") inches.

J) Design of Pipe

Reinforcement - The pre-stress wire shall not be smaller than one quarter (¼") inch diameter. Adjacent wires shall not touch at any point. End wraps shall not be placed more than one and one-half (1½") inches or less than one inch (1") from the edge of the core to be coated with the full depth of the mortar coating. Splices in the pre-stress wire shall not be closer than three (3') feet as measured along the longitudinal axis of the pipe.

K) Concrete for Pipe Core

Mixing - The temperature of the mix shall not exceed ninety (90?) degrees F at the time of placement. The measured slump of the concrete used in embedded-cylinder pipe shall not vary more than one inch (1") from the approved mix design, as measured at the mixer discharge. Pipe made with a concrete slump exceeding this limit shall be rejected.

L) Curing of Pipe

General - Cores shall be cured by the accelerated curing method only. The total continuous cure including the delay period, but excluding the time required to remove the forms or end rings, shall be a minimum of twenty-four (24) hours. Forms or rings shall not be removed until after a minimum of twelve (12) hours of accelerated curing, including the required four (4) hour delay period.

Accelerated Curing - The delay period before temperature is increased during accelerated curing shall not be less than four (4) hours for any pipe core or coating, during which period temperature shall not be raised above one hundred (100?) degrees F and the humidity shall be maintained as specified in AWWA C-301, Placing of Wire Reinforcement.

M) Placing of Wire Reinforcement

General - The temperature of the cores shall be at least forty (40?) degrees F and the cores shall be in a surface dry condition at the time of pre-stressing. Air pockets, honey combing, holes or voids three-eighths (? ") inch depth and/or diameter or greater and offsets as defined in "Repair of Core and Coating" and deeper shall be filled and patched at the time the form is removed. Patches shall be adequately cured prior to pre-stress and finished in such a manner as to prevent bridging or gaps under the pre-stress wire.

Portland Cement Slurry - A retarding admixture shall be used in the mix. The point of application shall be eight (8") to twelve (12") inches ahead of the leading wire or between the lead wraps and final wraps of the lead wrap machines. The rate of application shall not be less than one (1) gallon per ninety (90) square feet. Cores shall not be pre-stressed prior to the fourth calendar day (96 hours) following the completion of casting.

N) Pipe Coating

General - The coating shall be applied within sixteen (16) hours after pre-stressing. The temperature of the pipe shall be at least forty (40?) degrees F at the time of coating.

Mortar Coating - Cement mortar coating shall not contain any rebound and shall consist of a cement-to-fine aggregate ratio between 1:2 and 1:2.75 by weight on the pipe. Batched fine aggregate weights shall be compensated for moisture in the fine aggregate.

The moisture content of the coating as applied shall not be less than six (6%) percent of the total saturated surface dry weight of the sand and cement. Ambient accelerated curing temperatures of the coating shall not exceed one hundred and ten (110?) degrees F. The cured coating shall be free of holes, hollows, delaminations, and cracks.

O) Curing of Coating

Accelerated Curing - All cement mortar coating shall be cured by the accelerated method only and shall be continuous for a minimum of twelve (12) hours, including the four (4) hours delay period.

P) Repair of Core and Coating - Repairs shall not be made without prior approval of the detailed written repair and testing procedures. The following procedures shall be employed where applicable. Exceptions shall be submitted for approval.

"Cylinders" through "Finished Pipe" are created herein, to define what may be repaired and what is not acceptable to be repaired.

Cylinders - All oil, grease, soap, mud, ice, snow, etc., shall be removed. Bumps and dents shall be taken out of cylinders before they are used. To remove bumps or dents, use only a rubber, rawhide, or fiber mallet. For a core that has been rejected, when the concrete is knocked out of the cores, the cylinder must be hydrostatically retested before being reused.

Cores

a. Embedded Cylinder - Cores with indentations which cause bridging of the wire and/or gate offsets in the outer concrete surface exceeding one-eighth (? ") inch will not be pre-stressed without repair.

   Depth of depression and offset shall be determined by an outside template placed on the core surface. Cores having air pockets in the outer envelope three-eighths (? ") inch deep and/or one quarter (¼") inch wide shall be repaired. Surface skin shall be removed. Elongated pockets of equivalent surface area shall be repaired. Sand streaks, honeycombs, casing leaks, or soft and rotten concrete in the inner and outer envelopes shall be removed and patched. So that patches may cure with the pipe, all core repairs shall be done in the bays after the casings are removed and the core temperature is below ninety (90?) degrees F. The patching mix shall be at the same temperature as the core.

b. Embedded Cylinder Core Cracks Prior to Pre-stress - Pipe shall be patched as soon as possible and prior to pre-stressing. Inside longitudinal cracks due to handling, plastic shrinkage, sags or tears must be patched or the concrete broken out and recast or the core rejected.

   Lining circumferential or helical slump cracks of less than fifteen hundredths (0.015") inches in width need not be patched. Circumferential cracks in excess of fifteen thousandths (0.015") inches width, but less than three-thousandths (0.030") inches may be repaired. Cracks that exceed thirty-thousandths (0.030") inches width and twelve (12") inches in length shall not be repaired and the core shall be rejected.

   Cores with external longitudinal cracks of any width are not acceptable and the core shall not be pre-stressed, except for cracks less than five thousandths (0.005") inches width within one (1') foot of bell end or spigot end.

Brush Coating

a. Application Faults - Defects appearing in mortar coating, such as blisters, hollow spots, falloffs, or slippage cracks during or immediately after application, shall be removed and repaired before the pipe is placed in the bay for curing.

   Defective areas greater than fifty (50) square inches or extending more then ninety (90?) degrees circumferentially or exposing pre-stress wire shall be repaired on the machine, not by hand.

   Defective areas smaller than fifty (50) square inches that are not over the pre-stress wire may be hand patched. Pipe to be hand repaired shall be positioned in a revolving machine so that area to be patched is on top when in curing bins.

b. Other Conditions - Holes caused by the depth gauge, used to measure the coating thickness, must be fully pressed closed immediately after removing gauge. Stone holes in the mortar shall be filled and repaired in the curing bins, preferable prior to curing, otherwise prior to yarding. Drip holes shall be repaired prior to yarding pipe.

Finished Pipe

a. Interior of Pipe - Core cracks shall not be slurried, painted over or otherwise dressed to improve appearance. Holes larger than three-eighths (? ") inch diameter and/or one-fourth (¼") inch deep must be repaired. Pre-stressed pipe with shrinkage cracks, either circumferential or helical, shall not be shipped if cracks exceed fifteen thousandths (0.015") inches in width at any point.

   Inner lining longitudinal cracks exceeding two thousandths (0.002") inch width, after pre-stress or with an offset, are cause for rejection except for cracks less than one hundredth (0.01") inches maximum width in the unpre-stressed area between the spigot face and joint ring weld. Circumferential spigot cracks wider than thirty thousandths (0.030") inches at any point, resulting from pre-stressing, shall be filled by epoxy injection prior to shipment.

b. Exterior of Pipe - Cracks in coating of pipe may be cause for rejection. This does not apply to surface craze cracks whose width cannot be measured or where cracks occur over saddles which may be repaired.

c. Ends of Pipe (Over Joint Rings) - All visible coating cracks must be repaired.

Q) Fittings

Design - All fittings shall meet the minimum thickness requirement shown below. Fittings shall be mortar coated on the interior and exterior surfaces. Fittings employing supplemental external reinforcement cages shall not be used.

Pipe Inside Diameter (inch)	**Steel Cylinder Thickness (inch)**
48	½
54	9/16
60	?
? 72	¾

Steel Fabrication

a. General - Remove all scale and other foreign matter accumulating on the plate during rolling and forming operation by an air blast so that it will not be rolled or pressed into the surface of the plate. Complete all rolling and forming prior to making butt welds. Do not heat or hammer for the necessary forming of angles.

b. Fit up - Prior to welding using fillet welds, fit the plates to be welded closely; and during welding hold them firmly together.

   Tack weld the edges of the butt joints or clamp in place in proper alignment and so hold through out the welding process. Do not use dogs, clips, lugs or equivalent devices welded to the steel plate for the purpose of forcing it into position.

c. Cleaning - Prior to welding, clean the surfaces of all plates and members to be welded of all scale and rust for a distance of not less than one inch (1”) and of all oil or grease for a distance of not less than three inches (3”) from the welding edge on both sides of the plates in the case of butt joints.

Remove grease or oil with gasoline, lye or other approved means. Do not use kerosene or any heavier petroleum solvent. When it is necessary to deposit metal over a previously welded surface, remove scale, slag or welding flux by a roughing tool, chisel, air chipping hammer, or other means.

d. Aligning - Where butt-welded joints are used, align edges to be jointed to ensure complete penetration and fusion at the bottom of the joint. Limit the offset in abutting edges to one-sixteenth (1/16") inch at circumferential seams and to one thirty-second (1/32") inch at longitudinal seams.

e. Quality of Welds - Butt welds shall not be made prior to the completion of the rolling and forming. All butt welds for both hand and automatic welding shall be grounded out or back-gouged to sound metal before welding reverse side.

Longitudinal seams shall be welded before girth seams. All welds shall be full strength, ductile, and shall be made to ensure uniform distribution of load throughout the welded section. All welded joints shall be of a type that will produce complete fusion of the plates and shall be free from unsound metal, pinholes, and cracks.

The finish of welded joints shall be uniform, smooth, and free from grooves, depressions, burrs and other irregularities. There shall be no valley or undercut in the center or edges of any weld.

Flanges shall be flat faced. The gasket surfaces shall have a V-serrated finish of approximately thirty-two (32) serrations per inch, approximately one sixty-fourth (1/64") inch deep. Serrations may be either concentric or spiral.

Welded-type outlets shall have a mounting diameter the same as that of the surface upon which they are to be mounted, except that where the mounting surface is curved to a diameter of thirty-six (36") inches or more, the outlet bottom may be flat. Welded-type outlets shall be forged steel.

Steel plate fittings shall be designed in accordance with AWWA M11. Steel plate shall conform to ASTM A-36 or an approved equal. The fittings, specials and appurtenances shall be hydrostatically tested to a pressure not less than that for the pipe. Non-destructive testing in accordance with AWWA C-200, Section 4.3 can be substituted for the hydrostatic test.

Lining and Coating - All fittings shall be cement mortar coated and lined.

R) Curves, Bends and Closures - Where restrained joints are called for on the plans, they shall be made by fully welding the spigot contact ring to the bell mating surface to produce a watertight joint without the use of a rubber gasket. The spigot ring shall be prepared for welding during manufacture of the pipe by cutting off the spigot groove. The fillet weld size shall be equal to the thickness of the bell joint ring.

S) Outlets and Connections on Pipe - Openings for manholes and connections for air valves, blowoffs, and other branches shall be built into the walls of the concrete pipe and shall be designed in accordance with AWWA M-11.

In all cases, the primary steel reinforcement shall not be in the form of a collar. In the case where a collar is sufficient reinforcement according to AWWA M-11, a three hundred sixty (360?) degree wrapper shall be substituted. If secondary reinforcement is required by the AWWA M-11 procedure, a collar may be used. The steel plate shall conform to ASTM A-36 or an approved equal. The wrapper thickness shall be no greater than four times the thickness of the cylinder in the concrete pipe section.

The wrapper shall be welded to the exterior of the cylinder of the pipe section and the portion of the cylinder between the circumferential welds removed. The welds shall be penetrant dye tested for their entire circumference.

The flanges for specials and fittings shall be in accordance with AWWA C-207 Class E with bolt-hole

drillings as for Class 125 cast iron flanges. All flanged joints shall be made with single-piece, red rubber gaskets one-eighth (? ") inch thick. Gaskets shall be full face for exposed installation and ring type or full faced for buried service meeting AWWA C-207 requirements. All nuts and bolts for buried flange joints shall be of stainless steel meeting the requirements of ASTM A-193, Grade B7.

526.05 – TESTING (MANUFACTURERS' TESTING)

526.05.01 – PLANT QUALITY CONTROL AND INSPECTION

A) General - Procedures, tests and requirements as set forth herein are in addition to, and for the purpose of monitoring the quality of pre-stressed concrete pipe supplied under AWWA C-301 standard. The inspections and tests required shall be performed by the material supplier, pipe manufacturer, or designated laboratory and the results forwarded to the Engineer. The Engineer reserves the right to inspect the materials, fabrication process or product at any or all times.

B) Tests and Inspections - Tests and inspections to assure conformance with the specifications are established herein. Inspection to verify the quality of work shall be performed by persons other than those engaged in the activity being examined. Such persons shall not report directly to the production supervisor responsible for the work.

The Engineer will make an effort to inspect each section of pipe at various stages of production. Accordingly, the manufacturer shall provide the Engineer with a written production schedule to facilitate inspections. Testing shall be performed in accordance with the approved procedures. In the absence of established written procedures, the test methods shall be documented by the manufacturer and proved by actual demonstration to the satisfaction of the Engineer. When approved, the manufacturer shall be notified in writing. At lease one (1) copy of the procedures to be followed shall be available to all appropriate personnel at the testing site for reference and use.

All instruments, gauges and other testing and measuring equipment used in activities affecting quality shall be of proper range, type, and accuracy to verify conformance with specification requirements. Procedures shall be in effect to assure that they are calibrated and certified at no longer than annual intervals. Calibration shall be against measurement standards that have known relationship to national standards where such exist. Gauges must be calibrated and certified for the piece of equipment of which they are a part and must remain on the piece of equipment following certification. Materials and items including products previously checked or manufactured with equipment found to be out of calibration or adjustment shall be considered unacceptable until it can be determined that all applicable requirements have been met.

The manufacturer shall maintain records of all required tests and inspections. These records shall include documents such as records of materials, manufacturing, inspection, repairs, and test data taken before and during fabrication. The Engineer reserves the right to request specific data be included in the report which may not otherwise be included. Whenever tests and inspections are performed on a pipe element or pipe, the appropriate identification number shall be shown on the report. Copies of all reports of tests by the manufacturer, including computer printouts of production records, independent laboratory, or material suppliers shall be given to the Engineer in such form as to be appropriate for permanent records.

The Engineer shall have access to all records of tests and inspections related to pipe manufactured and shall also have the right to witness any tests being performed by the manufacturer or his suppliers relative to products, materials, or the pipe being produced.

C) Fabrication Testing and Inspection - Testing and inspection of the materials, used in fabrication of the pipe, shall be executed in accordance with the procedure and at the frequency listed in the following table. The required testing shall be done by either the material supplier, an independent laboratory, or the manufacturer. The test area wherein the tests are performed shall be properly certified and such certification shall meet with the Engineer's approval. Where the frequency of

testing differs in the following table from that required by the referenced specification or test method, the greater frequency shall govern.

MATERIAL	REQUIREMENTS	REFERENCE OR TEST METHOD	FREQUENCY
Cement	Physical and chemical properties	ASTM C-150	Each Shipment
Aggregates	Gradation	ASTM C-136	Weekly
	Moisture content	ASTM C-566	Daily
	Material finer than #200 sieve	ASTM C-117	Weekly
	Organic impurities	ASTM C-40	Test frequency shall be on a source basis. The Engineer reserves the right to call for tests during the manufacture of the pipe. The tests applied to new sources and the results approved by the Engineer prior to use.
	Flat and elongated particles	CRD-C-119	Same as above
	Friable particles	ASTM C-142	Same as above
Aggregates	Lightweight particles	ASTM C-123	Same as above
	Specific gravity and absorption	ASTM C-127 or ASTM C-129	Same as above
	Chlorides	ASTM C-1411	Same as above
	Potential reactivity	ASTM C-289	Same as above
	Soundness	ASTM C-88	Same as above
Admixtures	Chemical composition	Infrared spectro-photometry, pH, and solids content in accordance with ASTM C-494	Each Shipment
Concrete	Mixer uniformity	ASTM C-94	Initially and every six months
	Sampling	ASTM C-172	
	Cylinders	ASTM C-31	
	Compressive strength	ASTM C-39	One set of 2 cylinders daily for each test age for each 50 cu. yd. or portion thereof and for each class of concrete
	Slump	ASTM C-143	First batch placed each day and every 50 cu. yd. or portion thereof for each class of concrete
	Temperature		Same as above
	Unit weight/yield	ASTM C-138	Weekly
Casting	Proportions on pipe wash out test		Weekly
Mortar	Hardened mortar absorption	ASTM C-497 Method A	Weekly
Slurry	Proportions	Specific gravity	Daily
	Application rate	Discharge nozzle flow	Initially
Pre-stressing	Tension Test	ASTM A-370 Supplement IV	Tests shall be applied to each 10,000-pound lot with samples representing one test for each coil, and not less than every fifty consecutive pipes wrapped. If any sample test indicates defective product, each coil within the lot or heat shall be tested. If any additional tests indicate any defective product, the entire heat shall be rejected.
	Wrapping test	ASTM A-370 Supplement IV	Same as above
	Torsion test	ASTM E-558	Same as above

D) Proof of Design Test - Prior to the start of manufacture, one section of the highest class of each size of pipe shall be fabricated in accordance with the approved design and the requirements of this specification. At age five (5) to seven (7) days after completion, each section shall be subjected to a hydrostatic test.

During this test, the pressure shall be raised from eighty (80%) of the $P_?$ (internal pressure required to overcome all compression in the concrete) to $P_?$ in twenty (20 psi) pound per square inch increments pausing at least five (5) minutes at each increment.

At the $P_?$ pressure, the pressure shall be raised in ten (10 psi) pound per square inch increments to the working plus surge pressure, pausing at least five (5) minutes at each increment.

At the working plus surge pressure, there shall be no coating crack exceeding three thousandths (0.003") of an inch at any location nor a coating crack in the barrel exceeding two thousandths (0.002") of an inch by one (1') foot long, nor any evidence of delamination. The barrel is defined as the coated portion of pipe exclusive of area six (6") inches from the spigot shoulder and twelve (12") inches from the bell face.

It shall be permissible to keep the exterior of the pipe wet for a period not exceeding forty-eight (48) hours prior to test. Before the test shall commence and during the entire period of the testing, the coating shall be in a surface dry condition.

During the first week of production, two (2) additional sections of pipe of the highest class of each size shall be selected at random by the Engineer and subjected to the hydrostatic test. Failure to meet the hydrostatic test requirements shall be cause for reducing the pressure rating of each pipe class to a class that can be shown to meet the criteria established.

If in the judgment of the Engineer, additional test are warranted because of variations in design, materials, manufacturing or handling/storage methods, they shall be conducted as directed in accordance with the above procedures.

The Contractor/Manufacturer shall provide means or equipment, meeting OSHA requirements, to the Engineer, to safely inspect the pipe during the hydrostatic testing.

E) Manufacturer's Plant Inspection

1. Manufacturer's Inspection - In addition to all other hydrostatic tests, the Engineer shall select at random one (1) of the pipe produced each day for hydrostatic testing. When less than ten (10) pipes are produced in a day, one (1) pipe shall be selected from each lot of twenty (20) pipes manufactured, for hydrostatic test. The pipe shall be tested at age five (5) to seven (7) days to the working plus surge pressure for a period of time sufficient to determine the coating crack behavior. Pipes developing coating cracks shall be rejected and further testing required to establish acceptable performance in the opinion of the Engineer.

   Prior to final inspection by the Engineer, the manufacturer shall conduct a complete inspection and place an appropriate stamp on the lining indicating the pipe to be complete and ready for shipment.

2. Engineer's Inspection - In-Process examination by the Engineer will encompass all phases of manufacturing and testing, and will include but not be limited to the following, for each section of pipe at the indicated stages of pipe production:

   a. Cylinder Prior to Casting Concrete. - (1) Number of leaks at first pressure test. Excessive repairs in the opinion of the Engineer shall be cause for rejection; (2) Dents or indentations; (3) Surface dirt or contamination; (4) Advanced corrosion. Pits exceeding ten (10%) percent thickness of the sheet shall be cause for rejection.

   b. Pipe Cores Prior to Pre-stressing. - (1) Voids and patching; (2) Offsets and bulges which

may cause bridging and gaps under wire; (3) Damage or cracking in core concrete.

c. Pre-stressing Pipe Core Prior to Coating. - (1) Adequacy of slurry coverage; (2) Clearance between pre-stress wires; (3) Proper position and number of pre-stress wires;

d. After Coating and Curing. - All pipe, fittings and specials shall be inspected for cracks, delaminations and spalls. Inspection in the areas listed above shall also be routinely included in the manufacturer's quality control program.

The Engineer's examination shall include but not be limited to: (1) Joint ring dimensions and roundness (manufacturer shall provide templates, if necessary); (2) Mortar coating defects such as cracks, delaminations, spalls, coating thickness, soft areas and foreign matter; (3) Marking and identification.

F) Field Inspection - After shipment to the job site and prior to installation, the pipe may be re-inspected by the Engineer for cracks, delaminations, spalls or other defects. In addition, the coating may be "sounded", using a ball peen hammer having a head weight of not more than one (1-lb) pound, over its entire exterior surface at the spacing of approximately one (1') foot both circumferentially and longitudinally to locate any hollow or drummy areas which may indicate a delamination or void.

526.05.02 – HYDROSTATIC PRESSURE TESTING AND DISINFECTION

Hydrostatic pressure testing and disinfection shall be accomplished in accordance with Sections 522 and 523.

526.07 – BASIS OF PAYMENT

Payment shall be made pursuant to Section 505.

SECTION 527 – STEEL PIPE

527.01 – DESCRIPTION

This section covers steel pipe and fittings, for pressure applications, intended to be used for conveyance of raw or potable water, in sizes forty-eight (48") inches and larger when specified on plans and specifications.

527.02 – MATERIALS

527.02.01 – GENERAL

All steel pipe and fittings shall meet the requirements of ASTM A-572, Grade 52 or ASTM A-139, Grade C, and conform to the requirements of the following standards listed below or as modified herein.

AWWA M11,	Steel Pipe - A Guide for Design and Installation
AWWA C-200,	Steel Water Pipe 6 inch and Larger
AWWA C-209,	Cold - Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
AWWA C-214,	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C-206,	Field Welding of Steel Water Pipe
AWWA C-602,	Cement - Mortar Lining of Water Pipelines - 4 inch and Larger - In Place
AWWA C-208,	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C-207,	Steel Pipe Flanges for Waterworks Service - Sizes 4" through 154"
AWWA C-205,	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4" and Larger - Shop Applied
AWWA C-210,	Liquid Epoxy Coatings Systems for the Interior and Exterior of Steel Water Pipelines

AWWA C-213,	Fusion Bonded Epoxy Coating for Interior or Exterior Pipeline Coating
ASTM A-193,	Alloy Steel and Stainless Steel - Bolting Materials for High Temperature Service
ASTM A-139,	Electric-Fusion (Arc) - Welded Steel Pipe (sizes 4 inch and over)
ASTM A-370,	Mechanical Testing of Steel Products
ASTM A-673,	Sampling Procedure for Impact Testing of Structural Steel
ASTM C-150,	Portland Cement

527.02.02 – SUBMITTALS

The Contractor shall submit the following. No pipe, special sections and fittings shall be manufactured until shop drawings have been reviewed and approved by the Engineer.

Review and approval of the Contractor submittals, by the Engineer, shall not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities for manufacturing steel pipe and fittings as described herein.

A) General - Detail drawings of pipes, specials, fittings, and joints, with design calculations for fittings and specials.

B) Laying Schedule - Detail tabulated pipe-laying schedules corresponding to the numbers or identification painted on the pipes, specials and fittings.

C) Certification - Type "A" and "D" certification for pipe, specials, fittings, gaskets, and lining material pursuant to, but not limited to, applicable standards in Section 527.02.01. A registered professional engineer shall certify the affidavits of compliance and test reports.

D) Guides - The manufacturer's pipe installation guide, standard pipe material repair guide, and written quality control manual.

E) Mill Test Reports - Mill test reports of steel plates, sheets or coils used in the fabrication of pipe, specials, fittings and appurtenances.

F) Copies - The Contractor shall provide eight (8) copies of all submittals requested herein.

527.02.03 – MANUFACTURER

Pipe shall be the product of one manufacturer that has had not less than five (5) years successful experience manufacturing pipe of the particular type and size indicated. Pipe manufacturing operations (pipe, fittings, lining, and coatings) shall be performed at one (1) location. The manufacturer's plant shall be certified under S.P.F.A. quality certification program for steel pipe and accessory manufacturing.

527.02.04 – DESIGN BASIS

A) General - All steel pipe and fittings are designed in accordance with AWWA M11 or as modified herein, and shall conform to minimum wall thickness in Sections 527.02.05 and 527.02.06. For buried pipes, the design satisfies internal pressure, deflection, and buckling requirements. Buckling loads are made up of hydrostatic and earth loads plus live load or internal vacuum.

B) Depth of Cover - The minimum design depth of cover shall be ten (10') feet. The assumed depth of cover for design purposes shall be fifteen (15') feet for burial depths of ten (10') to fifteen (15') feet, twenty (20') feet for burial depths of fifteen (15') to twenty (20') feet, twenty-five (25') for depth of twenty (20') to twenty-five (25') feet, thirty (30') feet for depth of twenty-five (25') to thirty (30') feet, and the actual cover for depths over thirty (30') feet. Pipe to be installed inside a casing shall be designed for full cover including live load (a single H-20 or Railroad E-80) neglecting the casing.

C) Allowable Stresses - The hoop stress shall not exceed (50%) fifty percent of minimum specified yield strength for both working pressure, and combined working pressure plus surge pressure conditions.

D) Deflection - The allowable deflection for the specified mortar lined and flexible coated system, is three (3%) percent, for both shop lined and field applied lining and coating system. Deflections are determined based on the following:

a. Deflection lag factor = 1.0
b. Bedding Constant = 0.10
c. Modulus of soil reaction, E' = 1000 psi
d. Earth load considered is prism of ordinary clay backfill with a unit weight of one hundred and twenty (120 pcf) pound per cubic foot, compacted to ninety (90%) percent density (ASTM D-698).
e. A highway live loading of AASHTO HS-20 truck, or railroad live loading of Cooper Axle E-80.

E) Buckling -

a. Buried Installations - The controlling load for buried pipes is determined from the greater of hydrostatic and earth loads plus vacuum or hydrostatic and earth load plus live load with a factor of safety of 2.5 or 3.0 as determined in accordance with Section 6.3 of AWWA M-11. It is assumed that the groundwater level is equal to natural ground surface and the ground is fully saturated.

b. Unburied Installations - For unburied pipes, the internal collapsing vacuum pressure is used in determining the minimum wall thickness in accordance with equation 4-2 of AWWA M-11 for a factor of safety of 1.5 against buckling. The Possion's ratio is 0.30 and modulus of elasticity is 30 x 10^6 psi.

c. Vacuum Pressure - For both buried and unburied installations, the internal collapsing vacuum pressure is taken as 14.7 psi.

527.02.05 – MINIMUM WALL THICKNESS FOR BURIED INSTALLATIONS

Unless otherwise specified, steel pipe and fittings for buried installations, including boring, tunneling and micro and small diameter tunneling, shall have a minimum thickness of 0.375 inches and shall be not less than the minimum thickness, in inches, shown in the following tables.

For boring, tunneling, and micro and small diameter tunneling installations, the minimum pipe design shall be equal to or greater than the minimum pipe design on either side of the installation.

The minimum design pressure is equal to one hundred fifty pounds per square inch working pressure plus one hundred pounds per square inch surge pressure.

A) Pipe Nominal Size: 48 inches

Design Pressure (psi)	Live Load Condition	Maximum Depth of Cover (feet)				
		10	15	20	25	30
250	HWY	0.3750	0.3750	0.3750	0.3750	0.5000
	RR	0.3750	0.3750	0.3750	0.4375	0.5625
300	HWY	0.3750	0.3750	0.3750	0.3750	0.5000
	RR	0.5375	0.3750	0.3750	0.5375	0.5625
350	HWY	0.5375	0.5375	0.5375	0.5375	0.5000
	RR	0.5375	0.5375	0.5375	0.5375	0.5625
400	HWY	0.5000	0.5000	0.5000	0.5000	0.5000
	RR	0.5000	0.5000	0.5000	0.5000	0.5625

B) Pipe Nominal Size: 54 inches

Design Pressure (psi)	Live Load Condition	Maximum Depth of Cover (feet)				
		10	15	20	25	30
250	HWY	0.3750	0.3750	0.3750	0.5375	0.5625
	RR	0.5375	0.3750	0.3750	0.5000	0.6250
300	HWY	0.5375	0.5375	0.5375	0.5375	0.5625
	RR	0.5375	0.5375	0.5375	0.5000	0.6250
350	HWY	0.5000	0.5000	0.5000	0.5000	0.5625
	RR	0.5000	0.5000	0.5000	0.5000	0.6250
400	HWY	0.5652	0.5625	0.5625	0.5625	0.5625
	RR	0.5625	0.5625	0.5625	0.5625	0.6250

C) Pipe Nominal Size: 60 inches

Design Pressure (psi)	Live Load Condition	Maximum Depth of Cover (feet)				
		10	15	20	25	30
250	HWY	0.5375	0.5375	0.5375	0.5375	0.6250
	RR	0.5375	0.5375	0.5375	0.5625	0.6875
300	HWY	0.5000	0.5000	0.5000	0.5000	0.5260
	RR	0.5000	0.5000	0.5000	0.5625	0.6875
350	HWY	0.5625	0.5625	0.5625	0.5625	0.6250
	RR	0.5625	0.5625	0.5625	0.5625	0.6875
400	HWY	0.6250	0.6250	0.6250	0.6250	0.6250
	RR	0.6250	0.6250	0.6250	0.6250	0.6875

D) Pipe Nominal Size: 66 inches

Design Pressure (psi)	Live Load Condition	Maximum Depth of Cover (feet)				
		10	15	20	25	30
250	HWY	0.5000	0.5000	0.5000	0.5000	0.6875
	RR	0.5000	0.5000	0.5000	0.6250	0.7500
300	HWY	0.5000	0.5000	0.5000	0.5000	0.6875
	RR	0.5000	0.5000	0.5000	0.6250	0.7500
350	HWY	0.6250	0.6250	0.6250	0.6250	0.6875
	RR	0.6250	0.6250	06250	0.6250	0.7500
400	HWY	0.6875	0.6875	0.6875	0.6875	0.6875
	RR	0.6875	0.6875	0.6875	0.6875	0.7500

E) Pipe Nominal Size: 72 inches

Design Pressure (psi)	Live Load Condition	Maximum Depth of Cover (feet)				
		10	15	20	25	30
250	HWY	0.5000	0.5000	0.5000	0.5625	0.7500
	RR	0.5625	0.5000	0.5000	0.6250	0.8125
300	HWY	0.5625	0.5625	0.5625	0.5625	0.7500
	RR	0.5625	0.5625	0.5625	0.6250	0.8125
350	HWY	0.6250	0.6250	0.6250	0.6250	0.7500
	RR	0.6250	0.6250	0.6250	0.6250	0.8125
400	HWY	0.7500	0.7500	0.7500	0.7500	0.7500
	RR	0.7500	0.7500	0.7500	0.7500	0.8125

F) Pipe Nominal Size: 78 inches

Design Pressure (psi)	Live Load Condition	Maximum Depth of Cover (feet)				
		10	15	20	25	30
250	HWY	0.5625	0.5625	0.5625	0.6250	0.8125
	RR	0.6250	0.5625	0.5625	0.6875	0.8750
300	HWY	0.6250	0.6250	0.6250	0.6250	0.8125
	RR	0.6250	0.6250	0.6250	0.6875	0.8750
350	HWY	0.6875	0.6875	0.6875	0.6875	0.8125
	RR	0.6875	0.6875	0.6875	0.6875	0.8750
400	HWY	0.8125	0.8125	0.8125	0.8125	0.8125
	RR	0.8125	0.8125	0.8125	0.8125	0.8750

G) Pipe Nominal Size: 84 inches

Design Pressure (psi)	Live Load Condition	Maximum Depth of Cover (feet)				
		10	15	20	25	30
250	HWY	0.6250	0.5625	0.5625	0.6250	0.8750
	RR	0.5260	0.5625	0.5625	0.7500	0.9375
300	HWY	0.6250	0.6250	0.6250	0.6250	0.8750
	RR	0.6250	0.6250	0.6250	0.7500	0.9375
350	HWY	0.7500	0.7500	0.7500	0.7500	0.8750
	RR	0.7500	0.7500	0.7500	0.7500	0.9375
400	HWY	0.8750	0.8750	0.8750	0.8750	0.8750
	RR	0.8750	0.8750	0.8750	0.8750	0.9375

527.02.06 – MINIMUM WALL THICKNESS FOR UNBURIED INSTALLATIONS

Unless otherwise specified, steel pipe and fittings for unburied installations shall have a minimum thickness of 0.375 inches and shall be not less than the thickness, in inches, shown in the following table:

Pipe Nominal Size (inch)	Design Pressure (psi)			
	250	300	350	400
48	0.3750	0.3750	0.5375	0.5000
54	0.5375	0.5375	0.5000	0.5625
60	0.5375	0.5000	0.5625	0.6250
66	0.5000	0.5000	0.6250	0.6875
72	0.5625	0.5625	0.6250	0.7500
78	0.5625	0.6250	0.6875	0.8125
84	0.6250	0.6250	0.7500	0.8750

527.02.07 – SPECIALS AND FITTINGS

The specials and fittings shall be fabricated in accordance with AWWA C-200. Fittings shall meet the requirements of AWWA C-208 for dimensions. All tees, laterals and outlets shall be designed in accordance with AWWA M11. The specials and fittings shall be provided in accordance with approved submittals or as shown on the plans.

527.02.08 – JOINTS

A) General - Pipe joints shall be made with flanges, sleeve couplings, or lap welded slip joints.

B) Flanges - The flanges for steel pipe, specials and fittings shall be in accordance with AWWA C-207 Class E with bolthole drillings as for Class 125 cast iron flanges. All flanged joints shall be made with single-piece, red rubber gaskets one eighth (? ") inch thick. Gaskets shall be full face for exposed installation and ring type or full faced for buried services meeting AWWA C-207 requirements. Flange nuts and bolts shall be of stainless steel and shall meet the requirements of ASTM A-193, Grade B7.

C) Sleeve Couplings - All sleeve couplings, except as shown on the plans, shall be restrained with tie rods and shall be designed for pipe design pressure and maximum allowable stress not to exceed sixty-five (65%) percent of minimum yield strength of steel used. Harnessed joints shall be designed in accordance with AWWA M-11. See below for approved sleeve couplings.

Dresser Style 38
Rockwell Steel Coupling 511
Smith-Blair

D) Lap-Welded Slip Joints - Welding of pipe joints shall be done in accordance with the requirements of AWWA C-206. Buried pipe, specials, fittings and tied joints, except as shown or noted on the plans shall have full size, single fillet lap-welded slip joints, welded inside and outside. All welds shall be sound and free from embedded scale or slag. The welded joints shall have tensile strength across the weld not less than that of the thinner of the connected sections and shall be leakfree.

The type and use of welding electrodes for the carbon steel shall meet the requirements of AWS B2.1. During welding of pipe sections, coating shall be protected to avoid damage to the coating by hot weld splatters. No welding ground shall be made on coated part of the pipe. All field welding shall be done in accordance with the requirements of AWWA C-206.

527.02.09 – EXTERIOR COATING

A) Pipe and Specials - The exterior of steel pipe and specials shall be coated and wrapped with prefabricated, multi-layer, cold-applied tapes by mechanical methods and tested in accordance with the requirements of AWWA C-214.

The tape coating system shall be a minimum of three (3) layers with a total thickness of eighty (80) mils. The three layers shall consist of a primer, twenty (20) mil thick inner layer and two (2) thirty (30) mil thickness layers outer layers.

The properties of the entire system shall conform to the appropriate values used in Tables 1, 2 and 3 of AWWA C-214. The field joints shall be coated with cold-applied tapes in accordance with the requirements of AWWA C-209.

The bell shall provide for a two (2") inch lap with three fourths (¾") inch allowable pull for a required one inch (1") minimum lap. Shop applied exterior coating shall be held back four inches (4") each end.

B) Connections, and Fittings - The exterior of connections and fittings for steel water pipelines shall be primed and wrapped with prefabricated cold-applied tape coating in accordance with the requirements of AWWA C-209. The thickness of prefabricated tape coating shall be two (2) thirty-five (35) mil layers.

527.02.10 – INTERIOR LINING

The interior of steel pipe, specials and fittings shall be cement mortar lined. The thickness of cement

mortar lining shall be one-half (0.50") inch.

Field linings shall be placed mechanically in accordance with AWWA C-602. Shop applied lining shall be in accordance with AWWA C-205.

Portland Cement for cement mortar lining shall be in accordance with the requirements of ASTM C-150, Type I cement.

Field joints shall be made in accordance with the requirements of AWWA C-205, Appendix A.

The interior of all outlets and connections smaller than six (6") inches shall be painted with liquid epoxy in accordance with the requirements of AWWA C-210. Shop applied interior coating shall be held back four inches (4") on both ends.

527.02.11 – CONNECTIONS

A) General - Air valves, blow-offs, manholes, outlets and shut-off line valves shall be designed and manufactured to meet the combined working and surge pressures of the pipe.

B) Connection to Other Pipe Materials - When connecting steel pipe to either gray or ductile cast-iron pipe, or to steel-reinforced concrete pipe, an electrically insulating joint shall be used. The insulating joint can be accomplished with an insulating gasket with sleeves and washers on a flanged connection or with an insulating sleeve-type flexible coupling.

   Any valves or other ferrous equipment connected to steel pipe shall be encapsulated in polyethylene sheeting in accordance with these specifications, or coated with a coating compatible with the steel pipe coating. Similar precautions are not necessary when connecting to nonmetallic pipe, such as asbestos-cement or plastic.

C) Flanged Connections - Attachment of flanges shall be in accordance with AWWA C-207. Outlet nozzles shall be as short as possible.

D) Blow-Off and Air Valve Connections - Connections to the pipe for blow-offs and air valves shall be shop welded thread lets, half couplings or flanged nozzle with reinforcing collar in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section VIII, Division I, Paragraph UG-37 and AWWA M11. An outlet less than six (6") inches in diameter shall be lined with epoxy paint in accordance with the requirements of AWWA C-210.

E) Manhole and Outlet Connections - Manhole and outlet connections shall be fabricated and designed in accordance with AWWA M11.

F) Air-Release and Air-And-Vacuum Valves - Air-release valves and air-and-vacuum valves, if not installed directly over the pipe, may be located adjacent to the pipeline. A horizontal run of pipe shall connect the air valve and the pipeline. The connecting pipe shall rise gradually to the air valve to permit flow of the air to the valve for venting.

527.04 – CONSTRUCTION METHODS

The City retains the right to inspect the pipe, specials and fittings, all work performed and materials furnished at the manufacturer's plant and at the project site and to independently monitor the fabrication of the pipe, specials and fittings. Such inspection shall not relieve the Contractor or the manufacturer of their responsibility to furnish material and perform the work in accordance with these specifications.

527.05 – TESTING

527.05.01– HYDROSTATIC PRESSURE TESTING AND DISINFECTION

Field Testing shall be accomplished in accordance with Section 522 and Section 523.

527.05.02 – SOURCE QUALITY CONTROL

A) Hydrostatic Test - Each length of pipe shall be shop tested hydrostatically to a pressure which will induce a hoop stress equal to at least seventy-five (75%) percent of the minimum yield stress of steel used. The test requirements shall be in accordance with AWWA C-200, Section 3.4.

The fittings, specials and appurtenances shall be hydrostatically tested to a pressure not less than that for the steel pipe. Non-destructive testing in accordance with AWWA C-200, Section 4.3 may be substituted for the hydrostatic test when approved by the Engineer.

Test reports of the hydrostatic testing of steel pipe, specials and fittings shall be submitted to the Engineer on a weekly basis during production.

B) Plant Welding - Quality control tests of production welds during the manufacture of steel pipe shall be conducted in accordance with the requirements of AWWA C-200, Section 3.3.5.

C) Field Welding - At the beginning of work, a yield point determination of a welded joint shall be made by an independent testing laboratory. When directed by the Engineer, welded test specimens shall be furnished for testing. All costs for laboratory testing shall be borne by the Contractor. Use of back up welding strips or rings for shop welds shall not be permitted.

D) Welder Qualifications - All welding shall be done by ASME qualified welders. Welders shall meet the general requirements of Section 9 of ASME Boiler and Pressure Vessel Code.

E) Holiday Tests - The Contractor shall conduct an electrical inspection of all wrapped surfaces. The electrical inspection shall be conducted in accordance with the requirements of AWWA C-209 and C-214.

527.07 – BASIS OF PAYMENT

Payment shall be made pursuant to Section 505.

SECTION 528 – STEEL CASING PIPE

528.01 - DESCRIPTION

This section covers steel pipe intended to be used as a casing pipe for boring and micro and small diameter tunneling installations.

528.02 – MATERIALS

528.02.01 – SUBMITTALS

When requested, the Contractor shall submit the following, provided that all applicable requirements are met, and that visual inspection at destination shows the workmanship and condition of material to be satisfactory.

A) Type "A" certification for pipe

B) Shop drawings of pipe, joints and seams

C) Documentation of manufacturer's on-going quality control program.

528.02.02 – GENERAL

A) General - Steel pipe shall conform to ASTM A-139, Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and Over). The steel material shall be new, smooth wall, carbon steel, Grade B, with minimum sixty thousand (60,000 psi) pounds per square inch tensile strength, and minimum thirty-five thousand (35,000 psi) pounds per square inch yield strength.

The pipe shall be straight seam pipe, seamless pipe, or spiral weld pipe. For spiral weld pipe, the spiral shall be one hundred (100%) percent welded, and the weld's height over the outside wall surface shall be equal to or less than three-sixteenths (3/16") inch. All steel pipe shall be square cut and shall have a roundness such that the difference between the major and minor outside diameters shall not exceed one (1%) percent of the specified nominal outside diameter or one-fourth (¼") inch, whichever is less. The outside circumference must be within plus or minus (±) one (1%) percent of the nominal circumference or within plus or minus (±) one-half (½") inch, which is less. The pipe shall have a maximum allowable straightness deviation in any ten (10') foot length of one-eighth (?") inch. Steel pipe joints shall be continuously welded with an approved butt weld. The welds shall attain the full strength of the pipe and shall result in a fully watertight section. The welded joints shall conform to the requirements of AWWA C-206.

B) Boring (Micro and Small Diameter Tunneling) Installations

a. Casing Pipe Size - Steel casing pipe shall have the follow minimum inside diameters:

Pipe Nominal Size (inches)	Casing Pipe Inside Diameter (inches)
4	8 to 10
6	10 to 12
8	14 to 16
10	16 to 18
12	18 to 20
15	20 to 22
18	24 to 26
24	31 to 33
27	33 to 36
30	36 to 42
36	42 to 48
42	54 to 60
48	60 to 66

b. Casing Pipe Thickness - Steel casing pipe shall be the following minimum thickness, in inches, for the indicated maximum depth of cover(s), in feet:

OUTSIDE DIAMETER (inches)	UNDER HIGHWAY		UNDER RAILROAD	
	Wall Thickness (inches)	Maximum Cover (feet)	Wall Thickness (inches)	Maximum Cover (feet)
? 12¾	0.188	30	0.250	30
16	0.250	30	0.281	30
18	0.250	30	0.322	30
20	0.250	30	0.344	30
24	0.250	30	0.406	30
30	0.322	30	0.469	30
36	0.375	30	0.531	30

OUTSIDE DIAMETER (inches)	UNDER HIGHWAY		UNDER RAILROAD	
	Wall Thickness (inches)	Maximum Cover (feet)	Wall Thickness (inches)	Maximum Cover (feet)
42	0.375	25	0.531	30
48	0.438	25	0.531	25
54	0.438	25	0.531	20
60	0.438	25	0.531	20
66	0.438	20	0.531	20

528.07 – BASIS OF PAYMENT

Payment shall be made pursuant to the appropriate Section of 505 or 254.

SECTION 529 – RESTRAINED JOINTS

529.01 – DESCRIPTION

This section covers restrained joints intended to be used to control unbalanced thrust forces when called for on the plans or specified.

529.02 – MATERIALS

A) Ductile Iron Pipe - Restrained joints shall be American Lok-Ring or approved equal. Retainer glands shall not be permitted. Flanged joints shall be used for above ground installations.

B) Steel Pipe - No restraint shall be required for welded joints.

C) PVC Pipe - Restraint mechanism shall be same as that specified for ductile iron pipe in part A).

D) Pre-stressed Concrete Cylinder Pipe - Restrained joints shall be welded, clap type harness, or snap ring type harness. Approved manufacturers are shown in Section 524.02.06.

529.06 – METHOD OF MEASURMENT

Payment for "Restrained Joints" shall be made at the unit price bid per each for each size. The price established shall be full compensation for all materials, labor, tools, equipment and incidentals necessary to complete this item of work. Flanged joints shall not be paid for separately but shall be included in the price bid for "Waterline Pipe" pursuant to Section 505.

529.07 – BASIS OF PAYMENT

Restrained joints shall be paid as per Section 505.07.

SECTION 530 – CLOSURE PIECES

530.01 – DESCRIPTION

This section covers pipe closure pieces intended to be used for connecting water lines where a standard connection (joint) cannot be made.

530.02 - MATERIALS

530.02.01 – GENERAL

The pressure rating of closure pieces shall be equal to or greater than the pressure rating of the water main.

530.02.02 – TYPES

Unless otherwise specified or called for on the plans the following requirements shall be adhered to:

A) Ductile Iron Pipe - Closure pieces shall be either solid sleeve joints meeting the requirements of ANSI/AWWA C-110/A21.10.

B) PVC Pipe - Closure pieces shall be mechanical joint ductile iron fitting as specified in Part A above.

C) Steel Pipe - Closure pieces shall be sleeve coupling, double-butt weld, or butt strap joint meeting the requirements of Section 527 and AWWA M11.

D) PCCP - Closure pieces shall be follower ring or welded. Standard length shall be six (6') feet and shall not be less than a minimum of two (2') feet. When necessary, double spigot adapter may be used to convert a bell end on a pipe section to a spigot end to facilitate proper alignment and closure of the pipe sections. The spigot ends shall not be more than one inch (1") out of line or grade. Closure with restrained joints shall be used when the pipe has restrained joints.

530.07 – METHOD OF MEASUREMENT

Payment for "Closure Piece" shall be made at the unit price bid per linear foot for each size. The price established shall be full compensation for furnishing and installing of all materials including closure piece assembly, repair kits, labor, tools, equipment and incidentals necessary to complete this item of work.

530.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) CLOSURE PIECE LF.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 531 – THRUST COLLARS

531.01 – DESCRIPTION

This section covers thrust collars intended to be used, with pre-stressed concrete cylinder pipe, to transmit thrust forces into undisturbed soil adjacent to the thrust collars.

531.04 – CONSTRUCTION METHODS

All construction shall be in accordance with the Standard Detail for Thrust Collars when called for on the plans or as directed by the Engineer. Concrete thrust block shall be cast around steel thrust collar after pipe is installed.

531.06 – METHOD OF MEASUREMENT

Payment for "Thrust Collars" shall be made at the unit price bid per each for each size. The price established shall be full compensation for all material including the steel thrust collar (fitting), labor, tools, equipment, and incidentals necessary to complete this item of work.

Payment for the concrete "Thrust Block" shall be made pursuant to Section 518.

531.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) THRUST COLLARS EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and

incidentals, and for performing the work in accordance with these specifications.

SECTION 532 - TAPPING SLEEVES

532.01 - DESCRIPTION

This section covers tapping sleeves intended to be used for tapping water mains.

532.02 - MATERIALS

Tapping sleeves shall be manufactured in accordance with AWWA C-110 and equipped with gaskets made in accordance with AWWA C-111. Tapping Sleeve shall be Ductile Iron or Steel, Mechanical Joint and shabby be manufactured by the following:

Following is a list of approved manufacturers or equal:

American Cast Iron Pipe Company	JCM Model 414, 439, 459
Smith Blair	Model 623
Ford Meter Box Company	Model 3490 Mechanical Joint by Power Seal Pipeline Products Corporation
Mueller Stainless Steel	H304SS or H304MJ

All Steel Tapping Sleeves must have Fusion-Bonded Epoxy Coating and Type 304 Stainless Steel Bolts and Nuts.

532.04 – CONSTRUCTION METHODS

The installation shall conform to the recommendation of the manufacturer of the pipe being tapped.

532.06 – METHOD OF MEASUREMENTS

Payment for "Tapping Sleeve" shall be made at the unit price bid per each for each size. The price established shall be full compensation for furnishing and placing of all materials including tapping sleeve, labor, tools, equipment, and incidentals necessary to complete this item of work.

532.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) TAPPING SLEEVE EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 533 – TAPPING SADDLES

533.01 – DESCRIPTION

This section covers tapping saddles used for tapping water mains.

533.02 – MATERIALS

Tapping saddle shall be manufactured in accordance with AWWA C-110 and equipped with gaskets made in accordance with AWWA C-111.

533.04 – CONSTRUCTION METHODS

A) General - Tapping saddles shall have a body with a threaded outlet, seal, and suitable means for attachment to the main. The body shall be made to conform to the outside configuration of

the main. Tapping saddles shall be designed to provide a drip-tight connection when used as a service connection to the main. The materials used to produce tapping saddles shall comply with Section 510.

B) Three-quarter (¾") inch to one inch (1") services - Tapping saddles shall be required when tapping other than cast iron or ductile iron pipe. Saddles shall be brass or stainless steel. Saddles may be required on older cast-iron and ductile-iron as directed by the Engineer. Tapping saddles shall be the same size as the service line. The reducing of tapping saddles shall not be allowed.

C) One and one-half (1 ½") inch and larger services - One and one-half (1½") inch and larger tapping saddles shall be ductile iron, stainless steel or approved equal. Three (3") inch and larger taps shall require solid back tapping saddles. Four-bolt epoxy-coated alloy bolts shall be required. No shop coat bolts shall be allowed. No strap tapping saddles shall be allowed.

533.06 – METHODS OF MEASUREMENTS

Payment for "Tapping Saddle" shall be made at the unit price bid per each for each size. The price established shall be full compensation for furnishing and placing all materials, including tapping saddle, labor, tools, equipment and incidentals necessary to complete this item of work.

533.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) TAPPING SADDLE EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 534 - CORROSION MONITORING SYSTEM

534.01 - DESCRIPTION

This section covers corrosion monitoring system intended to provide protection against corrosion for PCCP, and steel waterlines, when called for on the plans or specified.

534.01.01 - GENERAL

The contractor shall provide corrosion engineering services and shall design, furnish, and install a corrosion monitoring system for steel or embedded type pre-stressed concrete cylinder pipe. All design, installation, and testing shall be consistent with sound corrosion engineering practice as determined by the Engineer. The corrosion engineer designing the system shall be NACE certified.

534.01.02 - REQUIREMENTS

A) Steel Cylinder Bonding - For PCCP, bonds shall be provided between the steel cylinders of adjacent pipe sections and all non-insulating joints as necessary to assure electrical continuity except where electrical isolation is necessary or required. The joint bonds shall be designed with sufficient slack to allow for some joint displacement and rotation.

Two steel bonding clips per joint shall be placed at the spring line of the pipe. The increase in electrical resistance due to the joint bonds per one hundred (100') feet of pipe shall not exceed two hundred and fifty (250%) percent when compared to the electrical resistance of one hundred (100') feet of pipe when calculated as follows:

$$I = \left(1 + \frac{R_B}{R_p}\right)100$$

Where:

I = percent increase in electrical resistance

R_B = resistance in ohms of the joint bonds per 100 feet of pipe

R_p = resistance in ohms per 100 feet of pipe when calculated as follows:

$$R_p = \frac{0.2158}{W_p}$$

W_p= weight of steel in 1 foot length of pipe

The effective resistance of parallel circuit, pre-stress wire path and cylinder path, shall be used as R_p for embedded cylinder pre-stressed concrete pipe.

Bonds shall consist of insulated copper or steel cable metallurgically welded or brazed to adjacent cylinders. All bare copper and steel shall be insulated by approved means.

B) Pre-stress Wire Bonding - For PCCP, intermediate bonds for pre-stress wire of embedded cylinder shall also be provided as required to minimize attenuation. The intermediate bonds shall be in the form of steel straps embedded in the outer surface of the concrete core directly upon which the pre-stress wire is tightly wound. The size and number of straps shall be designed to provide uniform current distribution to all embedded metallic surfaces of the pipe.

C) Electrical Isolation - Electrical isolation in the form of either flexible or rigid insulating fittings as specified herein shall be provided as required to obtain electrical discontinuity at:

1. The beginning and end of all portions of the pipeline to be monitored.
2. Joints where the line-pipe is joined to steel manifolds or steel pipe.
3. Joints where steel or ductile iron or nonferrous metals are joined to structures other than air valves, blo-off valves, and turnouts.
4. All points where ductile iron is joined to PCCP.

D) Flexible Insulating Fittings - Flexible insulating fittings required shall be plastisol or epoxy coated adapter units or approved equal.

E) Rigid Insulating Fittings - Rigid insulating fittings required shall be flanged joints with full-faced neoprene phenolic gaskets, polyethylene sleeves and steel washers backed with insulating micata washers or an approved equal.

F) Corrosion Test Stations - Corrosion test stations shall be installed meeting the following requirements:

1. Locations
   a. All buried line crossings.
   b. The beginning and end of the portions of the pipeline to be monitored.
   c. Both sides of insulated fittings.

d. Intermediate locations along the line, such that test stations are no more than 1200 feet apart.

e. Casing and carrier pipe.

f. Corrosion stations shall be installed on both the carrier pipe and the casing at both ends of the metallic casings.

2. Types

a. Two-Wire Type - Test stations may be of the two-wire type with one of the wires being No. 6 AWG or larger such that it can be used for bonding. The other wire, for determining pipe-to-soil potentials, shall be No. 12 AWG or larger. Both leads shall be continuous (without splices) and laid with sufficient slack to prevent stress. The leads shall be insulated with 600-volt rated solution suitable for direct burial. Prior to backfilling, the insulation shall be inspected for defects. All defects shall be repaired by approved methods.

b. Flush Type - Test stations may be of the flush type (terminals below grade) or above-surface type, protected as required for permanency. The flush type shall be installed in developed, urban areas (streets, alleys, sidewalks, etc.) and above-surface type (mounted on a post) shall be installed in undeveloped open areas; where possible, test stations shall be located at or closely adjacent to clearly identifiable topographical features (fences, line, road, intersection, section line, etc.) of the pipeline right of way.

G) Testing - The contractor shall perform tests as required to determine the following, and to correct corrosion monitoring system to comply with these specifications.

a. Pipeline electrical continuity.
b. Effectiveness of insulating joints.
c. Test station integrity.
d. Static pipe-to-soil potentials at each test station.
e. Soil resistivity at each test station.

534.06 – METHOD OF MEASUREMENT

Payment for Corrosion Monitoring System shall be made at the unit price per lump sum. Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

534.07 – BASIS OF PAYMENT

Unless otherwise called out on plans, the item measured as provided above will be paid for at the contract unit price bid:

CORROSION MONITORING SYSTEM L.S.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 590 - WATER CONSTRUCTION STANDARD BID ITEMS

590.01 - DESCRIPTION

This section covers Standard Bid Items used in the contract documents for the construction of waterlines and their appurtenances. Additional bid items may be called out in the Special Provisions, other sections of the Standard Specifications, or as directed by the Engineer for additional work covered and change orders.

SECTION	DESCRIPTION	UNIT
505	(SIZE) (TYPE) WATERLINE PIPE (JOINT TYPE) (NOM WALL THICK)	L.F.
505	FITTINGS (SIZE AND TYPE)	LBS.
505	FITTINGS (SIZE AND TYPE)	EA.
510	WATER SERVICE LINE CONNECTION (SIZE)	EA.
511	WATER SERVICE LINE SINGLE (SIZE)	EA.
511	WATER SERVICE LINE DOUBLE (SIZE)	EA.
511	WATER SERVICE LINE SHORT(SIZE)	EA.
511	WATER SERVICE LINE LONG (SIZE)	EA.
511	WATER SERVICE LINE EXTRA LONG (SIZE)	EA.
512	METER RELOCATION (SIZE)	EA.
513	WET CONNECTION (SIZE)	EA.
514	(SIZE) TAP	EA.
516	FIRE HYDRANT	EA.
517	REMOVAL OF FIRE HYDRANT	EA.
518	THRUST BLOCK	EA.
519	BLOW-OFF CONNECTION (SIZE)	EA.
520	(SIZE) (TYPE) VALVE AND VALVE BOX	EA.
520	(SIZE) (TYPE) VALVE AND VAULT	EA.
522	HYDROSTATIC PRESSURE TESTING AND DISINFECTION	L.SUM
524	DUCTILE IRON PIPE (SIZE)	L.S.
529	RESTRAINED JOINT (SIZE)	EA.
530	CLOSURE PIECE (SIZE)	EA.
531	THRUST COLLARS (SIZE)	EA.
532	TAPPING SLEEVE (SIZE)	EA.
533	TAPPING SADDLE (SIZE)	EA.

SECTION 591 - WATERLINE CONSTRUCTION STANDARD DETAILS

591.01 - DESCRIPTION

This section covers Standard Details used as a supplement to the plans and specifications for the construction of waterlines and their appurtenances.

I D NUMBER	TITLE
SD NO. 1	STANDARD DETAIL FOR INSTALLATION OF RIGID PIPES
SD NO. 2	STANDARD DETAIL FOR INSTALLATION OF FLEXIBLE PIES
SD NO. 3	STANDARD DETAIL FOR INSTALLATION OF DUCTILE IRON PIPES
SD NO. 4	STANDARD DETAIL FOR PLAIN CONCRETE CRADLE
SD NO. 5	STANDARD DETAIL FOR REINFORCED CONCRETE CRADLE
SD NO. 6	STANDARD DETAIL FOR PLAIN CONCRETE ARCH
SD NO. 7	STANDARD DETAIL FOR REINFORCED CONCRETE ARCH
SD NO. 8	STANDARD DETAIL FOR EMBEDMENT PLUG
SD NO. 9	STANDARD DETAIL FOR INSTALLATION OF SUBDIVISION METER
SD NO. 10	STANDARD DETAIL FOR INSTALLATION OF SUBDIVISION METER
SD NO. 11	STANDARD DETAIL FOR INSTALLATION OF SUBDIVISION METER
SD NO. 12	STANDARD DETAIL FOR SERVICE REPLACEMENT
SD NO. 13	STANDARD DETAIL FOR BORING
SD NO. 14	STANDARD DETAIL FOR COMBINATION DETECTOR AND METER PIT
SD NO. 15	STANDARD DETAIL FOR METER PIT COVER
SD NO. 16	STANDARD DETAIL FOR FIRE HYDRANT NOZZLE THREADS
SD NO. 17	STANDARD DETAIL FOR GUARD POST
SD NO. 18	STANDARD DETAIL FOR DETECTOR CHECK WITH HYDRANT AND STANDPIPE
SD NO. 19	STANDARD DETAIL FOR DETECTOR CHECK AND STANDPIPE
SD NO. 20	STANDARD DETAIL FOR DOUBLE DETECTOR CHECK
SD NO. 21	STANDARD DETAIL FOR INSTALLATION OF FIRE HYDRANT
SD NO. 22	STANDARD DETAIL FOR INSTALLATION OF FIRE HYDRANT ON EXISTING MAIN
SD NO. 23	STANDARD DETAIL FOR METER PIT FOR DOUBLE DETECTOR CHECK
SD NO. 24	STANDARD DETAIL FOR TAPPING SLEEVE BLOCKING
SD NO. 25	STANDARD DETAIL FOR DRIVEWAY AND PAVING CUT PERMANENT REPAIR
SD NO. 26	STANDARD DETAIL FOR REMOVAL OF FIRE HYDRANTS
SD NO. 27	STANDARD DETAIL FOR REVERSE TAP
SD NO. 28	STANDARD DETAIL FOR 1" & 2" AIR VACUUM VALVES, ¾" AIR RELEASE VALVES
SD NO. 29	STANDARD DETAILS FOR 2" BLOW-OFF
SD NO. 30	STANDARD DETAILS FOR CAST IRON VALVE BOX AND LID
SD NO. 31	STANDARD DETAILS FOR THRUST BLOCKS
SD NO. 32	STANDARD DETAILS FOR 4" AIR VACUUM AND RELEASE VALVE
SD NO. 33	STANDARD DETAILS FOR SERVICE REPLACEMENT
SD NO. 34	STANDARD DETAILS FOR INSTALLATION OF SUBDIVISION METER
SD NO. 35	STANDARD DETAILS FOR INSTALLATION OF SUBDIVISION METER
SD NO. 36	STANDARD DETAILS FOR INSTALLATION OF SUBDIVISION METER
SD NO. 37	STANDARD DETAILS FOR REMOVING AND REPLACING ALLEY AND SIDEWALK PAVEMENT

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SECTION 600

SECTION 600 – SANITARY SEWER CONSTRUCTION

SECTION 600 – GENERAL REQUIREMENTS

600.01 – DESCRIPTION

This section covers general construction requirements of sanitary sewers and sewer appurtenances as described herein.

600.01.01 – PREQUALIFICATION

As a minimum, all Contractors and Bidders shall meet the prequalification requirements of the City's Prequalification Board, and be prequalified to perform work in the "Sanitary Sewer ALL Construction" Category. Prequalification for additional categories of work, when required may be specified in the Special Provisions.

600.02 – MATERIALS

Construction materials shall not be delivered to the site of the work more than three (3) days in advance of their anticipated use nor shall the quantity of pipe or other materials on hand at the site of the work at any time be in excess of the amount required to complete three hundred (300) feet of sewer unless with special permission of the Engineer.

Unless otherwise specified, all concrete used in construction of sewers and their appurtenances shall have a minimum twenty-eight (28) day compressive strength of thirty-five (3,500 psi) pounds per square inch and shall conform with the applicable requirements of Section 900. All steel reinforcement used shall be grade sixty (60) with a minimum yield strength of sixty thousand (60,000 psi) pounds per square inch and meet the applicable material requirements of Section 900.

600.04 – ORDER OF CONSTRUCTION

The Contractor shall start at enough different locations to complete the entire contract within the time limit specified. The construction of all sewers shall begin at the low point in the line in every case working toward the high point. When the construction involves the building of main or submain sewers having one or more lateral or tributary, the construction of tributary lines shall not be started until the main or submain sewer has been completed to the point where the tributaries or laterals discharge into it, except as may be approved by the Engineer. Approval by the Engineer does not relieve the Contractor of any responsibility for meeting the specified connections.

Sewer appurtenances shall be constructed as soon as the sewer that they serve is constructed to their locations. The postponing of the construction of appurtenances until the sewer line has been completed, or the building of appurtenances in advance of the construction of the sewer line, will not be permitted.

The construction of sewers eighteen (18) inches in diameter and smaller for more than six hundred (600) feet, and sewers twenty-one (21) inches in diameter and larger for more than three hundred (300) feet in advance of appurtenances which are incomplete or the construction of which has not been started, will not be permitted.

Unless otherwise directed by the Engineer, the Contractor shall leave no more than nine hundred (900) feet between backfilling operations and the complete restoration of paving, paving repairs, fencing, sodding, etc.

When temporary surfacing is provided for in the contract documents, the Contractor shall complete temporary paving repair as per Section 824 immediately before backfill is completed.

600.04.01 – TEST HOLES

Test hole information, when shown on the plans or included in the specifications, shall only represent subsurface characteristics to the extent indicated, and only for the point location of the test hole.

Each bidder shall make his own interpretation of the character and condition of the materials that will be encountered between test hole locations. Each prospective Bidder may, at his own expense, make additional surveys and investigations as he may deem necessary to determine conditions which will affect performance of the work.

600.04.02 – SEWER GRADES

General - The grade line shown on the plans is the elevation of the invert or flow line of the sewer. The sewer grade shall be established by use of laser beam, or other methods approved by the Engineer.

Laser Beams - When laser beams are used to establish line and grade, they shall first be calibrated in accordance with the equipment manufacturers recommended procedures. The Contractor shall establish horizontal and vertical controls (offset stakes) with a transit or theodolite or any other equipment approved by the Engineer. The Contractor may then proceed to establish line and grade using the laser equipment. In conjunction with the laser beam, the Contractor may also be required to provide temporary benchmarks at intervals as specified by the Engineer.

600.04.03 – STOPPERS OR BULKHEADS

Dead ends of all sewers, wyes, tees, etc., shall be closed with approved stoppers securely cemented in place. When shown on the plans or required by the Engineer, such openings shall be tightly walled up with brick masonry or concrete. Tight fitting stoppers or bulkheads shall be securely placed in or across the end of all sanitary sewer lines when construction is stopped at the end of each day's work or for any other cause. When work is stopped temporarily on sanitary sewers twenty-four (24) inches in diameter and smaller, the exposed end of the pipe shall be closed to prevent trash or debris from entering the pipe. Such stoppers need not be watertight.

600.04.04 – SURFACE DRAINAGE STRUCTURES

When not called for on the plans or specified as separate bid item, all surface drainage structures and appurtenances shall be removed and replaced in a condition equal to or better than the original installation when required. No additional compensation shall be made for this work, and the cost of same shall be included in the other pay items.

600.04.05 – TEMPORARY SEWER AND DRAIN CONNECTIONS

When existing sewers have to be taken up or removed, the Contractor at his own expense, shall provide and maintain temporary outlets and connections for all private or public drains, sewers or sewer inlets. He shall also take care of all sewage and drainage which will be received from these drains, sewers and sewer inlets; and for this purpose he shall provide and maintain at his own expense, adequate pumping facilities and temporary outlets or diversions. He shall construct such trough, pipe or other structures necessary and be prepared at all times to dispose of drainage and sewage received from these temporary connections until such time as the permanent connections are built and in service. The existing sewers and connections shall be kept in service and maintained under the contract, save where specified or ordered to be abandoned by the Engineer. All water or sewage shall be disposed of in a satisfactory manner so that no nuisance is created and that the work under construction will be adequately protected.

600.04.06 – CLEANUP

After installation of each section of sewer line, the Contractor shall remove all spoils resulting from work, debris, construction materials and equipment from the site of work, grade, and smooth over surfaces on both sides of the line, and leave the right-of-way in a clean, neat, and serviceable condition prior to sodding.

SECTION 610 - PIPE INSTALLATION

610.01 - DESCRIPTION

This section covers installation of pipes in open-cuts, in conformity with the lines, grades, and dimensions and as provided in applicable sections of these specifications.

610.02 – PIPE MATERIALS

610.02.01 - PIPE

Acceptable pipe materials and fittings shall meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Rigid	Reinforced Concrete Pipe (RCP)	647
	Vitrified Clay Pipe (VCP)	649
Flexible	Ductile-Iron Pipe (DIP)	650
	High Density Polyethylene (HDPE) Pipe	651
	Polyvinyl Chloride (PVC) Pipe	652
	Reinforced Fiberglass Pipe (RFP)	653

610.02.02 - EMBEDMENT MATERIAL

General - Embedment material shall meet the requirements of Section 215. Prior to delivery, the Contractor shall submit laboratory tests for materials to be used for embedment, and backfill. The Engineer prior to placement shall approve materials.

Invoices - The Contractor shall submit invoices for the purpose of complying with the minimum quantities necessary to complete installation pursuant to the appropriate standard details and the minimum dimensions specified.

610.04 – CONSTRUCTION METHODS

610.04.01 – BEDDING AND HAUNCHING

Rigid Pipes - All rigid pipes shall be embedded in accordance with ASCE Manual No. 60, "Gravity Sanitary Sewer Design and Construction", Class "B" Bedding and in accordance with the dimensions and lines shown on the "Standard Detail for Installation of Rigid Pipes" and meeting the requirements of Section 215.

Flexible Pipes - All flexible pipes shall be embedded in accordance with ASTM D-2321, "Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe", and in accordance with the dimensions and lines shown on the "Standard Detail for Installation of Flexible Pipes" and meeting the requirements of Section 215.

610.04.02 - INSTALLATION REQUIREMENTS

Shipping, Handling and Storage - Pipe shall be transported from the plant, where it is manufactured, to the job site employing special methods of packaging to prevent damage to the pipe. After the pipe is received at the job site, it shall be carefully inspected for any damage that may have occurred in transit. The pipe shall be handled at all times with care using padded slings or hooks. The pipe shall not be dropped, skidded or rolled against pipe already on the ground. If any damage occurs to pipe, the pipe

shall be rejected. All pipe and accessories shall be stored on flat, level ground with no rocks or other objects under the pipe. Gaskets for push-on joints and pipe shall be stored in cool location out of direct sunlight in accordance with the manufacturer's recommendations.

Quality of Work - Watertight joints, first grade material and accurate construction shall be required. Furthermore, utmost care shall be exercised in laying pipe to line and grade, constructing inverts in manholes, transitions, drop manhole connections and etc.

Pipe Foundation - No sewer shall be laid unless the foundation is in a condition satisfactory to the Engineer. Where trenches are excavated in soft, unsuitable soil, or rock, trench bottom shall be stabilized in accordance with Section 212 when directed by the Engineer.

Laying Requirements - All pipes, specials, fittings and other appurtenances shall be examined carefully for damage and other defects before installation. The City retains the right to reject damaged and defective materials.

The pipe ends shall be free of all lumps, blisters and they shall be wiped clean of foreign materials such as dirt and sand before installation.

Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells uphill, using laser beams or other methods approved by the Engineer pursuant to Section 505.

Bell holes for bell-and-spigot pipe shall be excavated at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper installation of pipe. Bell holes shall not be excavated more than ten (10) joints ahead of pipe laying. Filling and ramming earth or other material beneath the pipe to raise it to grade shall not be permitted.

The Contractor shall use every precaution at all times during construction of the pipeline. All pipe, specials, fittings, and other appurtenances shall be lowered carefully into the trench with suitable equipment, to prevent damage to the sewer main materials. In rock trenches, plywood shields or other approved means shall be used to prevent the cradled pipe from swinging against the sides of the trench.

All joint preparation and joining operations shall comply with the instructions and recommendations of the pipe manufacturer and meet the joint requirements in the appropriate material section. For reinforced concrete pipe the position of the rubber gasket shall be checked with a feeler after each joint is completed. Additionally, when laying reinforced concrete pipe, the maximum joint opening shall not exceed three-eighths (? ") inch. Rubber gaskets shall be positioned on the joint in accordance with the manufacturer's recommendations. Immediately before joints are pushed together, all joint surfaces shall be coated with the lubricant furnished with the pipe.

Any damage to the pipe, from any cause during installation of the pipeline shall be cause for replacement, as directed by the Engineer, and at the expense of the Contractor.

After a section of pipe is properly installed and approved for backfill, the trench shall be backfilled and compacted as per section 212.

610.06 – METHOD OF MEASUREMENT

Payment for "Sanitary Sewer Pipe" shall be made at the unit price bid per lineal foot of pipe installed for each size. The price established shall be full compensation for all materials including pipe, material, labor, tools, equipment and incidentals necessary to complete this item of work. Payment shall not include the cost of trench excavation and backfill nor foundation material.

Measurement for "Sanitary Sewer Pipe" shall be from station to station through manholes, junction boxes and other small structures.

610.07 - BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SANITARY SEWER PIPE (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications. Embedment material shall be paid for under Section 215.

SECTION 611 – SEWER SERVICE CONNECTION

611.01 – DESCRIPTION

This section covers construction of sewer service connections where called for on the plans or as directed by the Engineer.

611.02 – MATERIALS

611.02.01 – PIPE MAT ERIALS

Acceptable pipe materials and fittings shall meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Rigid	Vitrified Clay Pipe (VCP)	649
Flexible	* Ductile-Iron Pipe (DIP)	650
	Polyvinyl Chloride (PVC) Pipe	652

* Not to be used for wye branches but for risers only.

611.02.02 – CONNECTION TYPES

The following connection types may be required to make sewer service connections:

External Connections for New Construction

Wye Branches - For new construction there shall be installed wye branches of size and type shown on the plans with a minimum of four inch (4”) openings at locations shown on the plans or as designated by the Engineer.

External Connections to Existing Main - Connections to existing main may be accomplished as follows:

Saddles - Connections may be made by excavating to the existing main and cutting a hole using approved equipment and installing a saddle. When existing main has been rehabilitated by a trenchless method of construction, the saddle connection shall be made to the trenchless pipe and/or liner.

Tees - Connections may be made by removing a section of the existing pipe and installing a tee.

Wye Branches - Connections may be made by removing a section of the existing pipe and installing a wye branch.

Fittings, riser, and closure assembly shall be used to make the connection and shall be supplied in a nominal diameter a minimum of four inches (4”). The external connections shall be considered complete when backfilling and subsequent surface restoration is completed.

Internal Connections (Reinstatements) – Shall not be allowed.

611.02.03 – RISER

General - Risers shall be connected to sewer pipe using standard wyes, tees or saddles. No services may be connected to sewer pipe that is twenty-one inches (21”) and larger in diameter unless directed

by the Engineer. The concrete encasement support and collar shall be required in all cases and constructed in accordance with the following schedule:

Pipe Nominal Size (inches)	Depth of Encasement (feet)	Width of Encasement (feet)	Length of Encasement (feet)
8	1.5	2.2	2.0
10	2.0	2.2	2.0
12	2.0	2.2	2.0
15	2.5	2.6	2.0
18	3.0	3.0	2.5

Riser Construction - Particular care shall be exercised in cutting the sewer pipe so that no damage is done to the pipe and its strength impaired by shattering or cracking of the pipe wall. The end of the fitting shall not protrude beyond the inside surface of the sewer main. The annular space around the fitting shall be completely filled and smoothly finished with Class "C" mortar with type II cement. The backfill shall be thoroughly compacted under and above the pipe in the main sewer trench and up to at least the top of the concrete riser support. The backfill around the vertical pipe shall be carefully placed and tamped avoiding disturbance of the alignment of the pipe and damage to the joints. The vertical pipe shall be anchored to sewer trench wall with one-fourth inch (1/4") round hairpin bars.

A locator tape, green in color, and stating "CAUTION - SANITARY SEWER RISER PIPE BURIED BELOW" shall be attached to the sanitary sewer riser and extend to a minimum of two feet (2') above ground. The tape shall be three inch (3") width DuraTec as manufactured by THOR Enterprises, Inc. of Sun Prairie, Wisconsin or approved equal.

611.04 – CONSTRUCTION METHODS

General - All work shall be constructed in accordance with the "Standard Detail for Sanitary Sewer Connection". Unless otherwise specified, sanitary sewer connections shall be installed so that a plane through the center of the branch and the centerline of the main sewer shall make an angle of forty-five (45º) degrees with the horizontal. One (1) cubic foot of concrete shall be placed around each connection, the cost of which shall be included in other items.

Wye Branches - Sewer Service Connections constructed with wye branches shall include a one-eighth (1/8º) degree bend, elbow, and when required, a closure piece.

Tees - Sewer Service Connections constructed with tees shall include a one-eighth (1/8º) degree bend, and when required, an elbow and a closure piece.

Saddles - Sewer Service Connections constructed with saddles shall include straps, a one-eighth (1/8º) degree bend, and a closure piece.

611.06 – METHOD OF MEASUREMENT

Payment for "Sewer Service Connection" shall be made at the unit price bid for each external connection. The price established shall be full compensation for all material, labor, equipment, trench excavation, backfill, and incidentals necessary to complete this item of work.

When external sewer service connections are made in conjunction with installation of Formed-In-Placed Pipe (FIPP) per Section 617. Payment for external sewer connection shall be made at the unit price bid for each "Point Repair" regardless of depth. External connection (reinstatement) of services shall be considered incidental to the lining process and the cost shall be included in other items. The price established for "Point Repair" shall be full compensation for all material, labor, equipment, trench excavation, backfill, and incidentals necessary to complete this item of work.

Payment for "Riser Pipe" shall be made at the unit price bid per lineal foot of pipe for new sewer construction. The price established shall be full compensation for materials, labor, tools, equipment

and incidentals necessary to complete this item of work.

Payment for "Riser Pipe" for replacement and/or rehabilitative sewer construction shall not be made directly, but shall be included in the cost for "Sewer Service Line" as described in Section 612.

611.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SEWER SERVICE CONNECTION	EA.
RISER PIPE	L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 612 – SEWER SERVICE LINE

612.01 – DESCRIPTION

This section covers service lines for future or existing connections. The service line shall be installed to a point where an acceptable connection can be made to the existing service if necessary. Pipe shall be supplied in nominal diameter a minimum of four inches (4”).

612.02 – MATERIALS

Acceptable pipe materials and fittings shall meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Rigid	Vitrified Clay Pipe (VCP)	649
Flexible	Ductile-Iron Pipe (DIP)	650
	Polyvinyl Chloride (PVC) Pipe	652

612.04 – CONSTRUCTION METHODS

The installation of a service line includes removing any cap or plug from existing riser, cutting and removing any existing service line, and reconnecting the riser and the existing service line if necessary.

612.06 – METHOD OF MEASUREMENT

Payment for "Sewer Service Line" shall be made at the unit price bid per lineal foot of pipe, including closure piece, and when required, adapters and other fittings. The price established shall be full compensation for all material, labor, tools, equipment and incidentals necessary to complete this item of work.

612.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SEWER SERVICE LINE	L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 613 - DELETED

SECTION 614 – ABANDONING SEWER

614.01 – DESCRIPTION

This section covers filling of abandoned sewer lines with grout or concrete.

614.02 – MATERIALS

The materials shall meet the requirements of Section 218.02 for “Flowable Fill Plugs”.

614.06 – METHOD OF MEASUREMENT

Payment for "Abandoning Sewer" shall be made at the unit price bid per cubic yard. The price established shall be full compensation for furnishing and placing all materials, labor, tools, equipment and incidentals necessary to complete this item of work.

614.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

ABANDONING SEWER C.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 615 – PIPE BURSTING

615.01 – DESCRIPTION

This section covers furnishing and installation of pipe by trenchless method of bursting existing pipes as shown on the plans and in conformity with these specifications. The operation shall be conducted with a hydraulic pulling or pushing apparatus and a pipe expander (i.e. pig and swab). The pipe expander shall be pushed or pulled through the existing pipe on grade, widening the existing pipe material for insertion of the new pipe material.

615.02 – MATERIALS

615.02.01 – SUBMITTALS

The Contractor shall furnish for the Engineer's approval, a plan showing his proposed method of handling, including the design for the equipment, equipment support of backstop, arrangement and position of jacks, pipe guides, etc., complete in assembled position. The approval of this plan by the Engineer will not relieve the Contractor from his responsibility to obtain the specified results.

615.02.01 – PIPE MATERIALS

Acceptable pipe materials and fittings shall meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Flexible	High Density Polyethylene (HDPE) Pipe	651
	Polyvinyl Chloride (PVC) Pipe	652

615.04 – CONSTRUCTION METHODS

615.04.01 – GENERAL

Where pipe is required to be installed under railroad embankments or under highways, streets, or other facilities by trenchless methods, construction shall be made in such a manner that will not interfere with the operation of the railroad, street, highway, or other facility, and shall not weaken or damage any embankment or structure. During construction operations, barricades and lights to safeguard traffic and pedestrians shall be furnished and maintained, as directed by the Engineer, until such time as the backfill has been completed and then shall be removed from the site.

The Contractor shall take proper precautions to avoid excavating earth or rock or shattering rock beyond the limits of excavation shown on the plans. All damages caused by excavating or blasting, either to surface or subsurface structures, shall be repaired or replaced by the Contractor at his own cost and expense.

Suitable pit shafts, or trenches shall be excavated for the purpose of conducting the trenchless operations and for placing end joints of the pipe. Wherever end trenches are cut in the sides of the embankment or beyond it, such work shall be sheeted securely and braced in a manner satisfactory to the Engineer to prevent earth caving.

The removal of any obstruction that may be found to conflict with the placing of the pipe shall not be measured for payment nor paid for as a separate contract pay item. The removal of any such obstruction shall be included in the cost of other items.

Once the pipe installation has commenced it shall be continued uninterrupted around the clock until the pipe has been installed between the specified limits.

Any pipe damaged during operations shall be removed and replaced by the contractor at his expense.

The pits or trenches excavated to facilitate the operations shall be backfilled immediately after the pipe has been installed.

615.04.02 – SEWER SERVICE CONNECTIONS

All sewer service connections shall be accomplished and paid for in accordance with Section 611.

615.06 – METHOD OF MEASUREMENT

"Pipe Bursting" shall be measured by the lineal foot of pipe completed. Payment for "Pipe Bursting" shall be made at the unit price bid per lineal foot of pipe for each size. The price established shall be full compensation for all materials, including pipe, labor, tools, equipment and incidentals necessary to complete this item of work.

615.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

PIPE BURSTING (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 616 – SLIPLINING

616.01 – DESCRIPTION

This section covers rehabilitation of deteriorated sewer lines by trenchless method of sliding a liner pipe of smaller diameter into an existing circular pipeline, then if required, re-establishing service connections to the new liner pipe.

616.02 – MATERIALS

616.02.01 – SUBMITTALS

General - The Contractor shall submit source of materials for the specified liner pipe, or proposed liner pipe when alternate materials are specified. No liner pipe shall be shipped to job site until all submittals have been reviewed and approved by the Engineer.

Construction and Laying Schedule - The Contractor shall submit an area map of the project designating the beginning and ending points as well as complete pipe laying and time schedule and detail drawings. The map shall also indicate the access points, length, and pipes to be installed. Unless surveyed plans accompany project specifications, all elevations shall be determined and included in the Schedule. This shall include verification of all elevations on as-built drawings when such information is provided. No pipe, special sections and fittings shall be manufactured until all submittals have been reviewed and approved by the Engineer. The drawings and data shall include but not be limited to the following for each size and class of pipe.

1) Details of the proposed pipe.
2) Properties, strengths, etc. of pipe
3) Details of joints.

Certification of Material Compliance - A signed letter from the manufacturer stating that all material satisfies claims made by the manufacturer and meets the requirements specified. Reports of the plant test including, but not limited to, liner thickness, flexural strength, and flexural modulus shall be submitted. A registered Professional Engineer shall certify submittals.

Insertion or Access Pits - The location and number of insertion or access pits shall be planned by the Contractor and submitted in writing for approval by the Engineer prior to excavation. The pits shall be located such that their total number shall be minimized, and the footage of liner pipe installed in a single pull shall be maximized. Locations of damaged pipe shall be used for insertion pits as directed by the Engineer.

Sealing Compound and Grout - The Contractor shall submit proposed sealing compounds to be used for sealing liner pipe at the manholes and type of grout and grouting equipment to be used.

Jacking Loads - The Contractor shall submit a complete record of all jacking loads for the insertion of the pipe liner. This information shall be submitted to the Engineer for review after each insertion operation.

Copies - The Contractor shall submit six (6) copies of all submittals requested in these specifications.

616.02.02 – LINER PIPE MATERIALS

Acceptable liner pipe materials are as follows and shall meet the requirements of the appropriate sections indicated below:

Pipe Type	Pipe Material	Section
Rigid	Vitrified Clay Pipe (VCP)	649
Flexible	High Density Polyethylene (HDPE) Pipe	651
	Polyvinyl Chloride (PVC) Pipe	652
	Reinforced Fiberglass Pipe (RFP)	653

616.04 – CONSTRUCTION METHODS

616.04.01 – CLEANING SEWER LINES

Cleaning sewer lines shall be accomplished in accordance with Section 619.

616.04.02 – SEWER FLOW CONTROL

Sewer flow control shall be accomplished in accordance with Section 618.

616.04.03 – POINT REPAIR

Point repairs shall be accomplished in accordance with Section 622. Segments between two consecutive manholes that require more than five (5) point repairs for successful rehabilitation may be deleted, by the Engineer, from the specified work. At the discretion of the Engineer, these segments may be replaced by conventional excavation in accordance with Section 212.

616.04.04 – INSPECTION OR ACCESS PIT EXCAVATION & BAC KFILL

Before excavation is begun, it shall be the responsibility of the Contractor to check with the various utility companies and determine the location of the utilities in the vicinity of the work area. The Contractor at no cost to the City shall arrange temporary construction easements and/or right-of-way areas.

All excavations shall be properly sheeted and shored in accordance with relevant specifications for trench safety systems. Any damage resulting from improperly shored excavations shall be corrected to the satisfaction of the Engineer with no compensation due to the Contractor.

All open excavations shall be kept secure at all times by the use of barricades with appropriate lights and signs, construction tape, covering with steel plates, etc., or as directed by the Engineer.

The cost for diversion pumping required around an insertion pit, from a manhole upstream to a manhole downstream, shall be per applicable item of these specifications.

Excavations initially begun as Point Repairs that, for convenience, are later used as Insertion Pits, shall be treated as incidental to sliplining. If the point repair excavation is used as an insertion pit, the Contractor shall not be required to replace the carrier pipe.

Excavation and backfill of insertion or access pits shall be accomplished pursuant to Section 212.

616.04.05 – LINER PIPE INSERTION

The insertion and installation of the liner pipe shall be in accordance with appropriate ASTM Standard Specifications and the Manufacturer's Recommendations.

The liner pipe shall be aligned in contact with the invert of the existing sewer. If more than one-third (1/3) of the top profile of the existing sanitary sewer line is not intact and cavities exist above the pipe, the condition of the sewer line shall be considered unsuitable and the sliplining operation shall not be performed.

The Contractor shall maintain sewage flow at all times. This may be accomplished by allowing flows to pass through the liner pipe. By-pass pumping may also be allowed.

Liner pipe shall not be installed prior to the Engineer's approval. The liner pipe shall be jacked, pushed or pulled, in case of a butt-welded polyethylene liner pipe (with no exceptions), into the existing pipe. An aqueous solution of Bentonite may be used to minimize the jacking load. For each section to be lined, insertion shall be one continuous operation until the planned termination point is reached. Precautionary measures shall be taken to insure against scarring the liner or breaking the joints. It shall be necessary to use a nose-cone to guide the pipe end past minor obstructions and prevent entry of debris and to put guards over the edges of the existing pipe at the inlet end to prevent their gouging the pipe during the insertion procedure. Once the insertion is initiated, it shall continue to completion without interruption.

Total jacking loads shall not exceed the manufacturer's recommendations. The Contractor shall provide a suitable means of measuring jacking loads, and shall monitor the load as the liner pipe is being installed. If at any time the load appears to rise non-uniformly, indicating possible obstruction of the pipe, jacking operations shall be terminated and the obstruction or other impediment removed before continuing.

Permanent bends to accommodate line or grade changes shall be limited to radii equivalent to a longitudinal strain recommended by the pipe manufacturer. At no time shall this minimum allowable radius of curvature be exceeded.

The Engineer shall approve equipment employed in the sliplining process. A hydraulic or cable operated winching pipe pushing device may be used. The machine operator must closely and continuously monitor and control the jacking load in uniformity and magnitude. A jacking ring or device shall be used to distribute the jacking load evenly over the entire surface perimeter of the pipe end. The Contractor shall also utilize a device that holds stable a nearly inserted joint preventing damage to it while the following joint is shoved home. All joint operations shall be made in full view of the inspector. The maximum pulling length recommended by the manufacturer shall not be exceeded.

After insertion, the pipe shall be allowed to normalize for the number of hours suggested by the pipe manufacturer to the temperature of the ground as well as recover any imposed strain before cutting the pipe to length between manholes.

616.04.06 – LINER PIPE SEALING

The annular space between the liner and the existing sewer main must be sealed at each manhole with a chemical seal and non-shrink grout. Oakum soaked in Scotchseal 6500, or 3-M Elastomeric Compound (CR-202) or approved equal, shall be placed in a band to form an effective watertight gasket in the annular space between the liner and the existing pipes in the manholes. The width of the band shall be a minimum of twelve inches (12”) or one-half (1/2) the diameter of the pipe, whichever is greater. It shall be finished off with a non-shrink grout placed around the annular space from inside the manhole and shall not be less than six inches (6”) wide. The Engineer shall approve the chosen method, including chemicals and materials. The Contractor shall cut the liner so that it extends four inches (4”) into the manhole. The Contractor shall make a smooth, vertical cut and slope the area over the top of the exposed liner using non-shrink grout. The Contractor shall also use cementitious grout to form a smooth transition with a reshaped invert and a raised manhole bench such that neither the sharp edges of the liner pipe, nor the concrete bench, nor the channeled invert shall exist to catch debris and create a stoppage. The invert of the manhole shall also be reworked (smoothed and built-up) to match the flow line of the new liner.

The liner pipe shall be allowed to normalize to ambient temperatures as well as recover from any imposed strain, in accordance with the manufacturer's recommendation before being cut to fit between manholes and proceeding with reshaping and/or smoothing the manhole invert.

616.04.07 – LINER PIPE GROUTING

D**escription** - The annular space between the liner pipe and the existing pipe shall be sealed with a grout having good flow characteristics, minimum shrinkage, and permanence of support such as Haliburton's LG-3 or an approved equal grouting system. A minimum twenty-eight (28) day compressive strength of the grout shall be one thousand (1,000 psi) pounds per square inch or greater shall be required to assure the structural integrity of the rehabilitated pipe. The safe grouting pressure shall conform to the type and the requirements of the pipe used. The maximum grouting pressure shall be in accordance with the liner pipe manufacturer's recommendations.

The sealing compound shall be suitable for underwater application and have elastomeric properties. The annular space shall be one hundred (100%) percent filled, but particular attention must be paid to those areas just downstream of manholes to avoid air traps. Equipment for placement of grout shall be used so as to prevent segregation of the grout components and to cause the grout to flow around the liner and completely fill the voids in the annular space. Under no circumstances shall grout be dropped

down the shafts onto the liner. Grout shall not be permitted to rise in the vertical shafts more than two (2) feet above the top of the existing pipe. The Contractor shall have operable vibrators on the job to aid the flow of the grout. The Contractor shall have operable pumps on the job site to remove water from the vertical shafts as it is displaced by grout to prevent an excessive hydrostatic head on the liner. Pumping pressures during the grouting process must not exceed the collapse pressure of the liner pipe.

The Contractor shall install a vent pipe higher than the upper end of the pipe to ensure that the annulus is completely filled with grout.

Basis of Payment - The cost of grouting shall be incidental to sliplining for pipes fifteen inches (15") and smaller in size. For larger pipes, "Grouting" shall be paid for at the unit price bid per cubic yard. The price established shall be full compensation for all materials including grout, placement of grout, labor, tools, equipment and incidentals necessary to complete this item of work.

616.04.08 – SEWER SERVICE CONNECTIONS

All sewer service connections shall be accomplished and paid for in accordance with Section 611.

616.05 – TESTING

616.05.01 – TELEVISION INSPECTION

Television inspection shall be accomplished in accordance with Section 624.

616.05.02 – SMOKE TESTING

Smoke testing shall be accomplished in accordance with Section 620.

616.05.03 – DYE-WATER TESTING

Dye-water testing shall be accomplished in accordance with Section 621.

616.05.04 – SEWER LEAKAGE TESTING

Leakage testing shall be required after liner has been installed and prior to services being re-connected. Leakage testing shall be conducted in accordance with Section 625.

616.05.05 – ACCEPTANCE OF SLIPLINING

Final acceptance of sliplining shall be based on, but not be limited to, review of post-television inspection, leakage testing, and conformance with all provisions of these specifications as determined by the Engineer. The installed liner pipe shall be watertight, smooth, and free from wrinkles, as well as defects, and improper house connections. Should any of these defects occur, the line shall be excavated, repaired and/or replaced, and complete restoration shall be made to the satisfaction of the Engineer at no additional cost to the City.

616.06 – METHOD OF MEASUREMENT

"Sliplining" shall be measured along the pipe, through manholes, junction boxes, and other small structures. Payment for "Sliplining" shall be made at the unit price bid per lineal foot of line, for each size installed and shall include liner pipe, grout for pipe sizes fifteen (15) inches and smaller, and buildup, shaping and reworking the manhole invert, and sealing the annular space, equipment, labor, tools, and incidentals necessary to complete this item of work. Addition of inverts/benches, if none already exist, shall be considered incidental to the cost of "Sliplining".

616.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SLIPLINING (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 617 – FORMED-IN-PLACE PIPE (FIPP)

617.01 – DESCRIPTION

This section covers rehabilitation of existing deteriorated sewers by trenchless method of installing formed-in-place pipe (FIPP) as hereafter described.

617.02 – MATERIALS

617.02.01 – SUBMITTALS

General - The Contractor shall submit source of materials for the specified liner pipe, or proposed liner pipe when alternate materials are specified. No FIPP shall be shipped to job site until all submittals have been reviewed and approved by the Engineer.

Construction Schedule - The Contractor shall submit an area map of the project designating the beginning and ending points as well as the time frames for each inversion or insertion. The map shall also indicate the access manholes, length, and FIPP thickness to be installed for said inversions and/or insertion runs. Unless surveyed Plans accompany project specifications, all elevations shall be determined and included in the Construction Schedule. This shall include verification of all elevations on as-built drawings when such information is provided.

Certification of Material Compliance - A signed letter from the manufacturer stating that FIPP meets the requirements of these specifications. The Contractor/manufacturer shall submit Type "A" and "D" certifications for the material.

Quality Control Reports - The manufacturer's results of quality control tests performed on the actual material used. The reports shall contain all the raw data and intermediate calculations, as well as the testing procedures.

Installation Manual - The Contractor shall submit installation manual describing the method of installation.

Copies - The Contractor shall submit six (6) copies of all submittals requested in these specifications.

617.02.02 – FIPP MATERIALS

Acceptable FIPP materials are as follows and shall meet the requirements of the appropriate sections indicated below:

FIPP Material Type	Section
Deformed High Density Polyethylene (HDPE) Pipe	655
Folded Polyvinyl Chloride (PVC) Pipe	656
Resin Impregnated Tube (i.e. Cured-In-Place Pipe)	657

617.02.03 – FIPP DESIGN BASIS

The minimum installed formed-in-place pipe material thickness(es) specified are determined based on the buckling requirements (equation #3) established in ASTM F - 1216, Appendix X1. Design Consideration, Section X1.2.2 Fully Deteriorated Gravity Pipe Condition.

The following design assumptions are used in determining the specified minimum thickness(es) for the acceptable FIPP materials:

Design Parameter	Design Assumption
Mean inside diameter of original pipe, D	Same as pipe nominal diameter
Soil unit Weight, ?	120 lb/ft^3

Design Parameter	Design Assumption
Height of soil above top of pipe, H	Minimum 10 feet
Height of water above top of pipe, H_w	Same as height of soil above top of pipe
Live Load, W_L	AASHTO H20
Water buoyancy Factor, R_w	0.67
Total external Load, q_t	Hydrostatic load + (R_w) (earth prism load) + Live load
Ovality of original Pipe, q	2%
Factor of Safety, N	2.00
Modulus of soil Reaction, E'_s	700 psi

617.04 – CONSTRUCTION METHODS

617.04.01 – GENERAL

The installation of formed-in-place pipe shall be in accordance with appropriate ASTM Standard Specifications and the Manufacturer's recommendations. If no ASTM Standard exists for the installation, the licensor/manufacturer shall furnish, in detail, step-by-step procedures for review and approval by the Engineer.

Temperatures and pressures shall be monitored and recorded throughout the installation process to ensure that each phase of the process is achieved at the approved manufacturers recommended temperature and pressure levels. When requested by the Engineer, the Contractor shall submit field records of temperatures, pressures, and other pertinent information regarding installation.

The minimum span for the FIPP shall be the distance from inlet to outlet of the respective manholes unless approval to do otherwise is given by the Engineer. Individual runs can be made over one or more manhole sections, but shall not exceed manufacturer's recommendations for maximum allowable tension during the pulling process. Care shall also be taken to cut each end of the formed-in-place pipe as directed by the manufacturer for extension into manholes before releasing tension.

The installed FIPP shall form a waterproof seal with the manhole wall. If pipe fails to seal properly, a material compatible with the pipe and manhole shall be used to provide a watertight seal.

617.04.02 – SEWER SERVICE CONNECTIONS

Prior to the installation of FIPP, the Engineer will review the pre-inspection videotapes and logs for each line to determine which services shall be externally reconnected. Service connections that may be a source of I/I or root propagation shall be externally replaced as directed by the Engineer. Such connections shall include but not be limited to the following:

A) A cracked or collapsed connection

B) Missing pipe segments around the connection

C) Presence of roots

D) Protruding or receding connections

External Connection of services shall be executed as per Section 611.02.02.

All sewer service connections shall be accomplished and paid for in accordance with Section 611.

617.04.03 – SEWER FLOW CONTROL

Sewer flow control shall be accomplished in accordance with Section 618.

617.04.04 – POINT REPAIR

Point repairs shall be accomplished in accordance with Section 622. The Engineer, from the specified work may delete segments between two consecutive manholes that require more than five (5) point repairs or external connections to rehabilitate. At the discretion of the Engineer, these segments may be replaced by conventional excavation in accordance with Section 212.

When performing an external connection, the Contractor may at his option perform a point repair prior to lining the pipe or to anchor a saddle to the liner after installation. Groups of services replaced within a thirteen (13') foot span are accessed with one point repair using whichever method is used to make the connections.

617.04.05 – CLEANING SEWER LINES

Cleaning sewer lines shall be accomplished in accordance with Section 619.

617.05 – FIPP MATERIAL TESTING

617.05.01 – GENERAL

Following the installation for each minimum design thickness, the Contractor shall obtain one (1) sample from the formed-in-place pipe as follows:

Sample Locations - Sample locations shall be determined by the Engineer. When necessary, a point repair shall be done in order to obtain the sample, the cost of which shall be paid for at the unit price bid per each point repair. The Contractor shall cut each sample to a minimum of three (3) feet in length, and ship the samples to a laboratory designated by the Engineer for testing as described herein. The results of these tests shall be forwarded to the Engineer directly from the approved laboratory for review.

Specimens - From each sample, five (5) specimens shall be prepared to determine flexural bending properties, namely the initial flexural modulus and flexural strength and thicknesses. The results of each test shall be used to determine average values.

Methods - Tests and measurements shall be in accordance with ASTM Test Method D 790 and the calculated average values shall meet the minimum material properties and thickness(es) established in these specifications.

Cost - The cost of each test, when the material passes, shall be borne by the City. When average test results do not pass, the Contractor shall be responsible for the cost.

Acceptance - When the average test meets the requirements of these specifications, the testing shall be considered accepted.

Penalty - In the event, the material fails to meet the requirements of these specifications, an actual factor of safety against buckling shall be calculated and a penalty shall be assessed in accordance with provisions specified in Section 617.05.05. The actual factor of safety shall be determined using the computed average values of test results and the assumed design parameters and equations specified in Section 617.02.03.

617.05.02 – TELEVISION INSPECTION

Television inspection shall be accomplished in accordance with Section 624.

617.05.03 – SMOKE TESTING

Smoke testing shall be accomplished in accordance with Section 620.

617.05.04 – DYE-WATER TESTING

Dye-water testing shall be accomplished in accordance with Section 621.

617.05.05 – PENALTY

Provided that the computed factor of safety is equal to or greater than the value specified, the penalty is not applicable. The penalty shall be computed as a percentage of the bid unit price for the minimum design thickness represented by the test results, and applied to the total length of a run, in accordance with the following schedule:

Computed Factor of Safety	Penalty (%)
? 2.00	0
1.90 - 1.99	5
1.80 - 1.89	10
1.70 - 1.79	20
1.60 - 1.69	30
1.50 - 1.59	40
1.40 - 1.49	50
1.30 - 1.39	70
1.20 - 1.29	90
< 1.20	100

If the computed factor of safety for a specified design thickness fails to meet the required factor of safety, the following shall apply:

On the run that the sample was taken from, the penalty applies to the entire run. A run shall not be tested more than once.

The Contractor, at his option, may conduct additional tests on one (1) sample from other runs of the same design thickness. If so, the penalty for that run is determined from that test.

For runs not tested, the penalty shall be the highest from the other runs tested.

A run is defined as the full extent of an insertion beginning at a manhole or access point and extending continuously to a designated manhole or termination point. Sample locations for additional testing shall be determined by the Engineer. The Contractor shall be responsible for all costs in securing additional test samples (i.e., point repairs, etc.) and all laboratory costs whether the results are passing or failing. In lieu of penalty, the Contractor may install additional formed-in-place pipe to meet the minimum factor of safety requirement.

617.04.06 – ACCEPTANCE OF THE FIPP

Final acceptance of the FIPP shall be based on, but not limited to, review of closed circuit television inspection, the required material testing, and conformance with all provisions of these specifications as determined by the Engineer. Additionally, no groundwater shall be observed and all service entrances shall be accounted for and unobstructed.

The installed formed-in-place pipe shall be continuous over the entire length of a run between manholes and be smooth and free from substantial wrinkles, as well as flat spots, reverse curvature, defects, improper house connection cut-outs and installation over debris. Should any of these defects occur, the line shall be excavated, repaired, and/or replaced, and complete restoration shall be made to the satisfaction of the Engineer at no additional cost to the City.

617.06 – METHOD OF MEASUREMENT

Payment for "Formed-In-Place Pipe" shall be made at the unit price bid per linear foot of pipe for each size. External connections (reinstatements) of services shall be considered incidental to the lining

process and the cost for such shall be included in this bid item. The price established shall be full compensation for all labor and materials including FIPP material, installation, external connection of services, equipment, tools, testing, and incidentals necessary to complete this item of work. All lengths shall be measured horizontally from centerline to centerline of manholes.

617.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

FORMED-IN-PLACE PIPE (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 618 – SEWER FLOW CONTROL

618.01 – DESCRIPTION

This section covers necessary sewer flow control to the extent required for each operation, as specified and directed by the Engineer.

618.01.01 – SEWER FLOW CONTROL FOR TELEVISION INSPECTION AND SMOKE TESTING

When depth of flow at the upstream manhole of the section being worked is above the allowable for television inspection, the flow shall be reduced to the level shown below by operation of pumps, plugging or blocking of the flow, or by pumping and bypassing of the flow as specified. Depth of flow shall not exceed that shown below for the respective pipe sizes as measured in the manhole when performing television inspection.

Pipe Nominal Size (inch)	Allowable Depth of Flow (% of pipe diameter)
? 10	20
12 - 24	25
? 27	30

618.01.02 – SEWER FLOW CONTROL FOR ALL OTHER OPERATIONS

General - The line shall be completely blocked off and plugged and all flows shall be by-passed to the extent necessary or as required by the Engineer.

Plugging or Blocking - A sewer line plug shall be inserted into the line upstream of the section being worked. The plug shall be so designed that all or any portion of the sewage can be released.

Pumping and Bypassing - When pumping and bypassing is required the Contractor shall supply the pumps, conduits, and other equipment to divert the flow of sewage around the manhole section in which work is to be performed. The bypass system shall be of sufficient capacity to handle existing flow plus additional flow that may occur during a rainstorm. The Contractor will be responsible for furnishing the necessary labor and supervision to set up and operate the pumping and bypassing system. If pumping is required on a twenty-four (24) hour basis, engines shall be equipment in a manner to keep noise to a minimum.

Flow Control Precautions - When flow in a sewer line is plugged, blocked, or bypassed; sufficient precautions must be taken to protect the sewer lines from damage that might result from sewer surcharging. Further, precautions must be taken to insure that sewer flow control operations do not cause flooding or damage to public or private property being served by the sewers involved. The Contractor shall be liable for damages resulting from sewer surcharge.

618.06 – METHOD OF MEASUREMENT

Payment for "Sewer Flow Control" shall be made at the unit price bid per lump sum. The price established shall include furnishing and operation of pumping and by-passing, labor, tools, and incidentals necessary to complete this item of work.

Plugging or blocking of the sewer flow shall be considered incidental to the work and shall not be considered for payment.

618.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SEWER FLOW CONTROL L.S.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 619 – CLEANING SEWER LINE

619.01 – DESCRIPTION

This section covers cleaning of existing sewer lines. The designated sewer manhole sections and the manholes themselves shall be cleaned using mechanical, hydraulically propelled and/or high velocity sewer cleaning equipment. Selection of the equipment shall be based on the condition of the sewer mains at the time the work commences. The equipment shall be capable of removing dirt, roots, sand, rocks, grease, and other materials from the sewer lines.

619.02 – EQUIPMENT

619.02.01 – APPROVAL OF CLEANING EQUIPMENT AND PROCEDURE

The Engineer shall approve the cleaning system and plan for each manhole section. The Contractor shall demonstrate the performance of the proposed cleaning equipment for use on the project. No work shall begin until the Engineer gives such time approval.

619.02.02 – MECHANICALLY POWERED CLEANING EQUIPMENT

Bucket machines shall be in pairs with sufficient power to perform the work in an efficient manner. Machines shall be belt operated or have an overload device. Machines with direct drive that could cause damage to the pipe will not be allowed. A power rodding machine shall be either a sectional or continuous rod type capable of holding a minimum of three hundred (300) feet of rod. The rod shall be heat-treated (tempered) steel. To ensure safe operation, the machine shall be fully enclosed and have an automatic safety clutch or relief valve.

619.02.03 – HYDRAULICALLY PROPELLED CLEANING EQUIPMENT

Hydraulically propelled devices that require a head of water to operate shall utilize a collapsible dam to obtain the head. The dam shall be designed to easily collapse in the event of a sudden surcharge of the line to prevent damage to the sewer, property, etc. Sewer cleaning balls are acceptable for use only in sanitary sewers having a diameter of eighteen inches (18”) or greater.

The movable dam shall be of equal diameter as the pipe being cleaned and shall provide a flexible scraper around the outer periphery to ensure effective operation.

Whenever possible, flows present in the sewer lines shall be used to provide necessary fluid for hydraulic cleaning devices.

619.02.04 – HIGH-VELOCITY CLEANING EQUIPMENT

All high-velocity sewer cleaning equipment shall be constructed for ease and safety of operation. The equipment shall have a selection of two (2) or more high-velocity nozzles. The nozzles shall be

capable of producing a scouring action from fifteen (15º) degrees to forty-five (45º) degrees in all size lines designated to be cleaned. Equipment shall also include a high-velocity gun for washing and scouring manhole walls and floor. The gun shall be capable of producing flows from a fine spray to a solid stream. The equipment shall carry its own water tank, auxiliary engines, pumps, and hydraulically driven hose reel. Filler piping on the tank shall have an air cap to prevent backflow and contamination of water supply system.

619.04 – CONSTRUCTION METHODS

619.03.01 – CLEANING PRECAUTIONS

Satisfactory precautions shall be taken to protect the sewer lines from damage that might be inflicted by the improper use of cleaning equipment. Whenever hydraulically propelled cleaning force or any tools which retard the flow of water in the sewer line are used, precautions shall be taken to ensure that the water pressure created does not cause any damage or flooding to public or private property being served by the manhole section involved. Additionally, the Contractor shall not allow the overflow from sanitary sewers to enter storm sewers.

The Contractor, at no additional cost to the City, and to the satisfaction of the Engineer, shall repair any damage inflicted upon the sewer, regardless of the cleaning method used.

619.04.02 – ROOT AND DEBRIS REMOVAL

All roots shall be removed. Special attention shall be given during the cleaning operation to assure complete removal of roots from the joints. Procedures may include the use of mechanical equipment such as rodding machines, bucket machines and winches using root cutters and porcupines, and equipment such as high-velocity jet cleaners. Chemical root treatment may also be used.

When chemicals are used to aid in the removal of roots, the chemical shall be EPA registered and labeled for use in sewer lines and acceptable to all applicable State and City agencies.

All materials and mixing/application procedures for chemical root treatment shall be consistent with the latest standards, requirements, and recommendations of the manufacturer of the chemical root treatment material used.

All sludge, dirt, sand, rocks, grease, and other solid or semi-solid material resulting from the cleaning operation shall be removed at the downstream manhole of the section being cleaned. Passing of debris from manhole to manhole shall not be permitted.

When hydraulic cleaning equipment is used, a suitable sand trap, weir, or dam shall be constructed in the downstream manhole in such a manner that the solids shall be trapped.

All solids or semi-solids resulting from the cleaning operations shall be removed from the site and disposed of at no additional cost to the City. The City shall provide a dumpsite for all debris removed from the sewers during the cleaning operation.

Under no circumstances shall sewage or solids removed therefrom be dumped onto streets or into ditches, catch basins, storm drains, or sanitary sewer manholes.

619.05 – TESTING (CLEANING AND FINAL ACCEPTANCE)

Acceptance of sewer line cleaning shall be made upon the successful completion of the television inspection and shall be to the satisfaction of the Engineer. If television inspection shows the cleaning to be unsatisfactory, the Contractor shall be required to reclean and reinspect the sewer line until the cleaning is shown to be satisfactory.

619.06 – METHOD OF MEASUREMENT

Payment for "Cleaning Sewer Line" shall be made at the unit price bid per lineal foot of pipe regardless of size. The price established shall be full compensation for furnishing and operation of all equipment,

labor, tools, and incidentals necessary to complete this item of work. No deduction shall be made for manholes.

619.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

CLEANING SEWER LINE L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 620 – SMOKE TESTING

620.01 – DESCRIPTION

This section covers testing of sewer lines with smoke where the origin of a connection as an inflow source is unknown. Common uses are to determine storm sewer cross connections, roof leaders, cellar, yard, fountain and area drains, abandoned building sewer and faulty service connections, and point source inflow due to leaks in drainage paths and ponding areas.

620.04 – CONSTRUCTION METHODS

Smoke testing shall not be used in sewer lines suspected of having sags or water traps or those that are flowing full.

Smoke testing shall not be conducted to bcate service connection when the soil surrounding and above the pipe is saturated, frozen or snow covered.

Smoke generated from bombs or canisters shall be non-toxic, odorless and non-staining. Air blowers shall have a minimum capacity of 1600 liters/second.

620.05 – TESTING

Police and fire departments shall be notified daily of the test locations. Also residents shall be informed individually on the day of testing by personnel displaying proper identification.

Photographs shall be taken of all leaks discovered during testing, and shall be numbered and direction orientated. They shall be taken close enough to clearly mark the point where the smoke is escaping.

The Contractor shall also submit a sketch of each leak describing its extent, the area and type of surface drained by it, the location or address, and the photograph number. The leak shall be marked at the site.

620.06 – METHOD OF MEASUREMENT

"Smoke Testing" shall be measured by the lineal foot of sewer line tested. Payment for "Smoke Testing" shall be made at the unit price bid per foot regardless of pipe size. The price established shall include all materials, labor, tools, equipment and incidentals necessary to complete this item of work.

620.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SMOKE TESTING L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 621 – DYE-WATER TESTING

621.01 – DESCRIPTION

This section covers dye-water testing used for detecting inflow such as storm sewer cross connections and point source inflow leaks in drainage paths or ponding areas, roof leaders, cellar, yard and area drains, fountain drains, abandoned building sewers, and faulty service connections. Dye-water testing shall only be performed as directed by the Engineer where the origin of a connection is questionable.

621.04 – CONSTRUCTION METHODS

The equipment needed for dye-water testing shall be limited to that required to carry the water to testing site and to block the sewers before testing. Sand bags or sewer pipe plugs may be used to block the sewer sections.

621.05 – TESTING

When inflow sources are located on private properties, property owners shall be notified before tests to identify in-flow sources.

A field log sheet shall be filled out for each dye-water test whether or not a positive transference is observed.

A sketch shall be made. It shall indicate exactly what was flooded and the relationship between that and the sewer system. A photograph shall be made to accompany the sketch. The photograph shall include the set up or the point of ingress.

Dye shall be safe to handle, visible in low concentrations, miscible in water, inert to the soils and debris in the sewers, and biodegradable.

621.06 – METHOD OF MEASUREMENT

The cost of dye-water testing shall be considered incidental and no additional compensation shall be made for this work and the cost of same shall be included in the other pay items.

SECTION 622 – POINT REPAIR

622.01 – DESCRIPTION

This section covers replacement of short segments of sections of the existing pipe as specified or directed by the Engineer.

The point repair is made by excavation to repair a line or remove an obstruction such as dropped joints, protruding service connections, or crushed or collapsed pipe, which cannot be removed or repaired by remote devices.

622.02 – MATERIALS

Acceptable pipe materials and fittings shall meet the requirements of Section 610.02 and 611.

622.04 – CONSTRUCTION METHODS

All point repairs require prior approval of the Engineer. Pipe and fittings for point repairs shall be installed according to the provisions set forth in Section 610. Trench excavation and backfill shall be accomplished in accordance with Section 212.

The length of any point repair shall not exceed thirteen feet (13').

Site cleanup and replacement of trees, shrubs, hedges, and sod shall be in accordance with the appropriate sections of the specifications.

622.06 – METHOD OF MEASUREMENT

Payment for "Point Repair" shall be made at the unit price bid per each regardless of depth. The price established shall include all material, equipment and labor costs for excavation, pipe, replacement, embedment materials, cleanup, and incidentals necessary to complete a point repair.

All sod, trees, shrubs, hedges, if required foundation material, and paving shall be replaced and paid for directly in accordance with the appropriate section.

Removal of obstructions by internal means shall be considered incidental to work. Television inspection and cleaning of sanitary sewer in pursuit of repair shall be considered incidental to work.

622.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

POINT REPAIR	EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 623 – DEFLECTION TEST

623.01 – DESCRIPTION

This section covers deflection tests intended to be performed on all flexible pipe installations.

623.05 – TESTING

All test results shall be signed and sealed by a Professional Engineer registered in the state of Oklahoma. The test shall be performed not less than thirty (30) days after backfill has been placed. The maximum allowable deflection shall not exceed five (5%) percent of the pipe's base internal diameter (Base ID). Base ID for PVC pipes shall be calculated from measurements taken in accordance with ASTM D 2122 and according to procedures outlined in Appendix XI of ASTM D 3034. For PE pipes Base ID shall be calculated from measurements taken in accordance with ASTM D 2122 and according to procedures recommended by the manufacturer and approved by the Engineer. For other flexible pipes, base ID shall be calculated in accordance with the manufacturer's recommended procedures and approved by the Engineer.

A mandrel (go/no-go) device cylindrical in shape shall be hand-pulled by the Contractor through all sewer lines. Any sections of pipe not passing the mandrel test shall be uncovered and the Contractor, at no additional cost to the City, shall replace the pipe to the satisfaction of the Engineer. The repaired sections shall be re-tested. All tests for pipes twenty-four inch (24”) and larger shall be performed in the presence of the Engineer.

The Engineer shall approve the mandrel and the testing procedures. Proving rings furnished by the Contractor shall be used to verify the mandrel diameter.

In lieu of mechanical measurement of deflection by a mandrel, manual measurement can be performed using an internal micrometer or telescoping gage accurate to plus or minus (±) one-thousandth (0.001”) inch. The manual measurement of the vertical internal diameter shall be taken at the centerline of the installed pipe.

623.06 – METHOD OF MEASUREMENT

Payment for "Deflection Test" shall be made at the unit price bid per lump sum for pipes smaller than twenty-four inches (24”) and per lineal foot for pipes twenty-four inches (24”) and larger in diameter. The price established shall be full compensation for all material, labor, tools, equipment and incidentals necessary to complete this item of work.

623.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

DEFLECTION TEST (< 24”)	L.S.
DEFLECTION TEST (= 24”)	L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 624 – TELEVISION INSPECTION

624.01 – DESCRIPTION

This section covers closed-circuit television (CCTV) inspection of existing sewer lines and rehabilitated and newly constructed sewer lines.

The work shall consist of furnishing all labor, materials, accessories, equipment, tools, transportation, services and technical competence for performing all operations required to professionally execute the internal inspection of sewers in strict accordance with these specifications.

Information concerning depths of flow, manhole depths, air quality in the sewers, accessibility of manholes, traffic conditions, and other safety considerations are to be the sole responsibility of the Contractor to obtain and to incorporate the necessary provisions into the overall contract price to complete the specified work under the conditions existing in the sewers to be inspected.

For large-diameter sewer inspections, the Contractor may be required to submit sample video recordings from recently completed projects demonstrating the picture quality obtained with each available inspection system for pipe diameters twenty-seven inches (27”) and larger.

All television testing shall be performed in accordance with guidelines published by the National Association of Sewer Service Companies (NASSCO) and as modified or specified in these specifications.

624.03 – EQUIPMENT

All television cameras used for inspection shall be color units specifically designed and constructed for the method of inspection performed. Camera(s) may be modified by mounting on conventional or floating skids, or rafts, for use in multiple-diameter, sewer line inspection work. Units shall have either automatic or remote focus and iris controls, and the complete system(s) shall be operable in conditions of hundred (100) humidity.

Lighting shall be suitable to allow a clear picture of the entire periphery of the main sewer pipe. For large-diameter twenty-seven inches (27”) and larger] pipe, the camera lens shall have not less than a sixty-five (65º) degree viewing angle. A radial viewing camera with a three hundred and sixty (360º) degree vertical rotation and a two hundred and seventy (270º) degree horizontal rotation, or any combination of the two, may be required to properly evaluate the condition of the main sewer and laterals. Lighting shall operate in a manner that allows the viewed object to be illuminated no matter what the angel of the lens. For a radial viewing camera, the lighting shall be built into the unit so that the lamp(s) remains aligned with the lens. A minimum illumination of three (3) lux with a light color in the twenty-two hundred (2200º) to thirty-two hundred (3200º) degree Kelvin range shall be provided. Auxiliary lighting acceptable to the Engineer shall be provided for large diameter pipe. For diameters of sixty inches (60”) and greater, a minimum of one million (1,000,000) candlepower lighting in the thirty-two hundred (3200º) degree Kelvin range shall be made available.

The Contractor shall be responsible for having the necessary camera skids, floats, and rafts available to allow for inspection of lines in a manner acceptable to the City under live flow conditions.

In all cases, the complete video system (camera, lens, lighting, cables, monitors and recorders) shall be capable of providing a picture quality acceptable to the Engineer, and if unsatisfactory, equipment shall

be removed and no payment shall be made for unsatisfactory inspections.

624.04 – CONSTRUCTION METHODS

624.04.01 – GENERAL

The Contractor shall use one of the following methods individually or in combination, as approved by the Engineer:

Conventional color inspection cameras specifically designed for use in sewer line inspection work, mounted on conventional camera skids or tracks.

Conventional color inspection cameras specifically designed for use in sewer line inspection work, mounted on floating skids or rafts.

Special industrial grade, color-inspection cameras contained in waterproof housings, and mounted on floating skids or rafts

Special industrial grade, color-inspection cameras, either hand held or contained in waterproof housings, and carried manually through the sewer during inspection work.

624.04.02 – PROCEDURE

Pre-work Submittals For Inspection Of Large Diameter Pipes - For pipes twenty-seven inches and larger, the Contractor shall submit a listing of actual measured flow depths and times of measurement at a sufficient number of locations to indicate the flow depths that could be expected during inspection work. A minimum of one (1) flow depth measurement shall be provided for each line section at no additional cost to the City. Additional off-peak flow measurements (i.e., night flow measurements) may be requested by the Engineer at various locations, also at no additional cost to the City.

A prestart-up meeting shall be scheduled prior to beginning any internal pipe inspection work to review the Contractor's proposed inspection methods for each of the line section groupings. At that time, the Contractor shall have available the necessary flow depth date as well as the overall listing of proposed inspection methods in each area.

Remote Inspections - Remote pipe inspections shall be permitted in cases where conditions are, as determined by the Engineer, to be unsafe or impractical for manual inspections, and where acceptable picture quality can be obtained by the Contractor.

The main sewer shall be cleaned as directed by the Engineer and in accordance with Section 619 of grease, roots and debris that may hinder movement of inspection equipment through the lines. Major line obstructions that require point repairs are excluded.

The maximum flow depth for remote inspection work in pipes twenty-four inches (24”) and less is twenty (20%) percent of the pipe diameter.

For large pipe diameters [twenty-seven inches and greater], the maximum flow shall be thirty (30%) percent of the pipe diameter. The contractor may be required to perform inspections during off-peak hours (night inspections) when specifically requested by the Engineer to obtain this flow standard.

No inspections shall be performed where flow depths exceed fifty (50%) percent of pipe diameter without prior approval of the Engineer.

Suspended moisture or fog in pipes shall be cleared with blowers. Filming shall commence only when the ambient temperature above ground is a minimum of forty (40º) degrees Fahrenheit.

CCTV inspection shall be done one manhole section at a time and the flow in the section being inspected shall be suitably controlled as specified in Section 624. The inspection shall proceed from one section to another starting either upstream or downstream and completing in that order for the entire line. When an obstruction prevents the camera from passing through the entire manhole section, the inspection shall be continued from the opposite manhole before proceeding to the next section.

The camera shall be moved through the line at a moderate rate, stopping when necessary to permit proper documentation of the sewer's condition. The maximum speed of the camera shall not exceed thirty (30) feet per minute. Caution shall be taken to not linger in one spot allowing the heat generated from the unit to ignite roots, debris, etc.

The camera shall be moved through the line by conventional means of manual winches, power winches, television cable, and powered rewinds or other devices, which do not obstruct camera view or interfere with proper documentation of the sewer conditions. In instances where manual or remote power winches are used to pull the camera through the sewer constant two-way communication shall be set up between the two manholes of the line being inspected.

Accurate and continuous footage readings shall be superimposed on the video recording for each line inspected by remote inspection methods. Also shown shall be the date of inspection and a manhole number designation that corresponds to the field logs for each manhole on the line section inspected.

When specified, a lateral sewer camera shall be employed to inspect up to twenty-five feet (25') of the lateral. The lateral camera launcher shall be brought into position by the main sewer television camera. Lateral sewers entering manholes shall be inspected with a mini push camera. Actual footage inspected shall vary depending on the condition of the pipe. Videotapes of laterals may be in black and white, and shall show a view of the lateral connection by the main sewer camera before showing the internal view of the lateral by the launcher.

The Contractor shall provide photographs developed from the television screen of problems revealed by the CCTV camera upon the request of the Engineer, as long as such photographing does not interfere with the Contractor's operations.

Manual (Walk Through) Inspections - Manual inspections shall be required in lines where conditions will allow the Contractor's inspection crew to safely walk through the sewer. In general, lines sixty inch (60") in diameter and larger, and having flow depths of less than twenty (20%) percent of the pipe diameter, shall be manually inspected as directed by the Engineer.

Inspection crews shall consist of two or more people. Blowers and exhaust fans shall be available to provide ventilation for the sewer line being inspected.

Manual pipe inspections shall be conducted in such a manner as to transmit the video signal to an aboveground viewing room to permit the Engineer to watch the inspection work live on a color monitor in the viewing facility. In addition, direct voice communication between the Engineer, the in-pipe inspection personnel, and the recording technician in the aboveground unit shall be maintained at all times during the manual inspection work. Video recording equipment shall also be located above ground in the inspection truck and accurate, continuous footage readings shall be superimposed on the video recording for permanent record. Camcorders shall not be permitted for use as the sole means of obtaining video records.

During manual inspections, the video camera shall be used to look up sidelines and laterals, whenever practical. Conditions noted in these sidelines and laterals shall be noted on the inspection logs and videotapes for the project.

During manual inspections, thirty-five (35mm) millimeter color photographs shall be obtained as instructed by the Engineer or as deemed necessary by the in-pipe technicians to document line conditions.

624.05 – DOCUMENTATION

Television Inspection Logs - Printed location records shall be kept by the Contractor and will clearly show the location in relation to an adjacent manhole of each infiltration point observed during inspection. In addition, other points of significance such as locations of building sewers, unusual conditions, roots, storm sewer connections, broken pipe, presence of scale and corrosion, and other discernible features will be recorded and a copy of such records shall be supplied to the Engineer. The

video audio recording and written report of the condition of each lateral, if inspected, shall be included along with an identification number corresponding to main sewer log and approximate locations of any pipe defects.

If preliminary inspection occurs in conjunction with a rehabilitation or replacement project, no construction activities shall begin without prior review and subsequent approval by the Engineer of the work outlined in the submittals.

During large-diameter pipe inspections, the Contractor shall document in writing observed conditions and comments given about each sewer line. These field logs shall then be reviewed by the Contractor's technical staff, along with reviewing the associated video record, as a means of insuring that no defects or entries are omitted or incorrect, and as a means of gaining a second opinion as to the condition of each sewer line. Edited field logs shall then be reprinted or typed for use in the final project reports. Detailed, one-page summaries shall also be prepared for each line section inspected, during the data review, presenting the Engineer's synopsis of the general Ine condition and the relative severity of observed defects. These summaries shall also be included in all field report copies immediately before each associated inspection report. Direct submittal of copies of the field technician's field logs, without this secondary review and summary pages, shall not be acceptable.

Five (5) complete copies of the final project reports shall be submitted to the City within fifteen (15) calendar days of completion of all field activities. One of the five (5) copies shall contain the original photos.

An overall summary narrative shall be provided in the final report describing the overall conditions found in each associated line section grouping and detailed summary tables shall also be compiled showing those lines where major and significant defects were located.

Original recordings, along with the required submittals, shall be forwarded to the Engineer upon completion of the inspection and shall become the property of the City.

Video Audio Recordings - A forward introduction sequence stating the time and date, location or segment number, depth, diameter, and pipe material for each length between manholes shall precede the recording of each line segment. The camera shall progress through the pipe indicating the beginning manhole and destination manhole as it marks the footage continuously. Should there be a need to access the line from the other direction, a new introduction track shall precede the setup, and the footage shall begin at zero.

The camera shall pause as it approaches a service so that the connection between pipe and service may be evaluated. The lens shall then rotate to display the interior of the service. The service inspection should reveal any roots, cracks, or capped risers.

Audio description shall accompany the visual. Operator's comments shall contain verbal verification of footage and condition of each service, and any defects or unusual conditions noted in the main. When television inspection is performed as a part of final examination for acceptance of project, it shall be performed after all the lines have been constructed and within twenty-four hours of conducting deflection test on a line. It shall be continuous and present each segment in the order laid out in the plans (e.g., Line A: station 0+00 to 4+00, station 4+00 to 8+00, Line B: station 0+00 to 3+00, etc.).

All recordings shall be dvd format or a format specified by the Engineer. Each tape shall be professionally labeled showing the Owner's name, project number, project location, the date(s), etc., lines recorded on the tape, and name of the Contractor. If the quality of the recordings is not satisfactory to the Engineer, the lines shall be rerecorded at the Contractor's expense.

Photographs - All photographs taken during manual, walk-through inspections shall be properly mounted and labeled on eight and one half by eleven (8.½" x 11") inch paper for inclusion in the final project reports. One (1) copy of the final reports shall contain the original thirty-five (35) millimeter photos, on fully laminated pages, and the remaining requested copies shall contain copier of pages of these photos. The photo pages shall be presented immediately following the inspection report for the

line section in which they were taken.

Photographs taken from the monitor for remote television inspections shall also be presented in the same manner as described above.

624.06 – METHOD OF MEASUREMENT

Payment shall be made for pre-construction inspection, when required for construction, and post construction inspection only. Unless separately specified, all other recording and/or photographs requested by the Engineer shall be considered incidental to the project and the cost included in the price for other items.

"Television Inspection" shall be measured along the stations, through manholes, junction boxes and other small structures. Payment for "Television Inspection (CCTV)" shall be made at the unit price bid per lineal foot of pipe regardless of size. The price established shall be full compensation for all equipment, labor, materials, mobilization, demobilization, reverse setups, recordings, reports, photographs, and incidentals necessary to complete these items of work.

624.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

TELEVISION INSPECTION (CCTV) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 625 – SEWER PIPE LEAKAGE TESTING

625.01 – DESCRIPTION

After backfilling has been completed, the Contractor shall conduct infiltration, exfiltration or air tests as directed by the Engineer and submit the results of all testing to the Engineer. All tests shall be performed in the presence of the Engineer for pipes twenty-four inches (24”) and larger.

Immediately prior to conducting a test, the ground water level shall be determined by boring a vertical hole adjacent to the pipe and measuring the distance to the water level, or by the use of a one inch (1”) diameter pipe installed horizontally through the upstream manhole wall with a clear plastic tube connected to the pipe and extending vertically.

625.05 – TESTING

625.05.01 – INFILTRATION TEST

Where sewers are laid under the groundwater, infiltration testing shall be conducted. If at any time the infiltration between two adjacent manholes is observed and measured to exceed ten (10) gallons per inch of nominal pipe diameter per mile of sewer per day. The Contractor shall locate the leakage and shall make such repairs as are necessary to reduce the infiltration. The infiltration shall be measured under the direction of the Engineer by use of a weir or other suitable flow rate-measuring device furnished and installed by the Contractor.

625.05.02 – EXFILTRATION TEST

Where sewers are laid above the groundwater table, exfiltration testing shall be conducted. Exfiltration tests shall be conducted by blocking off the other openings in the upper manhole and plugging the line where it enters the lower manhole of the reach to be tested, filling the line and the manhole with water at least five foot (5’) higher than the top of the pipe or five feet (5’) higher than the ground water elevation whichever is higher, and measuring the water required to keep the water level in the manhole at a constant elevation. The test section shall be filled not less than twelve (12) hours prior to testing. The total exfiltration shall not exceed ten (10) gallons per inch of nominal pipe diameter per mile (idm)

of pipe per day for each reach tested. For purposes of determining the maximum allowable leakage, manholes shall be considered as sections of pipe having an idm equal to the diameter times depth of the manhole. The exfiltration test shall be maintained on each reach for at least two (2) hours or longer if, in the opinion of the Engineer, this is necessary to locate all leaks.

The Contractor shall provide all necessary piping between the reach to be tested and the source of water supply, together with equipment and materials required for the tests. The methods used and the time of conducting the exfiltration tests shall be subject to the approval of the Engineer.

If the leakage in any reach exceeds the allowable maximum, the Contractor shall locate the leakage and shall make such repairs as are necessary for the pipe to pass testing. The pipe reach shall be retested after the leaks are repaired.

625.05.03 – AIR TEST

Air tests shall be conducted on each manhole-to-manhole section of sewer. The air test shall be performed in accordance with the following specifications.

Equipment - Cherne Air-Loc Equipment as manufactured by Cherne Industrial of Hopkins, Minnesota or approved equal. Equipment used shall meet the following requirements:

Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be inspected.

Pneumatic plugs shall resist internal test pressure without requiring external bracing or blocking.

All air used shall pass through a single control panel.

Three (3) individual hoses shall be used for the following connections:

From the control panel to pneumatic plugs for inflation;

from the control panel to sealed line for introducing the low pressure air; and

from sealed line to control panel for continually monitoring the air pressure rise in the sealed line.

Procedures - All pneumatic plugs shall be seal-tested before being used in the actual test installation. One length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air shall be introduced into the plugs to twenty-five (25 psi) pounds per square inch gauge. The sealed pipe shall be pressurized to five (5 psi) pounds per square inch gauge. If a ground water level over the top of the pipe is present, the pressure in psig shall be increased by the height of ground water level above top of pipe at upstream manhole divided by two and one third (2 1/3). The plugs shall hold against this pressure without bracing and without movement of the plugs out of the pipe.

After a manhole reach of pipe has been backfilled and cleaned, and the pneumatic plugs are checked by the above procedures, the plugs shall be placed in the line at each manhole and inflated to twenty-five (25 psi) pounds per square inch gauge. Low-pressure air shall be introduced into this sealed line until the internal air pressure reaches four (4 psi) pounds per square inch gauge. At least two (2) minutes shall be allowed for the air pressure to stabilize. After the stabilization period (three and one half (3 ½ psi) pounds per square inch gauge minimum pressure in the pipe), the air hose from the control panel to the air supply shall be disconnected. The portion of the line being tested shall be termed "acceptable" if the time required in minutes for the pressure to decrease from three and one half (3 ½ psi) to two and one half (2 ½ psi) pounds per square inch gauge is not less than that shown in the following table:

Table 625.05.01 – Air Test Requirements

Pipe Nominal Size (Inches)	Minimum Test Time (min:sec)	Length for Minimum Time (Feet)
6	2:50	751
8	3:47	564
10	4:43	450
12	5:40	376
15	7:05	302
18	8:30	250
21	9:55	215
24	11:20	188
27	12:45	167
30	14:10	150
33	15:35	138
36	17:00	125
42	19:50	107
48	22:40	94
54	25:30	83
60	28:20	75
66	31:10	68
72	34:00	63
78	36:50	58
84	39:40	54
90	42:35	51
96	45:20	47

For lengths in excess of "Length for Minimum Time" given in table above, additional testing time to be added to the "Minimum Test Time" is determined from the following equation:

$t = 0.011 (d^2) (L)$; where:

t = additional testing time, seconds

d = nominal pipe diameter, inches

L = additional length, feet

If the air leakage in any reach exceeds the allowable, it shall be re-tested after the leaks are repaired.

625.06 – METHOD OF MEASUREMENT

Payment for "Sewer Leakage Test" shall be made at the unit price bid per lump sum for pipes smaller than twenty-four inches (24”) and per lineal foot for pipes twenty-four inches (24”) and larger in diameter. The price established shall be full compensation for all material, labor, tools, equipment and incidentals necessary to complete this item of work.

625.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SEWER LEAKAGE TEST (SIZE)	L.S. (<24”)
SEWER LEAKAGE TEST (SIZE)	L.F. (=24”)

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 626 – SANITARY SEWER MANHOLES

626.01 – DESCRIPTION

This section covers construction of sanitary sewer manholes, zero (0’) to six (6’) feet deep. Manholes may be constructed of the following types at locations specified or directed by the Engineer:

A) Precast Reinforced Concrete

B) Cast-In-Place Non-Reinforced Concrete

626.02 – MATERIALS

626.02.01 – PRECAST REINFORCED CONCRETE MANHOLES

General - This specification covers construction of precast reinforced concrete manhole base sections, riser sections (walls) and appurtenances in accordance with ASTM C-478 Standard Specification for "Precast Reinforced Concrete Manhole Sections" and as modified herein.

Submittals - When requested by the Engineer, the Contractor shall submit the following, but not limited to, for review and approval.

1) Concrete cylinder compressive test results as per ASTM C-478.
2) Amount and detail layout of steel reinforcement as per ASTM C-478.
3) Type "D" Certification for the specified protective coating.
4) Daily log of applied protective coating per Part "J".
5) Affidavit of compliance with these specifications.

Types - Components of manholes shall be as follows:

1) Precast Risers and Grade Rings - Precast risers and grade rings shall be cylindrical type.
2) Precast Tops - Precast tops shall be of the following two types:
    a) Concentric cone
    b) Eccentric cone
3) Precast Base Sections - Base section types shall be as follows:
    a) Base riser section and separate base slab with Mastic sealer.
    b) Base riser section with integral floor and preformed socket to accept a rubber ring.

Sizes - The standard internal diameter of a manhole shall be four feet (4’). Non-standard internal diameters of five feet (5’), six feet (6’), and seven feet (7’) may be constructed when specified or called for on the plans.

Dimensions - The manholes shall be constructed pursuant to the appropriate "Standard Details for Precast Reinforced Concrete Manholes", and/or as specified in ASTM C-478. The minimum wall thickness shall be as specified in the following table or not less than one-twelfth (1/12) of the internal diameter of the largest cone or riser section or five (5”) inches, whichever is greater.

TABLE 626.02.01 – Manhole Diameter and Wall Thickness

Manhole Internal Diameter (feet)	Minimum Wall Thickness (inches)
4	5
5	5
6	6
7	7
8	8

Materials - All materials for construction of manholes shall be in accordance with Section 6 of ASTM C-478.

Design - Design including concrete properties, reinforcement type and grade, joints, manufacturing and physical requirements shall be in accordance with Section 7 to 10 of ASTM C-478.

Base slabs or floors shall have a minimum riser thickness of six (6”) inches for diameters up to and including forty-eight (48”) inches and a thickness of eight (8”) inches for larger diameters.

Manhole Steps and Ladders - Steps and ladders shall not be constructed unless otherwise directed by the Engineer. If called for, they shall conform to Section 13 of ASTM C-478.

Handling - All lifting holes shall be repaired with a mixture of cement and sand grout firmly packed.

Protective Coating - All inside surfaces (walls, bottom, and etc.) of pre-cast concrete manholes shall be shop coated with a total dry film thickness of not less than 8 mils of TNEMEC Series 69 Hi-Build Epoxoline II, or approved equal. The material manufacturer shall furnish an affidavit attesting to the successful use of their material as a lining for applications where sewage conditions are recognized as corrosive or otherwise detrimental to concrete. Coating materials shall be stored, mixed, applied and cured in accordance with guidelines set by the manufacturer.

For every manhole coated as required, a daily log shall be kept indicating the date, weather conditions, size and identification numbers of manholes coated, and number of gallons of coating applied to each manhole. The average number of gallons applied per manhole shall be equal to or exceed the manufacturer's recommended coverage rate for the coating.

Field Testing - When directed by the Engineer, a set of three cylinders, three (3”) inches in diameter, shall be cut from randomly selected manholes. Testing shall be performed to verify compliance with the requirements of these specifications. Basis of acceptance for testing shall be in accordance with the appropriate ASTM requirements.

Acceptance - Acceptance of manhole structure shall be based on the conformance and performance of materials required in ASTM C-478, and the Engineer's inspection of the installed product. The assessment shall include, but not be limited to, the Engineer's random plant inspections during production, the quantity and the placement of reinforcement, surface fractures and roughness, and the test results of compressive strength performed on cores and cured cylinders in accordance with Section 7 of ASTM C-497.

626.02.02 – CAST-IN-PLACE NON-REINFORCED CONCRETE MANHOLES

General - This specification covers construction of cast-in-place non-reinforced manholes consisting of plain concrete walls with brick masonry or precast grade ring at the surface and rings and covers (castings), shall be constructed in accordance with the dimensions and requirements of the standard details.

Types - Manholes may be constructed of the following three (3) types, when called for on the plans:

1) Concentric Manholes

2) Eccentric Manholes

3) Offset Manholes

Sizes - The standard manhole size shall be four (4') feet internal diameter. Non-standard sizes may be constructed when called for on the plans or specified. The wall thickness shall be a minimum of eight (8") inches.

Dimensions - The manholes shall be constructed pursuant to the appropriate "Standard Details for Cast-In-Place Non-Reinforced Concrete Manholes".

Materials - All materials for the construction of cast-in-place manholes shall be in accordance with the Material Specifications.

Protective Coating - Protective coating shall not be required unless otherwise called for on the plans or as directed by the Engineer.

Acceptance - Ready-mix concrete may be accepted on the basis of Type "E" Certification, provided that all applicable requirements are met, and that visual inspection at destination shows the workmanship and condition of the material to be satisfactory.

626.02.03 – MANHOLE INVERT AND BENCH

All loose materials shall be removed prior to shaping the invert. The invert shall be smooth, U-shaped, have a minimum depth of one half (1/2) pipe diameter and be channeled across the floor of the manhole using the materials specified herein to obtain the proper form and shape. The bench shall also be formed and built up with concrete approved by the Engineer. Additionally, all work shall comply with the appropriate "Standard Details for Precast Manhole Base Sections" and the "Standard Details for Cast-In-Place Non-Reinforced Concrete Manhole Base Section".

For precast manholes, inverts and benches shall be formed and poured in place after manhole base and pipe sections are in place.

Materials used for invert or benches shall not be allowed to enter the sewer line. Finished benches shall be smooth and free of any defects that could cause the accumulation of debris.

626.03.04 – MANHOLE RING AND COVER

General - Cast iron rings, tops, covers, gratings and all cast iron fittings shall be sound, true to form and thickness and neatly finished and shall fit together in a satisfactory manner. Castings shall be clean, uniform and whole, and without blow or sand holes, dorosit, hardspots, shrinkage, distortion or any other surface defects which would impair serviceability. Casting surfaces shall be smooth and well cleaned by shot blasting or other approved cleaning method. Plugging or filling of holes or other defects shall not be permitted. Parting fins and pouring gates shall be removed. Sharp edges resulting from fabrication shall be dulled by any acceptable method to ensure safety in handling. Casting shall conform to the requirements of the Standard Specifications for Grey Iron Fittings ASTM A-48, Class "30 B" for rings and "35 B" for covers and the appropriate "Standard Details for Manhole Ring and Cover".

All rings and covers shall be accurately and carefully placed. All rings shall be bedded in a substantial layer of mortar, or a flexible ring seal, shall have a full bearing, and shall be set to the exact grade. Unless otherwise shown, the top of covers shall be flush with, or slightly above, the surrounding surface. When each cover is placed in any position on the ring, the side play shall not exceed one-eighth (1/8") inch in any direction. Wording and markings on covers shall be in accordance with the Standard Details.

Rings - Rings may be manufactured in accordance with the "Standard Detail for Reversible Manhole Ring".

Covers -

1) General - Manhole covers may be manufactured in accordance with the appropriate "Standard

Detail for Vented or Non-Vented Manhole Cover". Unless otherwise specified or directed by the Engineer, non-vented manhole covers shall not be used in the streets.

2) Coating - When called for on the plans or specified, the underside of all manhole covers shall be given one (1) coat of asphalt varnish after visual inspection and approval on the job site.

626.04 – CONSTRUCTION METHODS

Foundation - Manholes shall be constructed in a dry excavation. A crushed rock foundation mat shall be constructed under the manhole. The mat shall be a minimum of six (6) inches thick. Placement of material and material properties shall comply with Section 626.

Backfilling - Backfilling for all manholes shall conform to the requirements of section 212.

Manhole to Pipe Connection at Inverts - Manhole to pipe connections shall be made pursuant to manufacturer's recommendations and "Standard Details for Concrete Manhole Pipe Connection". In addition, flexible gasket pipe seals shall be required where each pipe enters the wall of manholes. Where possible, the opening for each connecting sewer pipe shall be circular and match the diameter of the pipe. For manholes built over existing lines or for special conditions, horseshoe shaped openings shall be accepted. Flexible gaskets shall be A-Lok, or an approved equal. The Engineer prior to construction shall approve the method and materials used for grouting any remaining annular space. Flexible pipe seals may be accepted on the basis of Type "D" Certification and a sample, provided that all applicable requirements are met, and that visual inspection shows the workmanship and condition of the material to be satisfactory. All material furnished under certification shall be tagged, stenciled, stamped or otherwise marked with a lot number, heat number, order number, or other appropriate identification which can be readily recognized and checked against the certification.

Above Invert Manhole to Pipe Connection - Above invert manhole to pipe connection shall be constructed in accordance with the "Standard Detail for Above Invert Manhole to Pipe Connection".

Finishing Manhole to Grade - The manhole ring and cover shall be adjusted to grade with concrete grade rings or course(s) of brick masonry.

All brick masonry shall meet the requirements of the Material Specifications. Mortar shall be Class D, to which has been added an approved admixture unless otherwise shown on the plans or provided in the special provisions. All brick shall be laid in a full bed of mortar and all joints shall be shoved joints completely filled with mortar. The joints on the inside face or exposed face of the masonry shall be rubbed full and cut as the brickwork is built up. The masonry shall be built up in level courses, true to line, grade and dimension. Bats shall be used only when necessary to close joints. All brick shall be thoroughly wet down immediately before being placed unless otherwise permitted by the Engineer. All work shall be completed and finished in a careful, workmanlike manner. Old brick masonry shall be thoroughly cleaned and wetted before joining new masonry thereto. Where a mortar coating is required it shall have the minimum thickness shown on the plans, shall be troweled and re-troweled until a uniform, smooth and impervious surface is obtained.

All pipes that extend through masonry walls shall be tightly sealed in the wall with mortar throughout the circumference of the pipe. The mortar shall be pressed in and troweled off flush with the face of the wall.

Manhole Inserts - When called for on the plans or specified, manhole inserts shall be installed at locations shown on the Plans or as directed by the Engineer. It shall consist of a new disk, gasket and relief valves etc., meeting the requirements of these specifications, and shall be manufactured by Southwestern Packing and Seals or approved equal. The watertight inserts shall fit the walls and rings. Damaged or missing inserts identified prior to the final inspection shall be replaced at no cost to the City.

Outside Waterproofing - When called for on the plans or specified, waterproofing shall be required on the outside of manholes. The waterproofing material shall be TNEMEC Series 66 Hi-Build Epoxoline or

approved equal. The coating shall have a minimum dry thickness of four (4) mils. Coatings shall be environmentally non-hazardous. Spray applications shall be shop applied, and field applications are limited to brush and roller. Acceptance of material used for Waterproofing shall be on the basis of Type "D" Certification, provided that all applicable requirements are met.

Extra Depth Manhole Wall - Where required to construct manholes beyond a depth of six (6') feet, manhole walls shall be constructed to the depth called for on the plans or as directed by the Engineer. The construction requirements for Extra Depth Manhole Wall are the same as for "Sanitary Sewer Manhole".

626.05 – TESTING

626.05.01 - MANHOLE INSPECTION

After manhole construction has been completed, the manhole shall be visually inspected by the Engineer for acceptability. Visual inspection shall be done to check for leaks, thin spots, honey combs, voids, pinholes and conformance with these specifications.

626.05.02 - MANHOLE TESTING

Manhole testing shall be accomplished in accordance with Section 627.

626.06 – METHOD OF MEASUREMENT

Payment for "Sanitary Sewer Manhole" shall be made at the unit price bid per each size for a depth of zero (0') to six (6') feet. The price established shall be full compensation for excavation, backfill, crushed rock foundation, inverts and benches, walls and cones, manhole inserts when specified, ring and cover, protective coating, outside waterproofing when specified, removal of existing manhole when necessary or specified or called for on the plans, brick masonry or precast grade ring and all labor, materials, tools, equipment and incidentals necessary to complete this item of work.

Payment for "Extra Depth Manhole Wall" shall be made at the unit price bid per vertical foot for each size. The price established shall be full compensation for excavation, backfill, protective coating, outside waterproofing when specified, removal of existing manhole, brick masonry, and all labor, materials, tools, equipment and incidentals necessary to complete this item of work.

Extra depth shall be measured from the invert to within six feet (6') below top of cover.

626.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) SANITARY SEWER MANHOLE (0'-6')	EA.
EXTRA DEPTH MANHOLE WALL	V.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 627 – MANHOLE TESTING

627.01 – DESCRIPTION

This section covers testing of manholes when called for on the plans or specified. Manholes shall be tested, before acceptance, by either performing exfiltration or vacuum test. The Engineer shall determine which test shall be performed.

627.05 – TESTING

627.05.01 – EXFILTRATION TEST

All incoming and outgoing lines (including services) shall be plugged and the manhole filled with water

up to the bottom of the manhole ring. If the water loss exceeds the maximum allowable as shown, the manhole shall be considered to have failed the test. The Contractor shall drain, perform the necessary repairs as directed by the Engineer, and then retest the manhole until it passes, all at no additional cost to the City.

Manhole Depth (feet)	Maximum Allowable Water Loss
? 8	One (1") inch over Five (5) minutes
> 8	One-eighth (?") inch per vertical Foot of depth over five (5) minutes

627.05.02 – VACUUM TESTING

All incoming and outgoing sewer and service lines shall be plugged, the plugs restrained and the vacuum tester head placed on the manhole ring and sealed. A vacuum of ten inches (10") Hg shall then be drawn on the manhole and the time measured for the vacuum to drop to nine inches (9") Hg. The time measured shall be not less than that shown on the following table.

TABLE 627.05.01 – Manhole Diameter and Time Measured

Manhole Internal Diameter (feet)	Time Measured (seconds)
4	60
5	60
6	60
7	70

627.06 – METHOD OF MEASUREMENT

Payment for "Manhole Testing" shall be made at the unit price called out on plans. The price established shall be full compensation for all material, labor, tools, equipment, and incidentals necessary to complete this item of work.

627.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MANHOLE TESTING	LS. (< 24")
MANHOLE TESTING	EA. (= 24")

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 628 – SANITARY SEWER MANHOLE REHABILITATION

628.01 – DESCRIPTION

This section covers rehabilitation of existing manholes. This section is to provide for all aspects of manhole rehabilitation and waterproofing using various procedures either singularly or in combination.

Sewer manhole rehabilitation shall include the following work:

A) Plugging, patching, and waterproofing of the manhole structure, (including manhole chimney, corbel/cone, wall, and base with mortars), coatings and sealants to improve the surface condition, eliminate infiltration, and provide corrosion protection.
B) Lining or coating of manholes.
C) Cleaning Manholes
D) Reconstruction of benches and inverts

E) Repair or rebuilding of the manhole chimney and corbel to improve structural condition when excavation is required.
F) Removal of steps or ladder
G) Reinstallation or replacement of manhole rings and covers for grade adjustment, ring alignment, or inflow elimination.
H) Elimination of infiltration/inflow under manhole rings.
I) Elimination of inflow through and around manhole covers.

628.04 – CONSTRUCTION METHODS

628.04.01 –SEWER FLOW CONTROL

Manhole sewer flow control shall be accomplished in accordance with Section 618.

628.04.02 – CLEANING MANHOLES

Prior to any rehabilitation work on manholes, all concrete and masonry surfaces shall be cleaned to the satisfaction of the Engineer. Grease, laitance, loose bricks, mortar, unsound concrete, and other materials shall be completely removed. Water blasting with a minimum of five thousand (5,000 psi) pounds per square inch pressure at the nozzles shall be the primary method of cleaning, however, other methods such as wet or dry sandblasting, acid wash, concrete cleaners, degreasers or mechanical means may be required to properly clean the surface. Surfaces on which these other methods are used shall be thoroughly rinsed, scrubbed, and neutralized to remove cleaning agents and their reactant products. All existing steps and ladders shall be cut and disposed of properly.

628.04.03 – MANHOLE WATERPROOFING

Waterproofing of manholes shall be accomplished in accordance with the requirements of Section 630 to 634.

628.04.04 – PATCHING

General - Work includes patching, reworking, and reforming of invert and bench. Dry voids, cracks, and spalls shall be patched in concrete manholes. Brick manholes shall be re-pointed and filled.

Material - Patching material shall be formulated for use in high sulfide environments. Patching material shall be a premixed non-shrink cement-based patching material consisting of hydraulic cement, graded silica aggregates, special plasticizing and accelerating agents, which has been formulated for vertical or overhead use. It shall not contain chlorides, gypsums, plasters, iron particles, aluminum powder, or gas-forming agents or promote the corrosion of steel with which it may come into contact. Set time shall be less than thirty (30) minutes [ASTM C-191] with a maximum volume change of 0.02% percent [ASTM C-596] and designed to resist freeze-thaw environments. One-hour compressive strength shall be a minimum of two hundred (200 psi) pounds per square inch [ASTM C-109] and the ultimate compressive strengths shall be a minimum of five thousand (5000 psi) pounds per square inch [ASTM C109]. Bond strength shall be a minimum of one hundred and forty-five (145 psi) pounds per square inch [ASTM C-321].

If patching material is used in combination with a liner material, the products shall be deemed compatible as determined by the manufacturer. The following materials have been approved for use in accordance with the manufacturer's recommendations.

Strong-Seal QSR
IPA Systems Octocrete

Method - Loose material shall be removed from the area to be patched or pointed exposing a sound subbase. Holes or voids around steps, joints or pipes, spalled areas and cavities caused by missing or broken brick shall be patched and missing mortar repointed using a non-shrink patching mortar.

Cracks not subject to movement and greater than one sixteenth (1/16”) inch in width shall be routed out to a minimum width and depth of one half (1/2”) inch and patched with non-shrink patching mortar.

Epoxy grouts may be used for filling cracks and voids less than two (2”) inches in any dimension when preparing surface for application of an epoxy resin lining. The epoxy grout shall be Raven 810 High Build Epoxy Coating or approved equal.

628.04.05 – INVERT AND BENCH RECONSTRUCTION

Invert and bench reconstruction shall be accomplished in accordance with Section 635.

628.04.06 – RAISING MANHOLE

Raising manhole shall be accomplished in accordance with Section 457.

628.04.07 – LOWERING MANHOLE

Lowering manhole shall be accomplished in accordance with Section 458.

628.04.07 – RESETTING EXISTING MANHOLE RING AND COVER

Resetting existing manhole ring and cover shall be accomplished in accordance with Section 459.

628.04.08 – SETTING NEW MANHOLE RING AND COVER

Setting new manhole ring and cover shall be accomplished in accordance with Section 460.

628.04.09 – DELETED

628.04.10 – REHABILITATION METHOD

Manhole may be rehabilitated using one of the following methods as called for on the plans or as directed by the Engineer. Liner shall not be applied until all other repairs have been completed.

Rehabilitation Methods	Section
Cast-In-Place Concrete Manhole Liner	636
Cementitious Manhole Liner (Spray Applied)	637
Cured-In-Place Manhole Liner	638
Composite Manhole Liner (Grouted)	645
* Elastomeric Manhole Coatings	646

* Note: This rehabilitation method may be used only on manholes that do not have exposed rebars or bricks missing.

628.04.11 – SERVICE CONNECTIONS

All services connections shall be reinstated.

628.05 – TESTING

628.05.01 – MANHOLE TESTING

When called for on the plans or specified, manhole testing shall be accomplished in accordance with Section 627.

628.06 – METHOD OF MEASUREMENT

Payment for "Sanitary Sewer Manhole Rehabilitation" shall be made at the unit price bid per vertical foot for each internal diameter. The price established shall be full compensation for all materials and labor required to clean, patch, line, tools, equipment and incidentals necessary to complete this item of work.

Payment for this item shall not be made until all rehabilitation on the manhole has been completed.

Measurement shall be made from the bottom of invert to the finished grade.

628.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SANITARY SEWER MANHOLE REHABILITATION V.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

630 – MANHOLE WATERPROOFING

630.01 – DESCRIPTION

This section covers the requirements for the elimination of infiltration/inflow into manholes that are otherwise structurally sound. The waterproofing of the manhole shall include base, walls, corbel/cone, and chimney of brick, block or pre-cast manholes.

630.02 – MATERIALS

630.02.01 – GENERAL

The materials used shall be designed, manufactured, and intended for sewer manhole rehabilitation and the specific application in which they are used. The materials shall have a proven history of performance in sewer manhole rehabilitation. The materials shall be delivered to the job site in original unopened packages and clearly labeled with the manufacturer's identification and printed instructions. All materials shall be stored and handled in accordance with recommendations of the manufacturer.

630.02.02 – MANHOLE WATERPROOFING MATERIALS

General - After cleaning and preparing surface in accordance with Section 628.04.02, and when necessary, prior to the application of coatings and linings, active leaks shall either be stopped by application of the materials specified herein or an approved equal. When applying a liner or coating, plugging or channeling infiltration through "bleed" pipes installed at the bottom of the manhole may also be done.

Manhole structure waterproofing includes the waterproofing of the manhole base, walls, corbel/cone and chimney. Waterproofing shall be done during high groundwater conditions, unless done in conjunction with application of a liner or coating installed in accordance with Section 630.

Cementitious Grout Materials

A premixed fast-setting, volume-stable waterproof cement plug consisting of hydraulic cement, graded silica aggregates, special plasticizing and accelerated agents not containing chlorides, gas-forming agents, or promote the corrosion of steel it may come in contact with, may be used. Set time shall be approximately one (1) minute. Ten (10) minute compressive strength shall be approximately five hundred (500 psi) pounds per square inch.

The following materials have been approved for use in accordance with the manufacturer's recommendations:

Strong Seal Grout 250
Emaco 503 Hydraulic Cement
Standard Cement's Stop Leak

A) Chemical Grout Materials

1) **General -** All chemical grout or sealant shall comply with EPA requirements for performance attributes for a sewer sealant. In addition, they shall have the following

characteristics:

a) While being injected, the chemical sealant must be able to react/perform in the presence of water (groundwater);

b) The cured material must withstand submergence in water without degradation;

c) The resultant sealant (grout) formation must prevent the passage of water (infiltration) through the sewer joint;

d) The sealant material, after curing, must be flexible as opposed to brittle;

e) In place, the sealant formation should be able to withstand freeze/thaw and wet/dry cycles without adversely affecting the seal;

f) The sealant formation must not be biodegradable;

g) The cured sealant shall be chemically stable and resistant to the mild concentrations of acids, alkalis, and organics found in normal sewage;

h) Packaging of component materials must be compatible with field storage and handling requirements. Packaging must provide for worker safety and minimize spillage during handling;

i) Mixing of the component materials must be compatible with field operations and not require precise measurements of the ingredients by field personnel;

j) Cleanup must be done without inordinate use of flammable or hazardous chemicals;

k) residual sealing materials must be easily removable from the sewer line to prevent reduction or blockage of the sewage flow.

2) **Types** - The Contractor may use one of the following chemical waterproofing materials, or an approved equal:

a) **Acrylamide and Acrylic Base Gels** - Acrylamide and Acrylic Base Gels shall meet the following requirements:

(i) A minimum of ten (10%) percent acrylamide or acrylic base material by volume in the total sealant mixes. A higher concentration (%) of acrylic base material may be used to increase strength or offset dilution during injection;

(ii) The ability to tolerate dilution and react in moving water during injection;

(iii) A viscosity of approximately two (2) centipoise which can be increased with additives;

(iv) A constant viscosity during the reaction period;

(v) A controllable reaction time from ten (10) seconds to one (1) hour for acrylamide base gels and from five (5) seconds to six (6) hours for acrylic base gels;

(vi) A reaction (curing) which produces a homogeneous, chemically stable, non-biodegradable, flexible gel;

(vii) The ability to increase mix viscosity, density, and gel strength, by the use of additives.

b) **Polyacrylamide Base Gel** - Polyacrylamide Base Gel shall meet the following requirements:

(i) A minimum of ten (10%) percent polyacrylamide base material by volume in the total sealant mix. A higher concentration (%) of polyacrylamide base material may be used to increase strength or offset dilution during injection;

(ii) The ability to tolerate some dilution and react in moving water during injection;

(iii) A viscosity of thirty to thirty-five (30-35) centipoise at ten (10%) percent solids as applied. The ability to increase mix viscosity, density and gel strength by use of additives;

(iv) A controllable reaction time from ten (10) seconds to five (5) minutes;

(v) A reaction (curing) which produces a homogeneous, chemically stable, non-biodegradable, firm, flexible gel;

(vi) A resistance to degradation over a pH range of two (2) to ten (10);

(vii) A non-hazardous viscous liquid having ACUTE ORAL/RAT and Desnal/Rabbit LD60 greater than thirty-two (32) g/kg and sixteen (16) g/kg, respectively;

(viii) The ability to use water to clean packers and pumps.

c) **Urethane Base Gel -** Urethane Base Gel shall meet the following requirements:

(i) One (1) part urethane prepolymer thoroughly mixed with between five (5) and ten (10) parts of water by weight;

(ii) A liquid prepolymer having a solids content of seventy-seven (77) to eighty-three (83%) percent, specific gravity of 1.04 (8.65 pounds per gallon), and a flash point of twenty degrees F (20°);

(iii) A liquid prepolymer having a viscosity of six hundred (600) to twelve hundred (1200) centipoise at seventy (70) degrees F that can be pumped through five hundred (600) feet of one-half (1/2) inch hose with a one thousand (1000) pounds per square inch head at a flow rate of one (1) ounce per second;

(iv) The water used to react the prepolymer should have a pH of five (5) to nine (9);

(v) A cure time of eighty (80) seconds at forty (40°) degrees F, fifty-five (55) seconds at sixty (60°) degrees F, and thirty (30) seconds at eighty (80°) degrees F when one (1) part prepolymer is reacted with eight (8) parts of water only;

(vi) A cure time that can be reduced to ten (10) seconds for water temperatures of forty (40°) degrees F to eighty (80) degrees F when one (1) partprepolymer is reacted with eight (8) parts of water containing a sufficient amount of gel control agent additive;

(vii) A relatively rapid viscosity increase of the prepolymer/water mix. Viscosity increases from about ten (10) to sixty (60) centipoise in the first minute for one (1) to eight (8) prepolymer/water ratio at fifty (60°) degrees F;

(viii) A reaction (curing) which produces a chemically stable and non-biodegradable, tough, flexible gel; (9) The ability to increase mix viscosity, density, gel strength and resistance to shrinkage by the use of additives to the water.

(ix) The following materials have been approved for use in accordance with the manufacturer's recommendations:

Avanti International AV - 100
Strata Tech ST 502, 510, or 520 Injection Resin
De Neef Hydroacting Seal Foam
Preco Industries' Preco Plus
Scotch-Seal Brand Chemical Grout 5600 or 5610

3) **Cementitious Coating Material** - A liquid polymer modified hydraulic waterproof coating, which shall provide a secure (mechanical and chemical) bond. The material shall be available in contrasting colors. When fully cured, the two (2) coat or three (3) coat system shall be able to withstand a hydrostatic pressure of seven (7 psi) or thirty (30 psi) pounds per square inch, respectively, without any visible leaks.

a) The following material has been approved for use in accordance with the manufacturer's recommendations:

Tammstech Hey'Di Special System

630.04 – CONSTRUCTION METHODS

A) Grout Waterproofing Method

1) **Equipment** - The basic equipment shall consist of pumps, containers, injection packers, hoses, valves, and all necessary equipment and tools required to seal manholes. The chemical injection pumps shall be equipped with pressure meters that will provide for monitoring pressure during the injection of the grout sealants. When necessary, liquid bypass lines equipped with pressure-regulating bypass valves will be incorporated into the pumping system.

2) **Plugging Procedure** - At each point of leakage within the manhole structure a hole shall be carefully drilled from within the manhole and shall extend through the entire manhole wall. In cases where there are multiple leaks around the circumference of the manhole, fewer holes may be drilled, providing all leakage is stopped from these holes. Grout ports or sealant injection devises shall be placed in these previously drilled holes in such a way as to provide a watertight seal between the holes and the injection device. A hose, or hoses, shall be attached to the injection device from an injection pump. Chemical sealing materials as specified shall then be pumped through the hose until material refusal is recorded on the pressure gauge mounted on the pumping unit or a predetermined quantity of sealant has been injected. Care shall be taken during the pumping operation to ensure that excessive pressures do not develop and cause damage to the manhole structure. Upon completion of the injection, the ports shall be removed and the remaining holes filled with mortar and finished flush by trowel with the surface of the manhole wall or other surface. The mortar used shall be a non-shrink patching mortar meeting the requirements of Section 628.04.04. Small leaks may be sealed without drilling and with grout delivered directly into the site with a caulking applicator.

3) **Packing Procedure** - Dry twisted jute oakum is soaked in polyurethane resin and then manually packed into cavity at site of active flow. Cementitious grouts may be mixed into a thick slurry and then packed directly into gravity. Both procedures require holding the product in place until material sets and the leak is stopped.

4) **Cementitious Waterproof Coating Method** - A waterproof, cementitious coating as specified herein shall be applied to all surfaces, from and including the manhole bench to the bottom of the frame. The material shall be applied to surfaces that are free of cracks or voids wider then one-sixteenth (1/16”) inch. Coating may be applied over minor leaks and weeping around bricks, but major leaks will need to be plugged with cementitious or chemical grout before coating. A minimum of two (2) coats (of contrasting colors) shall be applied to manholes zero (0’) to fifteen (15’) feet, and three (3) coats applied to depths greater than fifteen feet (15’). When completed, the coating shall be free of any cracks or holes.

After proper curing of the applied materials, any "bleed" pipes that were used shall be removed, and the holes plugged and coated with the specified materials.

630.05 – TESTING & INSPECTION OF WATER PROOFING

After the specified waterproofing work has been completed, the manholes shall be visually inspected and tested by the Contractor (as required) in the presence of the Engineer and found to be acceptable.

Manhole structure waterproofing shall be visually inspected for watertightness against leakage of water into the manhole. All visible leaks and defects observed during inspection shall be repaired to the Engineer's satisfaction.

630.06 – METHOD OF MEASUREMENT

Payment for "Manhole Waterproofing" shall be made at the unit price bid per each. The price established shall be full compensation for all materials, tools, labor, equipment and incidentals necessary to complete this item of work.

630.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MANHOLE WATERPROOFING EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 631 – MANHOLE JOINT WATERPROOFING

631.01 – DESCRIPTION

This section covers waterproofing of joints in pre-cast concrete manholes. The work includes the sealing of barrel joints when general structural sealing is not required.

631.04 – CONSTRUCTION METHODS

Chemical Grout Sealing - Chemical grout sealing shall be accomplished in accordance with Section 630.04.

Cementitious Sealing - Cementitious sealing shall be accomplished in accordance with Section 630.04.

Expanded Gasket - Elastomeric polyurethane resin-soaked oakum method, using dry twisted jute oakum or resin rod with polyurethane resin (water activated) may be used.

Manufactured Seal - Manufactured manhole joint seal that generally conforms to the requirements of Section 632 with a stainless steel restraining hoop may be used. Detailed installation procedures shall be in accordance with the manufacturer's instructions.

631.05 – TESTING

Inspection and testing of waterproofing shall be accomplished in accordance with Section 630.05.

631.06 – METHOD OF MEASUREMENT

Payment for "Manhole Joint Waterproofing" shall be made at the unit price bid per each manhole. The price established shall be full compensation for all materials, tools, labor, equipment and incidentals necessary to complete this item of work.

631.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MANHOLE JOINT WATERPROOFING EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 632 – MANHOLE RING WATERPROOFING

632.01 – DESCRIPTION

This section covers manhole ring waterproofing.

632.01.01 – GENERAL

Manhole ring waterproofing includes the sealing of the ring joint area and the chimney above the cone of the manhole with either a manufactured or applied internal or external flexible seal. The seal shall be designed to prevent leakage of water into the manhole through these areas throughout a twenty (20) year design life. The seal shall remain flexible, allowing repeated vertical movements of the frame due to frost lift, ground movement, or other causes of up to two (2) inches and/or repeated horizontal movement of the frame due to thermal movement of pavement or other causes of up to one-half (1/2) inch.

632.04 – CONSTRUCTION METHODS

632.04.01 – GENERAL

Manhole ring waterproofing shall be accomplished by the following methods as directed by the Engineer.

A) Manufactured Chimney Seal

1) **General** - This product cannot be used on cones or where chimneys are "out of round" by more than two (2”) inches. If the flexible portion of the seal is made of a rubber type product, it shall have a minimum thickness of three-sixteenth (3/16”) inch, a minimum unexpanded width of eight (8”) inches, and be fabricated from a high-grade rubber compound conforming to the applicable requirements of ASTM C-923. The internal seal shall have a double pleated and the external seal a corrugated, expandable center section. Any extension used in conjunction with the sleeve to increase coverage shall be made of the same material and have the same minimum thickness as the sleeve and be designed to be mechanically attached to the sleeve. The bands used for compressing the sleeve and extension against the manhole shall be fabricated from minimum sixteen (16) gauge sheet, if channeled, or five-sixteenth (5/16”) inch diameter, if round, stainless steel conforming to ASTM A-240, Type 304, for sheet and ASTM A-479, Type 304, for rods. Any screws, bolts or nuts used on these bands shall be stainless steel conforming to ASTM F-593 and 594, Type 304. The internal seal or its appurtenances shall not extend into the manhole opening to prevent or unduly restrict manhole entry. If the seal is constructed of another flexible material, it shall have both tensile and tear strength equal to or greater than that of the rubber when tested in accordance with the applicable ASTM procedures.

2) **Installation** - The contact surfaces for the sleeve and extensions shall be clean, reasonably smooth and circular, and free of excessive voids. If the masonry surface is rough or irregular and will not provide an effective seal, it shall be smoothed with mortar. A bead of butyl rubber caulk shall be applied to the bottom-sealing surface of the seal or extension to fill minor irregularities in the masonry surface. After the rubber sleeve has been placed in the proper position, the bands are positioned and individually tightened or expanded as required to provide a watertight seal.

   When an extension is used, its top shall be positioned in the bottom band recess prior to installing the bottom band. The bands are then positioned in the extension and tightened or expanded as required to provide a watertight seal. Installation procedures shall be in accordance with the manufacturer's instructions.

B) Applied Ring Seal - An applied seal is one that is achieved by applying a product, approved by the Engineer, either between the precast adjusting rings of the chimney and under the ring or to either

the inside or outside surface of the chimney and ring to provide a seal that meets the performance criteria contained in this section. If the applied sealing product is a butyl compound, all of the surfaces that are to be sealed shall be clean, dry and dust free.

For application of flexible ring seal between joints, the waterproofing seal shall be applied only when setting the manhole ring to brick or cast-in-place manholes. For precast manholes, the waterproofing seal shall be applied between all adjustment ring joints including adjustment ring/cone joint, and to set the manhole ring.

If the applied seal utilizes the elastomeric polyurethane resin-soaked oakum method, each joint shall consist of two (2) concentric rings of two (2”) inch oakum. The outer ring shall be saturated with the urethane-base foam chemical-sealing material. The inner ring, saturated with water, shall be placed to prevent urethane foam from entering the manhole. The oakum saturated with urethane shall be sprayed with water. When foaming begins, the frame shall be set in place.

If the applied sealing product is a type of material that is applied to either the inside or outside surfaces of the ring and chimney and/or corbel/cone, the surface against which it is applied shall be clean, and free of rust, dust, oil, loose material and other contaminants. The product shall be applied by trowel, roller, or by spraying to achieve a thickness of not less than one hundred (100) mils. The sealing material shall extend far enough onto the ring to insure bonding and cover enough of the chimney to insure sealing. Application procedures shall be in accordance with the manufacturer's instructions.

632.04.02 – SETTING EXISTING OR NEW MANHOLE RING AND COVER

Setting of the manhole ring and cover shall be in accordance with ring seal manufacturer's instructions.

632.05 –TESTING

Inspection and testing of waterproofing shall be accomplished in accordance with Section 630.05.

632.06 – METHOD OF MEASUREMENT

Payment for "Manhole Ring Waterproofing" shall be made at the unit price bid per each manhole. The price established shall be full compensation for all materials, tools, labor, including resetting of existing manhole ring and cover, equipment and incidentals necessary to complete this item of work.

When waterproofing manhole ring requires installation of a new manhole ring and cover, a separate payment for the new manhole ring and cover shall be made in accordance with Section 626.07.

632.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MANHOLE RING WATERPROOFING	EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 633 – MANHOLE COVER WATERPROOFING

633.01 – DESCRIPTION

This section covers the waterproofing of manhole covers.

633.01.01 – GENERAL

Manhole cover sealing includes either the replacement of or sealing of existing manhole covers. All of the methods described, herein, require the thorough cleaning of the ring surface by wire brushing. Detailed installation procedures shall be in accordance with the manufacturer's instructions.

633.04 – CONSTRUCTION METHODS

A) **Cover Conversion** - Reuse the existing cover by making it watertight. This is accomplished by installing a gasket between the cover and the cover-bearing surface of the ring and plugging the vent and pick holes. One of the plugs shall be removable to facilitate removal of the cover.

Manhole cover gaskets and plugs shall be molded from a high-quality rubber compound such as Nitrile, EPDM or a blend thereof. The rubber product shall have a minimum tensile strength of two thousand (2,000) pounds per square inch with a hardness (durometer of sixty (60) ± five (5). The cover gasket shall be provided with an outside rib and have a minimum thickness of three-thirty seconds (3/32) inch.

B) Manhole Insert - Use the existing cover in conjunction with a watertight insert that is installed under the cover and prevents entry of water into the manhole. The manhole insert shall be designed to prevent inflow through and around manhole covers and manufactured to fit the manhole ring upon which the manhole cover rests.

The manhole insert shall be manufactured from a corrosion-resistant material able to withstand the environment of a sanitary sewer system, road salts, oils and fuel that it may come in contact with. The material shall be freeze-thaw resistant and withstand a temperature range of minus fifty (50°) degrees F to two hundred forty-five (245°) degrees F. The manhole insert shall have a minimum thickness of one-eighth (1/8″) inch.

The insert shall have an approved system of relieving gas and vacuum pressure and shall be complete with a closed-cell neoprene or polyethylene gasket with adhesive backing installed on the underside of the insert rim by the manufacturer. The insert shall have a corrosion-resistant strap installed within the bowl for ease of installation and removal. The manhole insert shall be fully seated upon the manhole ring and cover replaced to complete the installation.

633.05 – TESTING

Inspection and testing of waterproofing shall be accomplished in accordance with Section 630.05.

633.06 – METHOD OF MEASUREMENT

Payment for "Manhole Cover Waterproofing" shall be made at the unit price bid per each manhole. The price established shall be full compensation for all materials, tools, labor, equipment and incidentals necessary to complete this item of work.

633.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MANHOLE COVER WATERPROOFING	EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 634 – GROUT CURTAIN WATERPROOFING METHOD

634.01 – DESCRIPTION

This section covers waterproofing manholes by installing a grout curtain.

634.01.01 – GENERAL

When specified or called for on plans, a chemical grout curtain may be installed to prevent infiltration. Ports shall be drilled in a checkerboard fashion in the manhole chimney, corbel, and wall, and a chemical grout is pumped into the surrounding soil through the ports surrounding the manhole to create an impermeable "curtain". For brick and block manholes, the procedure may involve the use of a two-coat cementitious liner as described in Section 637 in combination with the grout curtain.

634.04 – CONSTRUCTION METHODS

634.04.01 – SURFACE PREPARATION

The manhole surface shall be cleaned, patched, and infiltration stopped in accordance with Section 628.

634.04.02 – GROUT PORTS OR INJECTORS

Holes shall be drilled and grout ports or chemical grout injection devices installed to insure proper grouting of the soil outside of the manhole. Some additional ports may be placed after the application of the cementitious liner.

634.04.03 – WATERPROOF COATING

Two (2) or three (3) coats, as required, of a cementitious liner shall be applied as required after any chemical grout is pumped. The liner shall provide a dam to optimize the grout sealing application and shall extend from the manhole base to the bottom of the ring seal.

634.04.04 – CHEMICAL SEALING

Chemical grout gel shall be injected into the soil surrounding the manhole as needed for complete sealing, using the same equipment and procedures as required earlier in this section. Grouts injected into near-surface and chimney-corbel areas shall be modified with shrink control agents, gel reinforcing agents and accelerators as needed for the type of chemical gel used.

634.06 – METHOD OF MEASUREMENT

Payment for "Grout Curtain" shall be made at the unit price bid per vertical foot of manhole. The price established shall be full compensation for all materials and labor including waterproofing grout, liner materials, surface preparation, application, tools, equipment and incidentals necessary to complete this item of work.

634.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

GROUT CURTAIN V.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 635 – INVERT AND BENCH RECONSTRUCTION

635.01 – DESCRIPTION

This section covers the reconstruction of invert and bench of manholes. When called for on the plans or specifications, or as directed by the Engineer, manhole benches and inverts shall be reconstructed in accordance with applicable requirements of Section 626. Hydraulic cement shall meet the requirements of Section 628.04.04.

635.06 – METHOD OF MEASUREMENT

Payment for "Invert and Bench Reconstruction" shall be made at the unit price bid per each. The price established shall be full compensation for all materials, labor, tools, equipment, and incidentals necessary to complete this item of work.

635.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

INVERT AND BENCH RECONSTRUCTION EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 636 – CAST-IN-PLACE CONCRETE MANHOLE LINER

636.01 – DESCRIPTION

This section covers utilization of an internal forming system for casting a structurally independent three-inch (3") concrete wall within the existing manhole. The liner is constructed of high-strength concrete in one pour without seams and without disrupting sewer flows.

636.02 – MATERIALS

636.02.01 – SUBMITTALS

The Contractor shall submit test reports of the concrete mix design meeting the requirements the following sub sections.

636.02.02 – GENERAL

Unless otherwise specified, the concrete shall be a standard (Type I/Type II) Portland cement mix, ASTM C-150, with three-fourth (3/4") inch minus coarse aggregate, ASTM C-33, Size No. 67, producing a minimum twenty-eight (28) day compressive strength of four thousand (4000 psi) pounds per square inch at full cure. When directed by the Engineer, a high-strength, quick-setting cement grout shall be used for positioning and sealing the form at the manhole base.

636.02.03 – FORMS

Segmented stackable steel forms having cylindrical and conical sections with either eccentric or concentric cones are employed. The assembled internal manhole form shall have sufficient stiffness and strength to preclude shifting and/or collapse during concrete placement and to ensure safe man-entry during the procedure. The assembled form shall have appropriate cross section size to provide an annular space with a three (3") inch average and a one and one-half (1 ½") inch minimum thickness.

636.04 – CONSTRUCTION METHODS

636.04.01 – SURFACE PREPARATION

The Contractor shall use cleaning methods that are adequate to remove loose material from the manhole in accordance with Section 628. All existing manhole steps or ladder are to be removed. The Contractor shall take all necessary precautions to prevent falling debris from damaging the manhole trough and/or entering the sewer. Infiltration through existing manhole walls that would adversely affect the material used in the annular space shall be eliminated or reduced to an acceptable level in accordance with Section 630 to 634.

636.04.02 – GENERAL

The Contractor shall place block-outs as needed to provide pipe inlets and outlets of the same diameter through the new concrete wall. All flows through the manhole shall remain active unless otherwise directed by the Engineer.

The internal form shall be sized, erected and braced as necessary to assure that the new interior wall has an average thickness of three (3") inches with a one and one-half (1 ½") inch minimum, extending from the manhole base to the bottom of the corbel/cone. The wall thickness may decrease to a minimum of one and one-half (1 ½") inches at the top of the corbel/cone and through the chimney portion of the manhole. The finished opening shall have a minimum diameter of twenty (20") inches unless otherwise specified.

The form shall be positioned, sealed and finished at the manhole base using cement grout to assure that concrete does not enter the sewer during the procedure. As the concrete is placed, it shall be

consolidated to assure that it makes contact with the form and fills all pockets, seams and cracks within the annular space. The Contractor shall use adequate but not excessive vibration that might cause segregation of the concrete components. The top of the new concrete interior shall not extend into the manhole ring.

When the concrete has sufficiently cured to preclude slump or damage, the form shall be removed. The resultant concrete manhole wall shall be smooth and free of honeycomb and areas of segregated aggregate.

636.05 – TESTING

A set of three concrete cylinders, three (3") inch by six (6") inch, shall be made from each days work with the date, location and job recorded on each. Testing shall be in accordance with ASTM C-39. A laboratory shall make the cylinders for testing. A twenty-eight (28) day compression test will be made and recorded using two (2) of the samples. One (1) sample shall be held for further instructions by the Engineer should the other two (2) fail to meet the specifications for the twenty-eight (28) day compression test.

636.06 – METHOD OF MEASUREMENT

Payment for "Cast-In-Place Concrete Manhole Liner" shall not be made separately, but is included in the unit price bid for "Manhole Rehabilitation" per Section 628.

SECTION 637 – CEMENTITIOUS MANHOLE LINER

637.01 – DESCRIPTION

This section covers the application of a premixed cementitious blend of binders, materials, aggregates, glass fiber and other additives. After mixing with water, the material is spray applied directly to all interior surfaces of manhole in a two (2) coat application with in-between and finish troweling which shall restore structural integrity and provide corrosion protection.

637.02 – MATERIALS

The material may be the following proprietary pre-blended product or approved equal:

A) **Strong-Seal MS-2A and MS-2C** - A mixture of Portland cement, chemically-active aggregates, glass fibers and other additives specifically selected for special properties as manufactured by StrongLite Products Corporation of Pine Bluff, Arkansas and designated Strong Seal MS-2A or MS-2C. Unless otherwise specified or called for on the plans, MS-2C shall be used.

B) **Reliner MSP** - A mixture of cementitious and pozzolantic materials, microsilica one hundred (100%) percent virgin polypropylene fibers, and other additives as manufactured by Standard Cement Materials, Houston, Texas. The "fume silica" shall be Force ten thousand (10,000) Microsilica as manufactured by W.R. Grace Co., Conn.

C) **EMACO S88C** - A mixture of Portland cement, specially graded aggregates, synthetic fibers, and admixtures as manufactured by Master Builders Technologies, Cleveland, Ohio.

D) **Quadex QM-1s Reliner** - A cementitious material enhanced with Donna Fill, a fine-graded granite aggregate as manufactured by Quadex Inc., Cabot, Arkansas.

E) **Physical Properties** - The cementitious liner shall have the following minimum properties at twenty-eight (28) days:

	Test Method	Minimum Value
Compressive Strength	ASTM C-495	3,000 psi
Tensile Strength	ASTM C-496	300 psi

Flexural Strength	ASTM C-293	600 psi
Shrinkage	ASTM C-596	0%
Bond	ASTM C-321	130 psi
Density, when applied		105 pcf

637.03 – EQUIPMENT

The equipment shall be of a type necessary for the application of the proprietary product used as recommended by the manufacturer and approved by the Engineer.

637.04 – CONSTRUCTION METHODS

637.04.01 – SURFACE PREPARATION

Surface preparation shall comply with Section 636.04.01 and the liner manufacturer's recommended procedures.

637.04.02 – APPLICATION

The materials shall be mixed and applied in accordance with the manufacturer's written instructions using approved equipment. When Reliner MSP is used, it shall be in powdered form and all additions must conform to the requirements of ASTM C-94. The material shall be spray applied directly to the prepared manhole surface. The material shall be troweled after each coat. All cementitious liner materials, approved herein, shall completely cover the interior surface of the manhole with a minimum thickness of one-half (1/2) inch.

637.05 – TESTING

Testing shall be done in accordance with Section 636.05.

637.06 – METHOD OF MEASUREMENT

Payment for "Cementitious Manhole Liner" shall not be made separately, but is included in the unit price bid for "Manhole Rehabilitation" as per Section 628.

SECTION 638 – CURED-IN-PLACE MANHOLE LINER

638.01 – DESCRIPTION

This section covers reconstruction and rehabilitation of sanitary sewer manholes by the installation of a resin impregnated flexible felt tube, inverted into the existing manhole. Cured-In-Place Liner and its minimum thickness shall conform to the requirements of ASTM F-1216.

638.02 – MATERIALS

A) **Tube** - The tube shall be compatible with the resin system and shall consist of one or more layers of flexible felt or an equivalent woven or nonwoven material. The material shall be able to stretch to fit irregular manhole sections. Allowance shall be made in the fabrication of the tube so that the installed, formed-in-place-pipe fits snugly to the interior circumference of the existing manhole, while allowing for stretching during inversion.

B) **Resin -** The resin shall conform to the requirements of Section 657.02.

C) **Minimum Physical Properties** - The cured resin impregnated tube shall conform to the requirements of Section 657.

D) **Chemical Resistance** - The resin impregnated tube shall conform to the requirements established in Section 657.

E) **Minimum Thickness** - The installed liner shall have a minimum SDR of 60 and shall meet the

following minimum thicknesses for various manhole internal diameters.

Internal Diameter (feet)	Minimum Thickness (inch)
4	0.80
5	1.00
6	1.20
7	1.40

F) **Submittals** - The Contractor shall provide appropriate submittals in accordance with Section 617.02.01.

638.04 – CONSTRUCTION METHODS

The Contractor shall designate a location where the tube will be vacuum impregnated prior to installation. The Engineer shall inspect the materials and the "wet-out" procedure and approve the location.

The wet-out tube shall be installed in the manhole using a top inversion. The inversion ring shall be built above the top of the manhole to an elevation required to create the standpipe section.

The tube shall be banded to the inversion ring with the impermeable plastic membrane side out and inverted through the ring with a minimal amount of water. The inversion shall be continued with a minimal amount of water until the tube reaches the bottom of the manhole.

After the inversion is completed, the water shall be pumped out if required, and personnel should enter the manhole to manually adjust the tube to fit smoothly against the manhole wall. The tube shall then be filled with water to the predetermined level and the curing process shall begin.

The Contractor shall then supply a suitable heat source and water recirculation equipment. The equipment shall be capable of uniformly raising the water temperature to a level required to effectively cure the resin.

The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing water supply. Another such gauge shall be placed between the tube and the manhole at or near the bottom to determine the temperature during cure. Water temperature in the manhole during the cure period shall be as recommended by the resin manufacturer.

Initial cure shall be deemed to be completed when inspection of the exposed portions of the tube appear to be hard and sound and the temperature sensor indicates that the temperature is of a magnitude to realize an exotherm. The cure period shall be of a duration recommended by the resin manufacturer and may require continuous recirculation of the water to maintain the temperature.

The Contractor shall cool the hardened tube to a temperature below one hundred (100°) degrees F before relieving the hydrostatic head in the inversion standpipe. Cool down may be accomplished by the introduction of cool water into the inversion standpipe to replace water being pumped out of the manhole.

The liner shall be cut off below the manhole cover and sealed as specified. The finished product shall be continuous over the entire manhole and be free from dry spots, delamination and lifts. It shall also meet the leakage requirements or pressure test specified. During the warranty period, any defects shall be repaired at the Contractor's expense.

After the liner has been cured in place, the Contractor shall reconnect the existing pipes entering the manhole as designated by the Engineer. This shall be done from the interior of the manhole by cutting the tube at the pipe openings.

If due to broken or misaligned pipe at the manhole wall the tube fails to make a tight seal, the Contractor shall apply a seal at that point in accordance with section 617.04.

638.06 – METHOD OF MEASUREMENT

Payment for "Cured-In-Place Manhole Liner" shall not be made separately, but is included in the unit price bid for "Manhole Rehabilitation" as per Section 628.

SECTION 645 – COMPOSITE MANHOLE LINER

645.01 – DESCRIPTION

This section covers rehabilitation of sanitary sewer manholes by the installation of a flexible plastic liner with profiled cross section cast into a structurally independent concrete wall three (3") inches thick or as directed by the Engineer.

645.02 – MATERIALS

645.02.01 – SUBMITTALS

Proposed grouting procedure including type of formwork used and/or measures taken to prevent buckling of liner, and cone entry assembly shall be submitted to the Engineer for review and approval. The Contractor shall submit a certificate that the PVC liner furnished under this specification is in conformance with the material and mechanical requirements in the appropriate ASTM and as specified herein. Submittals for concrete mix design shall be in accordance with Section 636.02.01.

645.02.02 – GENERAL

A) **Grout or Concrete** - Grout components shall be clean, fresh, and stored in suitable dry condition. Premixed grout and grout admixtures shall be used in accordance with the manufacturer's instructions and approved by the Engineer. The grout or concrete shall conform to the requirements of Section 636.02.01.

B) **PVC Liner -** The liner shall be of the following types or approved equal:

1) **PVC Panels or Coils** - PVC Panels or Coils shall be as manufactured by Danby of North America, Inc. Columbia, Maryland. The PVC materials shall be made from compounds specified for PVC pipe extrusion suitable for potable water and sanitary sewer, and DWV (Drain/Waste/Vent) with less than ten (10%) percent fillers and shall conform to ASTM D-1784, cell classifications 12454-B, or 13364-A, or 13364-B. The minimum panel base thickness and minimum panel "tee" profile height of the PVC panels shall be as follows, unless otherwise specified by the Engineer:

Dimensions	Minimum Size (inches)
Base Thickness	0.06
"Tee" Profile Height	0.40

2) **PVC Sheeting** - PVC Sheeting shall be as manufactured for Permaform Process by Action Products Marketing Corporation of Johnston, Iowa. The plastic liner shall be a white, high-polymer, vinyl chloride sheeting capable of being cast into the concrete, and made an integral part of the structure. It shall have a minimum thickness of sixty-five (65) mils, and shall be capable of resisting strong acid, alkaline and salt solutions. It shall be Amer-Plate 95Y T-Lock or equal.

3) **HDPE Liner** - HDPE manhole liner system shall be fabricated from polyethylene pipe manufactured in accordance with ASTM F-894. The liner shall have a minimum ring stiffness constant (RSC) of 63, and meet the material requirements of Section 651 as

manufactured by Chevron Spirolite Corporation of Norcross, Georgia.

645.04 – CONSTRUCTION METHODS

645.04.01 – PVC PANELS OR COILS

A) **Liner Installation (Panels)** - If the Contractor chooses to use the PVC liner in the form of panels, the panels shall be cut and trimmed to fit as near as practical to the internal circumference of the structure. The panels shall be placed commencing at the bottom of the manhole with the male locking edge of the panel to the bottom of the manhole. The bottom edge of the first panel shall be set in a bed of fast-setting grout. The panels shall be kept square with the vertical wall. A bead of selected sealant/adhesive, approved by the Engineer, and of sufficient width to seal the joint shall be applied to the female locking edge and the end-joining piece prior to the locks being engaged. The locks shall be snapped together. End joints shall be made with a manufacturer supplied/approved plasticized end-joining material which shall under-lap the panels by not less than three (3") inches. The end joints shall be staggered so the joints are not aligned. A bead of the approved sealant/adhesive shall be placed over the end joint after panel installation. If necessary, the panels may be shimmed off the wall to avoid discontinuities on the surface, or to achieve a more circular interior wall than the original as may be approved by the Engineer

B) **Liner Installation (Coils)** - If the Contractor chooses to use the PVC liner in the form of a one hundred fifty (150') foot - two hundred (200') foot coil of continuous strip, the liner shall be placed commencing at the bottom of the manhole. The ribbed profile of the strip shall be kept offset from the wall by vertical studs/spacers to maintain annular gap to grout (concrete) thickness specified. The strip is manually spirally wound around the interior of the manhole to a height that will exceed a scribe line on the liner that matches the bottom contour of the manhole by two revolutions. The bottom contour of the manhole is then scribed onto the liner. The liner is then cut along the scribe line so as to fit the interface of the bottom of the manhole and the wall. The liner is then positioned down into a bed of hydraulic cement. Winding then proceeds upward with the ribbed profile of the strip spaced from the wall as required. If necessary, the strip may be shimmed off the wall to avoid discontinuities of the wall surface. A bead of selected sealant approved by the Engineer, of sufficient width to seal the joint shall be applied to the male locking edge prior to the locks being engaged. The locks shall be snapped together with a rubber mallet or other means approved by the manufacturer. Additional coils of PVC strip may be introduced by joining the ends of the strip by means of a manufacturer supplied joiner pad inserted on the ribbed side of the strip. The joint shall be sealed on both sides of the strip with the approved sealant and pinned with a nylon fastener if required. Alternatively, the ends of successive coils may be joined in a simple lap joint by grinding off the "T's" on one end and overlapping the other end piece by three (3") to four (4") inches and joining the two with PVC solvent cement. The edge locks on the lapped piece shall be removed also and these locks shall be aligned on both edges at the mating ends. This process shall be done above ground with adequate ventilation. The strip shall be wound just past the designated liner height. After grouting and grout set, the liner shall be trimmed to the designated height.

C) **Grouting** - Once the liner is in place, the hydraulic cement bed at the bottom of the manhole is checked to determine if additional sealing is required. At the top and around the liner shall be placed a series of tubes that act as grout injection tubes. Alternatively or in addition, grout holes may be drilled in the PVC lining at appropriate points and grout pumped into them until satisfactory fill is obtained. When grouting holes are used, the holes shall be sealed with PVC plugs upon grout completion. The grouting plan shall be reviewed and approved by the Engineer in advance of the work. Care shall be taken not to allow the hydrostatic pressure of the fluid grout to buckle with the PVC liner. When required, temporary rigid vertical supports shall be placed on the inner perimeter of the PVC liner while the grout is being placed.

D) **Lining of Cone/Corbel** - The materials used in cone/corbel lining shall consist of truncated pie sections made by diagonally cutting two strips of material and inserting these, along the diagonal cut, into a center joiner strip supplied by the manufacturer. After trimming the ends to approximate the circular radiuses of the top and bottom of the cone and sealing all joints with approved sealant, the truncated pie sections shall be fitted together by interlocking the edges to form the cone lining. The cone lining shall then be braced and grouted after appropriate sealing at the bottom.

645.04.02 – INSTALLATION OF PVC SHEETING

Forms shall be sized, erected and braced as necessary to assure that the new interior wall shall have a minimum thickness of one and one half (1 ½") inches extending from the manhole base to the top of the cone section conforming generally to the interior dimensions of the existing structure. When casting a structurally independent wall three (3") inches in thickness or greater, an internal diameter of forty-two (42") inches shall be maintained in the existing manhole.

The form shall be positioned, sealed and finished at the manhole base to ensure that concrete does not enter the sewer. The PVC liner shall be fitted securely to the exterior of the steel forms during erection. When the forms are removed, any joints in the liner shall be cleaned and fusion or extrusion welded. When directed by the Engineer, the interior surface including welded joints shall be spark-tested with a holiday detector at fifteen thousand (15,000) to twenty thousand (20,000) volts. Any holidays or defects in the liner shall be repaired and retested.

The concrete shall be carefully placed in such a manner as to prevent segregation of the cement and aggregate. The concrete shall be consolidated to fill all pockets, seams and cracks within the existing wall. When the concrete has sufficiently cured to preclude slump or damage, the form shall be disassembled and removed.

Jointing seams in the plastic liner will be fusion welded by qualified personnel using only factory-approved methods and techniques. The welding operation of any joint shall be continuous until that joint has been completed. The welding strip shall be centered over the cleaned surfaces to be joined, and fused across its entire width using a hot air welding gun producing temperatures ranging between five hundred (500°F) and six hundred (600°F) degrees F.

645.04.03 – HDPE LINER

The surrounding roadway material or soil shall be excavated, and the existing chimney and cone sections shall be removed. Undamaged precast sections may be salvaged and reused as directed by the Engineer. All debris shall be properly disposed of off site at the contractor's expense.

The outer diameter of the liner shall not exceed ninety-seven (97%) percent of the internal diameter of the existing manhole. The liner shall be installed spigot end up and accurately trimmed around the bottom to conform to existing benches and sewer lines. The HDPE liner shall be centered in the manhole and the bottom edge set using Ram-nek or an approved equal as a seal between liner and bench and crown of pipes at bottom of manhole. Pipe stubs shall be installed through the liner wall matching inverts and flow lines, and sealed with an approved mastic before grouting annulus. The pipe material shall be a diameter equal to or slightly larger than the existing pipe.

Sound construction practice shall be taken in the placement of grout to insure that the annulus is free of voids and the liner is not buckled during the grouting operation. The annulus shall be filled to the bottom of the top rib on the polyethylene liner.

A polyethylene flat top or cone with bell assembly shall be installed on spigot end of liner and sealed with closure gasket or mastic as directed by the Engineer. The precast cone or slab and ring sections shall be placed so that they are fully supported by the existing concrete walls leaving an approximately one fourth (1/4") inch space between the polyethylene and precast top sections. The ring or cone section of the liner shall be trimmed so that the frame and lid will be fully supported by the concrete walls. The space between the entry sections shall be grouted. All remaining concrete grout exposed to

the sanitary sewer environment shall be coated in accordance with Section 646.

645.05 – TESTING

Testing shall be done in accordance with Section 636.05.

645.06 – METHOD OF MEASUREMENT

Payment for "Composite Manhole Liner" shall not be made separately, but is included in the unit price bid for "Sanitary Sewer Manhole Rehabilitation" as per Section 628.

SECTION 646 – ELASTOMERIC MANHOLE COATING

646.01 – DESCRIPTION

This section covers application of elastomeric coatings to the interior surfaces of a manhole to provide a high level of corrosive protection. The coatings may be sprayed, rolled, brushed or applied by trowel as required by the manufacturer. The material shall be suitable for overhead, vertical and horizontal surfaces.

646.02 – MATERIALS

646.02.01 – SUBMITTALS

The Contractor shall submit a certificate that the coating furnished under this specification is in conformance with the material and mechanical requirements in the appropriate ASTM and as specified herein. The ambient temperatures at time of application shall be recorded and submitted to the Engineer.

646.02.02 – GENERAL

The coating systems may be one of the following types:

A) High-Build Epoxy Coatings - The coating material shall be a two (2) part, one hundred (100%) percent solids epoxy-resin with fibrous and flake fillers specifically designed for sanitary sewer applications. The coating material shall have the following minimum properties as listed below:

	Test Method	**Minimum Value**
* Tensile Strength	ASTM D-638	8,000 psi
* Tensile Elongation	ASTM D-638	20%
* Compressive Strength	ASTM D-2240	80 Shore D
+ 25% Sulfuric Acid	ASTM C-267	¤ 28 days
* Solids by Volume		100%

* System cured for 7 days at 25° C
\+ Topping cured for 3 weeks at 25° C
¤ Days without deterioration after continuous contact with fresh chemical at 25° C

The following coating system has been approved for use in accordance with the manufacturer's recommendations:

	Product
Raven Chemicals, Tulsa, Oklahoma	Raven 405 High Build Epoxy Coating

B) Polyurea Coating Systems - The coating material shall be urethane-based one hundred (100%) percent solids resin with chemically resistant fillers specifically designed for sanitary sewer applications. The coating material, tested at 25°C, shall have the following minimum properties as listed below:

	Test Method	Minimum Value
* Tensile Strength	ASTM D-412	1,800 psi
* Recoverable Elongation	ASTM D-412	300%
* Surface Hardness	ASTM D-2240	80 Shore A
+ 20% Sulfuric Acid	ASTM C-267	¤ 28 days
* Solids by Volume		100%

The following coating systems have been approved for use in accordance with the manufacturer's recommendations:

	Product
Structural Polymer Systems, Inc., Chicago, IL	Spray-Seal
Thane-Coat, Inc., Houston, TX	T-C 300

646.04 – CONSTRUCTION METHODS

646.04.01 – SURFACE PREPARATION

Infiltration shall be stopped and surface preparation shall be accomplished in accordance with Section 636.04.01. Mechanical cleaning shall be done to provide a good bond between the epoxy coating and the substrate. Waterblasting with a minimum of five thousand (5,000 psi) pounds per square inch shall be done to remove oil, grease and foreign materials from all surfaces to be coated. For brick manholes, use a minimum of six thousand (6,000 psi) pounds per square inch of water pressure. In areas where the concrete has become softened due to chemical attack, several millimeters of the wall surface shall be removed using water pressures of twenty-five thousand (25,000 psi) pounds per square inch to thirty-five thousand (35,000 psi) pounds per square inch, or as recommended by the coating manufacturer, to ensure that a sound substrate is exposed. Surfaces shall be made damp or dry as required by the manufacturer before application of coating system begins.

646.04.02 – APPLICAT ION

The material shall be mixed and applied, in two (2) or three (3) coats, in accordance with the manufacturer's written instructions, using approved equipment. When applying a Polyurea coating, all surfaces to be coated shall be primed as required by the manufacturer. The material shall be applied to all interior surfaces of the manhole with a minimum thickness of one hundred (100) mils.

The Contractor shall allow a minimum of two (2) hours cure time before returning the manhole to active flow conditions or as recommended by the manufacturer. After seven (7) day cure, the liner's surface shall be free of runs, sags, and other irregularities that indicate improper application practice. When directed by the Engineer, liner shall be repaired following the manufacturer's recommendation and to the Engineer's satisfaction.

646.06 – METHOD OF MEASUREMENT

Payment for "Elastomeric Manhole Coating" shall not be made separately, but is included in the unit price bid for "Sanitary Sewer Manhole Rehabilitation" as per Section 628.

SECTION 647 – REINFORCED CONCRETE PIPE (RCP)

This Section is for Sanitary Sewer only. See Section 453 and 945 for other applications.

647.01 – DESCRIPTION

This section covers bar-cage reinforced concrete pipe and fittings with O-ring rubber gasketed joints

intended to be used for conveyance of sewage and industrial waste. Pipes shall be supplied in nominal diameters forthy-two (42") inches and larger.

647.02 – MATERIALS

647.02.01 – SUBMITTALS

Drawings, specifications, schedules, and other data showing complete details of the fabrication and construction of pipe and fittings, together with complete data covering all materials proposed for use, shall be submitted. The drawings and data shall include, but shall not be limited, to the following for each size of pipe.

A) Data on reinforcement
B) Details of joints
C) Details of fittings and specials
D) Test reports
E) Laying schedule
F) Type "A" Certification for pipe and protective lining
G) Type "D" Certification and sample of Elastomeric O-ring gasket
H) Documentation of an ongoing manufacturer's quality control program

All material furnished under certification shall be tagged, stenciled, stamped or otherwise marked with a lot number, heat number, order number, or other appropriate identification which can be readily recognized and checked against the certification. The Contractor shall submit six (6) copies of all submittals requested in this specification.

647.02.02 – PIPE

All pipe and fittings shall be manufactured in accordance with the following ASTM Standards or as modified herein.

1) ASTM C-76, Standard Specification "Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe".
2) ASTM C-655, Standard Specifications for "Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe".

Except for special design pipe, all concrete sewer pipe shall be ASTM C-76, Wall Type B and shall conform to Section 647.02.04. Except for fittings and closure pieces, each pipe shall be not less than seven and one half (7 ½') feet long.

647.02.03 – MATERIALS

Unless otherwise specified, all materials used in the manufacture of pipe, fittings, and accessories shall conform to ASTM C-76 or as modified herein.

A) **Fine Aggregate** - Fine aggregate shall conform to the requirements of ASTM C-33, and shall be clean natural sand. Artificial or manufactured sand will not be acceptable.
B) **Cement** - Cement shall conform to the requirements of ASTM C-150 containing not more than five (5%) percent tricalcium aluminate.
C) **Gaskets** - Gaskets shall conform to requirements of ASTM C-361, Section 6.9.1, except minimum tensile strength shall be fifteen hundred (1,500 psi) pounds per square inch, Shore A, hardness shall be forty (40). Polymer used in the manufacture of gaskets shall be synthetic rubber. Natural rubber will not be acceptable.
D) **Rubber Joint Filler** - Rubber joint filler shall be synthetic.
E) **Hardness** - Hardness shall be forty (40) plus or minus (±) five (5) when measured in accordance with ASTM D-2240, Type A durometer.
F) **Tensile Strength** - Tensile strength shall be twelve hundred (1,200 psi) pounds per square

inch minimum.

647.02.04 – MINIMUM PIPE DESIGN

A) **Design Basis** - Reinforced Concrete Pipes are designed using procedures outlined in Concrete Pipe Design Manual published by American Concrete Pipe Association. The minimum pipe designs provided herein are for AASHTO HS-20 truck highway live loading and Cooper Axle E-80 Railroad live loading conditions.

The designs are based on ordinary clay backfill with kμ' of 0.130 and a unit weight of one hundred twenty (120 pcf) pounds per cubic foot, Class "B" Bedding Installation and the maximum trench width specified in Section 212.04.02.

B) **Highways** - Minimum pipe classes for diameter forty-two (42”) inches to one hundred and two (102”) inches meeting the requirements of ASTM C-76 shall be as follows:

Maximum Depth of Cover (feet)	Minimum Class
10	III
15	IV
25	V

For maximum depth of cover of thirty (30’) feet, pipes ranging from forty-two (42”) inches to fifty-four (54”) inches in diameter shall be designed and manufactured in accordance with ASTM C-655 and shall have the following minimum three-edge bearing strength for 0.01 inch crack ($D_{0.01}$) in pounds per lineal foot per foot of inside diameter:

Pipe Nominal Size (inches)	$D_{0.01}$ (lb/lineal foot per foot of inside diameter)
42	3450
48	3300
54	3125

Pipes ranging in diameter from sixty (60”) inches to one hundred and two (102”) inches shall be Class V for a maximum depth of cover of thirty (30’) feet when manufactured in accordance with ASTM C-76.

C) Railroads - Minimum pipe classes for E-80 Railroad live load for pipe size forty-two (42”) inches to one hundred and two (102”) inches in diameter meeting the requirements of ASTM C-76, or ASTM C-655 shall be as follows:

? Maximum depth of cover ten (10’) feet - Diameters forty-two (42”) inches to one hundred two (102”) inches shall be Class IV.

? Maximum depth of cover fifteen (15) feet - Diameters forty-two (42”) inches shall be Class V and diameters forty-eight (48”) inches to one hundred two (102”) inches shall be Class IV.

? Maximum depth of cover twenty (20’) feet - Diameters forty-two (42”) inches to one hundred two (102”) inches shall be Class V.

? Maximum depth of cover twenty-five (25’) feet - Diameters forty-two (42”) inches to one hundred two (102”) inches shall be Class V.

? Maximum depth of cover thirty (30’) feet - Diameters forty-two (42”) inches to sixty (60”) inches shall have the following $D_{0.01}$.

Pipe Nominal Size (inches)	$D_{0.01}$ (lb/lineal foot per foot of inside diameter)
42	3550

Pipe Nominal Size (inches)	$D_{0.01}$ (lb/lineal foot per foot of inside diameter)
48	3400
54	3225
60	3100

Diameters sixty-six (66”) inches to one hundred and two (102”) inches shall be Class V.

647.02.05 – JOINTS

Joints shall be formed concrete bell and spigot types, conforming to Section 8 of ASTM C-361 except as modified herein.

Gaskets shall have a circular cross section and shall be confined in a groove in the pipe spigot. Pipe with collars in lieu of integral bells will not be acceptable.

Each concrete pipe joint shall be designed to withstand, without cracking, the gasket compression plus a differential load across the joint equal to four thousand (4,000 psf) pounds per foot of internal diameter.

Pipe sections connecting to manholes shall have a joint in each line within four (4’) feet of the inside face of each manhole or other structure.

647.02.08 – REINFORCEMENT

Circumferential reinforcement shall be full-circle type. Elliptical or part-circle reinforcement shall not be acceptable unless otherwise specified by the Engineer. The total area of longitudinal steel shall be not less than two-tenths (0.2%) percent of the concrete cross sectional area of the pipe. Longitudinal steel shall be spaced uniformly around the pipe and shall consist of at least eight (8) continuous or lap-spliced (20 bar diameters for deformed bars or 40 bar diameters for smooth bars) wires or bars in each cage. Splices shall not be welded.

At least three (3) circumferential bars shall be provided in each pipe bell. The bars shall be placed with one and one-half (1 1/2) times the socket depth from the end of the pipe and shall be equal in area to an equivalent length of the outside cage in the pipe barrel. The end circumferential bar shall be placed one inch (1) from the face of the bell. The inside cage (or the single cage) in the pipe barrel shall be extended to within one inch (1) of the end of the spigot.

The minimum concrete cover over circumferential reinforcement, except under the spigot groove of pipe with concrete spigots, shall be not less than three-fourths (3/4”) inch for fifty-four (54”) inch and smaller pipes or one (1”) inch for sixty (60”) inch and larger pipes.

647.02.09 – FITTINGS

A) **General** - All bends, tees, closure pieces, wall fittings, and other fittings which are indicated on the drawings or required to complete the work shall be furnished. Except as modified or otherwise provided herein, the design and manufacture of fittings shall be governed by the same requirements as the connecting piping.

B) **Bends** - At the option of the Contractor, bends for concrete sewer pipe shall be fabricated from segments of a steel cylinder with concrete or mortar lining and reinforced concrete exterior covering, or from segments of concrete pipe miter cut while the pipe is still green. The deflection angle between adjacent segments shall not exceed thirty (30°) degrees.

Steel cylinders for bends shall be at least USS ten (10) gauge and shall be lined with concrete or mortar at least three quarters (3/4”) inch thick. Bends fabricated from steel cylinders shall be designed for the same three-edge bearing loads as the adjacent piping.

Bends fabricated from miter cut segments of green concrete pipe shall have the concrete removed from around the reinforcing steel as necessary, the steel shall be welded, and the

concrete shall be replaced. After installation, the entire bend shall be encased in concrete. Concrete encasement shall be at least eight (8”) inches thick all around and shall extend the full length of the bend.

C) **Wall Fittings** - Bell type wall fittings shall be provided at the locations indicated on the drawings. Wall fittings shall be of the required length and shall have bells to match the joints on the concrete pipe.

D) **Outlets** - Fabricated outlet branches shall be provided as indicated on the drawings.

E) **Closure Pieces** - Closure pieces shall be cut in the field after pipe, fittings and specials, as indicated on the drawings, have been installed. The alignment indicated on the drawings shall be maintained by deflecting joints and by adding fittings if necessary. The length between structures and P.I. locations shall be adjusted in the field as required.

Closure pieces shall be field cut from full length pieces of pipe. At the option of the Contractor, field cuts may be made with a masonry saw or may be chiseled and neatly trimmed. Field cut ends shall be encased in reinforced collars at least eight (8”) inches thick and extending eighteen (18”) inches on each side of the field cuts in accordance with Section 610.

647.02.10 – PROTECTIVE LINING

Protective lining for reinforced concrete pipe shall be as follows:

Pipes Forty-two (42) Inches and Smaller - Interior surfaces of pipe shall be shop coated with a total dry film thickness of not less than 40 mils of coal tar epoxy or approved equal.

The coating material shall be TNEMEC 46H-413 Hi-Build Tnemec-Tar, or an approved equal. The material manufacturer shall furnish an affidavit attesting to the successful use of their material as a lining for applications where sewage conditions are recognized a corrosive or otherwise detrimental to concrete. Coating materials shall be stored, mixed, applied and cured in accordance with guidelines set by the manufacturer.

A daily log shall be kept indicating the date, weather conditions, size and identification numbers of pipe joint coated, and number of gallons of coating applied. The average number of gallons applied shall be equal to or exceed the manufacturer's recommended coverage rate for the coating.

Pipes Forty-two (42”) Inches and Greater - T-Lock liner shall be installed on all inside perimeter, three hundred sixty (360°) degrees. The T-Lock shall be premanufactured plastic lining material (either molded or extruded) for application to reinforced concrete sewer pipe and employing a plastic sheet with T-Lock ribs for mechanical bond to the interior surface of the pipe. This liner shall be a minimum of sixty-five (65) mils thick and as per Ameron "Amerplate T-Lock" or an approved equal. All linings shall be tested to be pinhole free over the extent of the lining.

647.04 – CONSTRUCTION METHODS

647.04.01 – MARKING

Each pipe or fitting shall have the following information plainly and permanently marked thereon. Markings shall be indented in the pipe or painted thereon with waterproof paint.

A) Date of manufacture
B) Manufacturer's name or trademark
C) On bends, the angle turned thereby

647.04.02 – DELIVERY

Prior to delivery to the site, concrete pipe and fittings shall be cured in the manufacturer's facilities until concrete control cylinders representing such pipe have attained a compressive strength of a least eighty (80%) percent of the specified minimum twenty-eight (28) day strength.

647.05 – TESTING

647.05.01 – PRELIMINARY TESTS

All preliminary tests shall be made at the Contractor's expense. Reports covering the following tests on each size of pipe shall be submitted for review.

A) Joint Leakage - Joint leakage shall be in accordance with ASTM C-443, Section 10.
B) Joint Shear - Suitable arrangement, to apply the specified loads, shall be provided to protect against joint shear.
C) Cement - Mill test report showing tri-calcium aluminate content.
D) Three-Edge Bearing - Three-Edge Bearing shall be accomplished in accordance with ASTM C-497. The reports shall indicate load required for 0.01 inch crack and for ultimate strength.
E) Absorption - Absorption test shall be accomplished in accordance with ASTM C-497. Absorption shall not exceed 5.5 percent (5.5%).

Tests for joint leakage, joint shear and three-edge bearing are for proof of design only. Reports covering tests made on other pipe of the same size, as specified herein, and manufactured from materials of equivalent type and quality, may be acceptable unless otherwise specified by Engineer.

647.05.02 - CONTROL TESTS

Control tests shall be made during the manufacture of the pipe to determine strength and absorption. Control tests shall be made by an independent testing laboratory at the expense of the Contractor.

At the option of the Contractor, strength tests may be made on cores or standard concrete cylinders. A set of two (2) cores or four (4) cylinders shall be taken from each day's production and every time the concrete mix is changed. One-half (1/2) of the samples shall be tested at seven (7) days or earlier to determine when the pipe has attained sufficient strength for delivery. The remainder shall be tested at twenty-eight (28) days.

Absorption tests shall be made on cores taken from the pipe barrel. Cores shall be made with a diamond drill and shall not be smaller than two (2”) inches in diameter. One (1) core shall be tested from each of the first three (3) lengths of pipe of each size. Thereafter, cores shall be tested from five (5%) percent of the pipe produced, but not less than one (1) from each day's production.

Core holes shall be repaired by cementing a properly shaped concrete plug in place with epoxy cement or by other methods acceptable to the Engineer.

The City reserves the right to sample and test any pipe after delivery and to reject all pipe represented by any sample which fails to comply with the specified requirements.

647.06 – METHOD OF MEASUREMENT

Reinforced concrete pipe will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

647.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REINFORCED CONCRETE PIPE (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 648 - ABANDONING/REMOVING MANHOLE

648.01 - DESCRIPTION

This section covers abandoning or removing existing manholes when called for on the plans or specified. This work shall be accomplished following abandoning and plugging existing sewer lines.

648.02 - CONSTRUCTION REQUIREMENTS

A) **Abandoning Manhole** - This work shall be accomplished in accordance with the Standard Detail for Abandoning Manholes. The manhole shall be broken down to a point two (2') feet below proposed or existing grade.

B) **Removing Manhole** - This work shall be accomplished in accordance with the "Standard Detail for Abandoning Manhole" except the manhole shall be broken down to a point two (2') feet below any proposed construction or totally removed when directed by the Engineer.

C) **Construction** - Manhole shall be filled with sand backfill and shall be compacted in accordance with the requirements of Section 212.

Salvaged materials, including ring and cover shall be disposed of by the Contractor.

648.07 - BASIS OF PAYMENT

Payment for "Abandoning Manhole" shall be made at the unit bid price per each. The price established shall be full compensation for all materials including sand backfill, labor, tools, equipment and incidentals necessary to complete this item of work.

Payment for "Removing Manhole" shall be made at the unit price bid per each when specified as an item of work, otherwise it shall be included in the cost of "Manhole" as per Section 626.

When so classified, the price established for "Removing Manhole" shall be full compensation for all materials including sand backfill, labor, tools, equipment and incidentals necessary to complete this item of work.

ABANDONING MANHOLE	EA.
REMOVING MANHOLE	EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 649 – VITRIFIED CLAY SEWER PIPE (VCP)

649.01 – DESCRIPTION

This section covers vitrified clay pipe and fittings intended to be used for the conveyance of sewage and industrial waste. Pipe may be supplied in sizes ranging from four (4”) inches to forty-two (42”) inches.

649.02 – MATERIALS

649.02.01 – SUBMITTALS

The Contractor shall submit the following:

A) Type "A" Certification for pipes and Type "D" Certification for fittings shall be prepared by the manufacturer and shall consist of a certified copy of a report covering tests conducted by an approved laboratory. Tests performed shall be sufficient to determine the conformance of the material to the Standard Specifications. Such tests shall have been conducted on samples obtained from the lot or lots of material in the shipment.

B) Tests results for Three-Edge Bearing Tests, Hydrostatic Tests, Joint Tests, Joint Leakage, Absorption, and Compressive Strength Tests.

C) The Contractor shall submit six (6) copies of all submittals requested in this specification.

649.04 – CONSTRUCTION METHODS

649.04.01 – OPEN-CUT CONSTRUCTION

A) **General** - All vitrified clay pipes and fittings shall be extra strength and conform to the requirements of the appropriate ASTM listed below or as modified herein.

1) ASTM C-700, Standard Specification for "Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.

2) ASTM C-425, Standard Specification for "Compression Joints for Vitrified Clay Pipe and Fittings."

3) ASTM C-12, Standard practice for "Installing Vitrified Clay Pipelines."

Minimum laying lengths shall not be less than five and one-half (5 ½') feet for pipes twelve (12") inches and smaller, and seven and one-half (7 ½') feet for pipes fifteen (15") inches and larger in diameter.

Pre-fabricated joints shall be of a type where the same resilient material is used both on the spigot end and the bell end of the pipe. Other type joints may be approved by the Engineer in writing, and shall similarly conform to the requirements of said ASTM C-425.

B) **Maximum Depth of Cover** - The maximum depth of cover above top of the pipe shall not exceed the value shown in the table below. The maximum depth of cover for each pipe size is based on AASHTO HS-20 live loading, ordinary clay backfill with kμ' of 0.130 and a unit weight of one hundred twenty (120 pcf) pounds per cubic foot, a design load safety factor of 1.30, Class "B" Bedding Installation, the maximum trench width specified in Section 212, and the minimum required three-edge bearing strength, for each pipe size as specified in ASTM C-700.

TABLE 649.04.01 – Maximum Depth of Cover

Nominal Size (inches)	Minimum Three-Edge Bearing Strength (lb/ft)	Maximum Depth of Cover (feet)
4	2000	25
6	2000	25
8	2200	20
10	2400	18
12	2600	16
15	2900	15
18	3300	14
21	3850	14
24	4400	14
27	4700	13
30	5000	13
33	5500	13
36	6000	13
39	6500	13
42	7000	12

649.04.02 – TRENCHLESS CONSTRUCTION

A) General - All VCP and fittings shall conform to the requirements of ASTM C-1208.

B) Sliplining Installations - Pipes used for sliplining installations shall meet the following requirements:

1) For existing pipes with a nominal inside diameter (I.D.) less then or equal to thirty-three (33”) inches, the outside diameter (O.D.) of the sliplining pipe shall not be more than three (3”) inches smaller than the nominal I.D. of the existing pipe.

2) For existing pipes with a nominal I.D. greater than thirty-three (33”) inches, the O.D. of the sliplining pipe shall not be more than six (6”) inches smaller than the nominal I.D. of the existing pipe.

3) In addition, the maximum outside diameter, and wall thickness of VCP liner pipe shall be as follows:

Existing Sewer Line Nominal Inside Dia. (inches)	Maximum Outside Diameter of VCP (inches)	Minimum VCP Wall Thickness (inches)
12	10.50	1.31
15	14.17	2.17
18	15.60	1.75
21	15.60	1.75
24	20.70	2.50
27	24.55	2.43
30	28.60	2.80
33	31.03	2.86
36	33.46	2.95
42	37.80	3.15

649.06 – METHOD OF MEASUREMENT

Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

649.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

VITRIFIED CLAY SEWER PIPE (VCP)(SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 650 – DUCTILE IRON PIPE (DIP)

650.01 – DESCRIPTION

This section covers Ductile Iron Pipe (DIP) and fittings intended to be used for conveyance of sewage and industrial waste. Pipes may be supplied in sizes ranging from four (4) to sixty-four (64) inches in diameter.

650.02 – MATERIALS

650.02.01 – SUBMITTALS

The Contractor shall submit the following provided that all applicable requirements are met, and that visual inspection at destination shows the workmanship and condition of the material to be satisfactory.

A) Type "A" Certification for pipe
B) Type "D" Certification for elastomeric gasket
C) Shop drawings of the pipe and joints
D) Documentation of an ongoing manufacturer's quality control program

All material furnished under certification shall be tagged, stenciled, stamped or otherwise marked with a lot number, heat number, order number, or other appropriate identification which can be readily recognized and checked against the certification.

The Contractor shall submit six (6) copies of all submittals requested in this specification.

650.02.02 – GENERAL, FITTINGS

All ductile iron pipe and fittings shall conform to the requirements of the following ASTM Standards listed below or as modified herein.

A) ASTM A-746, Standard Specifications for Ductile Iron Gravity Sewer Pipe

B) B) AWWA C-111/ANSI A21.11, Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings

C) AWWA C-150/ANSI A21.60, Thickness Design of Ductile-Iron Pipe

D) AWWA C-151/ANSI A21.61, Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lines Molds, for Water or Other Liquids

E) AWWA C-600, Installation of Ductile Iron Water Mains and Their Appurtenances

Pipe shall be provided on nominal lengths of twenty (20') feet. Pipe joints shall be push-on joints and comply with all applicable requirements of AWWA C-111/ANSI A21.11.

650.02.03 – COATING AND LINING

A) **Exterior Coating** - The exterior of ductile iron pipe, specials and fittings shall be coated with an asphaltic coating in accordance with ASTM A-746, Section 6.1. The coating shall have a minimum thickness of one (1) mil. The finished coating shall be smooth, continuous and strongly adherent to the pipe. Any damage to the outside coating during shipping, storage, handling and installation shall be field repaired with a fresh coating in accordance with the manufacturer's recommendations.

B) **Interior Lining** - Interior surfaces of pipe and fittings shall be lined with forty (40) mils of Virgin Polyethylene complying with ASTM D-1248 or Madison Polyurethane Lining, Corropipe II TX-5 Minute Number 17115, manufactured by Madison Chemicals, Inc., Canada, or an approved equal. The lining materials shall be compounded with a minimum of two (2%) percent carbon black to resist ultra violet rays.

650.02.04 – MINIMUM PIPE DESIGN

Unless otherwise specified, Ductile Iron Pipe shall have the following nominal thickness, in inches, and pressure class shown in the following table.

TABLE 650.02.01 – Minimum Pipe Design - DIP

Pipe Nominal Size (inches)	Depth of Cover (feet)									
	? 10'		> 10' or ? 15'		> 15' or ? 20'		> 20' or ? 25'		> 25' or ? 30'	
	Nominal Thickness (inches)	Standard Pressure Class AWWA C-151	Nominal Thickness (inches)	Standard Pressure Class AWWA C-151	Nominal Thickness (inches)	Standard Pressure Class AWWA C-151	Nominal Thickness (inches)	Standard Pressure Class AWWA C-151	Nominal Thickness (inches)	Standard Pressure Class AWWA C-151
3	0.25	360	0.25	350	0.25	350	0.25	350	0.25	350
4	0.25	360	0.25	350	0.25	350	0.25	350	0.25	350
6	0.25	360	0.25	350	0.25	350	0.25	350	0.25	350
8	0.25	360	0.25	350	0.25	350	0.25	350	0.25	350
10	0.26	360	0.26	350	0.26	350	0.26	350	0.26	350
12	0.28	360	0.28	350	0.28	350	0.28	350	0.28	350
18	0.31	260	0.31	250	0.31	250	0.31	350	0.34	300
24	0.33	200	0.33	200	0.33	200	0.38	300	0.38	300
30	0.34	160	0.34	150	0.34	150	0.42	250	0.45	300
36	0.38	160	0.38	150	0.38	150	0.47	250	0.50	300
42	0.41	160	0.41	150	0.41	150	0.52	250	0.63	350
48	0.46	160	0.46	150	0.46	150	0.64	300	0.70	350
54	0.51	160	0.51	150	0.51	150	0.72	300	0.79	350
60	0.54	160	0.56	150	0.54	150	0.76	300	0.83	350
64	0.56	160	0.56	150	0.56	150	0.80	300	0.87	350

650.06 – METHOD OF MEASUREMENT

Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

650.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

DUCTILE IRON PIPE (DIP)(SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 651 – HIGH DENSITY POLYETHYLENE (HDPE) PIPE

651.01 – DESCRIPTION

This section covers High Density Polyethylene (HDPE) pipe and fittings intended to be used for conveyance of sewage and industrial waste.

651.02 – MATERIALS

651.02.01 – SUBMITTALS

Submittals shall be furnished in accordance with Section 650.02.

651.02.02 – PIPE MATERIALS

The HDPE pipe shall be made of high density plastic compound meeting the requirements of Type III, Class C, Category 5, Grade P34 as defined in ASTM D-1248 and with an established hydrostatic design basis (HDB) of not less than sixteen hundred (1,600) pounds per square inch for water at 73.4° F determined in accordance with ASTM Test Method D-2837. Materials shall also meet the requirements of cell classification PE 345434C or higher cell classification with light color inside, when classified in accordance with ASTM D-3350, and as shown below.

HDPE pipes manufactured for trenchless installations such as sliplining, pipe bursting, etc. may be made, entirely or having inside surface, in light color (e.g. natural, white, green, etc.) to allow light reflection for robotic television inspection. Contractor/Manufacturer shall provide certification that the product has sufficient UV stabilizer for a minimum two (2) years of storage life and meets the requirements established below at the time of installation.

Property	ASTM Test Method	Minimum Value
Density	D-1505	0.941 (gm/cm^3)
Melt Index	D-1238	< 0.15 (gm/10 min.)
Initial Flexural Modulus	D-790	110,000 psi
Long-Term Flexural Modulus	*	28,200 psi
Initial Flexural Strength	D-790	3,000 psi
Long-Term Flexural Strength	*	1,500 psi
Environmental Stress Crack Resistance, Test Condition C, (failure % = hours)	D-1693	F_{20} = 192
Hydrostatic Design Basis	D-2837	1,500 psi
Color & Ultraviolet Stabilizer	D-3350	Black with minimum 2% carbon black

* Note: The long-term values are considered to be for a continuous load duration of fifty (50) years for design loading conditions and shall be certified by the manufacturer.

651.02.03 – SOLID WALL (HDPE)

A) **General** - All solid wall HDPE pipes may be used for open-cut and sliplining installations, in sizes ranging from six (6") inches to forty-eight (48") inches in diameter. All solid wall HDPE pipe and fittings shall be manufactured in accordance with ASTM F-714.

B) **Joint System** - Sections of polyethylene pipe shall be assembled and joined on the job site. Jointing shall be accomplished by the heating and butt-fusion method in strict conformance with the manufacturer's printed instructions.

The butt-fusion method for pipe jointing shall be carried out in the field by operators with prior experience in fusing polyethylene pipe with similar equipment using proper jigs and tools per standard procedures outlined by the pipe manufacturer. These joints shall have a smooth, uniform, double rolled back bead made while applying the proper melt, pressure, and alignment. It shall be the sole responsibility of the Contractor to provide an acceptable water-tight butt-fusion joint. Butt fusion procedures shall be qualified in accordance with Title 49 Code of Federal Register, Part 192.283 and personnel qualified in accordance with 49 CFR 192.285.

Pipe Stiffness - For all open-cut installations, HDPE pipe shall have a minimum pipe stiffness of forty-six (46 psi) pounds per square inch as determined in accordance with ASTM D-2412.

651.02.04 – PROFILE WALL (HDPE)

A) **General** - All open or closed profile wall HDPE pipe and fittings may be manufactured in accordance with ASTM F-894. Pipes shall be supplied in sizes from eighteen (18”) inches to one hundred and twenty (120”) inches in diameter. Regardless of size, open profile wall pipes will be allowed only on sections of pipe when there are no apparent service connections. Otherwise, open profile wall pipes will not be allowed.

B) **Pipe Stiffness** - For all installations specified, HDPE pipe and fittings shall have a minimum pipe stiffness of forty-six (46 psi) pounds per square inch as determined in accordance with ASTM D-2412.

C) **Joint System** - Pipe joining system shall be gasketed type and consist of integrally formed bell and spigot, one which is designed to accommodate a gasket, which when assembled forms a watertight seal by the radial compression. Joints shall provide a watertight seal and meet the requirements of ASTM D-3212.

D) **Gaskets** - Gaskets shall meet the requirements of ASTM F-477 and be molded into a circular form or extruded to the proper section, then spliced into circular form, and shall be made of a properly cured high grade elastomeric compound. The basic polymer shall be neoprene, synthetic elastomer, or a blend of both. The gasket shall be designed with an adequate compressive force, so as to effect a positive seal under all combinations of joint tolerances. Natural rubber gaskets will not be acceptable.

E) **Lubricant** - The lubricant used for assembly shall have no detrimental effect on the gasket or on the pipe. Type and application of the lubricant shall be in accordance with the manufacturer's recommendations.

651.04 – CONSTRUCTION METHODS

651.04.01 - SLIPLINING

A) **General -** Pipes used for sliplining installations shall meet the following requirements:

1) For existing pipes with a nominal inside diameter (I.D.) less then or equal to thirty-three (= 33”) inches, the outside diameter (O.D.) of the sliplining pipe shall not be more than three (> 3”) inches smaller than the nominal I.D. of the existing pipe.

2) For existing pipes with a nominal I.D. greater than thirty-three (> 33”) inches, the O.D. of the sliplining pipe shall not be more than six (6”) inches smaller than the nominal I.D. of the existing pipe.

3) In addition, sliplining pipes shall meet the requirements outlined in parts B or C as applicable.

B) **Solid Wall HDPE Pipes**

1) **General** - Solid Wall HDPE Pipes shall meet the requirements of Section 651.02 Parts “A” and “B”.

2) **SDR -** The HDPE liner pipe shall have the following minimum Standard Dimension Ratio (SDR) for various depths:

Maximum Depth of Cover (feet)	SDR
10	26
15	21
20	19
30	17

3) **Outside Diameter** - The minimum outside diameter (O.D.) of HDPE liner pipe shall be as designated below:

Existing Sewer Line Nominal Inside Diameter (inches)	Minimum O.D. of Liner (inches)
8	7.125
10	8.625
12	10.750
15	12.750
18	16.000
21	18.000
24	22.000
27	24.000
30	28.000
33	30.000
36	32.000
42	36.000
48	42.000
54	48.000

C**) Profile Wall HDPE Pipes -** Profile wall HDPE pipe shall meet the requirements of Section 651.02.04 Parts “A” through “E”.

651.04.02 – PIPE BURSTING, BORING, AND TUNNELING

The HDPE pipe used for these installations shall meet the material requirements of Section 651 and meet the SDR requirements of Section 651.04.01 Paragraph B 2. and have a minimum inside diameter equal to nominal pipe size. Outside diameter requirements of Section 651.04.01 Paragraph B 3 are not applicable.

651.06 – METHOD OF MEASUREMENT

Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

651.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

HIGH DENSITY POLYETHYLENE (HDPE) PIPE (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 652 – POLYVINYL CHLORIDE (PVC) PIPE

652.01 – DESCRIPTION

This section covers polyvinyl chloride (PVC) pipe and fittings intended to be used for conveyance of sewage and industrial waste.

652.02 – MATERIALS

652.02.01 – SUBMITTALS

Submittals shall be furnished in accordance with Section 650.02.

652.02.02 – SOLID WALL (PVC)

All solid wall PVC pipe and fittings shall conform to the requirements of the appropriate ASTM listed below or as modified herein.

A) **ASTM D-3034** - Standard Specification for "Type PSM Poly (Vinyl Chloride) (VC) Sewer Pipe and Fittings". Pipe and fittings shall have a minimum stiffness of forty-six (46 psi) pounds per square inch and a minimum SDR of thirty-five (35). Pipe and fittings may be supplied in sizes ranging from four (4”) inches to fifteen (15”) inches in diameter.

The pipe shall be made of PVC plastic having a cell classification of 12454-B or 12454-C or 12364-C or 13364-B (with minimum tensile modulus of 500,000 psi) as defined in ASTM D-1784. The fittings shall be made of PVC plastic having a cell classification of 12454-B, 12454-C, or 13343-C as defined in ASTM D-1784.

Elastomeric Gasketed Joints shall be used to provide a watertight seal and shall meet the requirements of ASTM D-3212.

B) **ASTM F-679** - Standard Specification for "Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings". Pipe and fittings shall have a minimum stiffness of forty-six (46 psi) pounds per square inch and a minimum SDR of thirty-five (35). Pipe and fittings may be supplied in sizes ranging from eighteen (18”) inches to thirty-six (36”) inches in diameter.

The pipe and fitting materials shall be made of PVC plastic having a minimum cell classification of 12364-C or 12454-C as defined in ASTM D-1784. Homopolymer PVC compounds must equal or exceed the requirements of the above listed minimum cell classification number.

Integral Bell Gasket Joint shall be used to provide a watertight seal and shall meet the requirements of ASTM D-3212.

C) **ASTM F-789** - Standard Specification for "Type PS-46 Poly (Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings". Pipe and fittings shall have a minimum stiffness of forty-six (46 psi) pounds per square inch. Pipe and fittings may be supplied in sizes ranging from four (4”) inches to eighteen (18”) inches in diameter.

The pipe shall be made of PVC plastic having a minimum cell classification of 12164-B as defined in ASTM D-1784. The fittings shall be made of PVC plastic having a cell classification of 12454-C or 13343-C as defined in ASTM D-1784.

Elastomeric Gasketed Joints shall be used to provide a watertight seal and shall meet the requirements of ASTM D-3212. Joints shall also be compatible to ASTM D-3034 joint dimensions.

652.02.03 – PROFILE WALL (PVC)

All profile (open or closed) wall PVC pipe and fittings shall conform to the requirements of the appropriate ASTM listed below and modified herein. Regardless of size, open profile wall pipes will be allowed only on sections of pipe when there are no apparent service connections. Otherwise, open profile wall pipe will not be allowed.

A) ASTM F-794 - Standard Specification for "Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter". Pipe and fittings shall have a minimum stiffness of forty-six (46 psi) pounds per square inch. Pipe and fittings may be supplied in sizes ranging from twelve (12”) inches to forty-eight (48”) inches in diameter.

The pipe and fittings shall be made of PVC plastic having a minimum cell classification of 12454-B or 12364-C as defined in ASTM D-1784.

Gasketed Joint Systems shall be used. The integral bell gasketed joint, coupling or fitting joints shall be designed so that when assembled, the gasket will be compressed radially on the pipe spigot or in the bell to form a watertight seal. The joints shall be designed to comply with and show no leakage when tested in accordance with ASTM D-3212.

Closed profile PVC pipes manufactured with a gasketed joint coupling system, with no bell and spigot, may be used for sliplining installations.

Couplings shall form a watertight seal when assembled with plain end pipe and show no sign of leakage when tested in accordance with ASTM D-3212.

B) ASTM F-949 - Standard Specification for "Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings". Pipe and fittings shall have a minimum stiffness of fifty (50 psi) pounds per square inch. Pipe and fittings may be supplied in sizes ranging from twelve (12”) inches to thirty-six (36”) inches in diameter.

The pipe shall be made of PVC plastic having a minimum cell classification 12454-B or 12454-C as defined in ASTM D-1784. The fittings shall be made of PVC plastic having a cell classification of 12464-B, 12464-C, or 13343-C as defined in ASTM D-1784.

Elastomeric Gasketed Joints shall be used to provide watertight seal and shall meet the requirements of ASTM D-3212.

652.02.04 – SPECIAL PVC PIPE

Special PVC pipe and fittings shall conform to the requirements of the appropriate standards listed below or as modified herein.

A) ASTM D-2241 - Standard Specifications for Polyvinyl Chloride (PVC) Pressure-rated Pipe (SDR Series). Pipe and fittings shall have a minimum SDR of thirty-two and one-half (32 1/2) and may be supplied in sizes ranging from four (4) inches to thirty-six (36) inches in diameter.

The pipe and fittings shall be made of PVC compounds having a cell classification of 12454-B, 12454-C, or 14333-D as defined in ASTM D-1784.

Elastomeric gasketed joints meeting the requirements of ASTM D-3212 shall be used to provide a watertight seal.

B) AWWA C-900 and AWWA C-905 - Standards for PVC Pressure Pipe from four (4”) inches through twelve (12”) inches, and fourteen (14”) inches through thirty-six (36”) inches, respectively. Pipes shall have a minimum DR rating of eighteen (18) for diameters four (4”) inches through twelve (12”) inches. For pipes greater than twelve (12”) inches in diameter, the minimum DR shall be thirty-two and one-half (32 1/2).

The pipe and fittings shall be made of PVC compounds having a cell classification of 12454-A or 12454-B as defined in ASTM D-1784.

Elastomeric gasketed joints meeting the requirements of ASTM D-3139, when measured in accordance with ASTM-2122, shall be used to provide a watertight seal.

652.02.05 – GASKETS AND LUBRICANTS

Gaskets and lubricants shall conform to the requirements of Section 651.02.03 Parts “D” and “E”.

652.02.06 – CHEMICAL RESISTANCE

All PVC pipe and fittings shall have demonstrated a resistance to damage when subjected to exposure and/or contact with liquid sewage and/or gasses associated with sewage and/or high hydrogen sulfide concentration.

652.04 – CONSTRUCTION METHODS

A) Open-Cut - PVC pipe and fittings shall meet the requirements of Section 652.02 through 652.04 as applicable.

B) Pipe Bursting - PVC pipe and fittings shall conform to the requirements of Section 652.04.

C) Jacking - PVC pipe and fittings shall conform to the requirements of Section 652.04.

D) Boring and Tunneling - PVC pipe and fittings shall meet the requirements of Section 652.02 and 652.03.

E) Micro or Small Diameter Tunneling - PVC pipe and fittings shall meet the requirements of Section 652.02 and 652.03, Part “A” and joint requirements specified in Part “F” of this subsection.

Sliplining –

General - PVC pipe shall be manufactured with a gasketed joint coupling system with no bell and spigot providing a watertight seal and meeting the requirements of ASTM D-3212. PVC pipe shall meet the material requirements specified in Section 652.02 and 652.03. The Contractor shall submit detailed drawings of joints to the Engineer for review and approval prior to manufacturing.

Dimensions - Pipes used for sliplining installations shall meet the following general requirements:

For existing pipes with a nominal inside diameter (I.D.) less than or equal to thirty-three (33) inches, the outside diameter (O.D.) of the sliplining pipe shall not be more than three (3) inches smaller than the nominal I.D. of the existing pipe.

For existing pipes with a nominal I.D. greater than thirty-three (33) inches, the O.D. of the sliplining pipe shall not be more than six (6) inches smaller than the nominal I.D. of the existing pipe.

In addition, sliplining pipes shall minimum pipe inside diameter specified and shall meet the following requirements:

Existing Sewer Line Nominal Inside Diameter (inches)	Minimum O.D. of Liner (inches)	Minimum I.D. of Liner (inches)
24	22.110	As Specified on the plans and or contract Documents
27	25.115	
30	28.232	
33	31.415	
36	31.415	
42	37.800	
48	44.200	
64	60.670	

652.06 – METHOD OF MEASUREMENT

Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

652.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

POLYVINYL CHLORIDE (PVC) (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 653 – REINFORCED FIBERGLASS PIPE (RFP)

653.01 – DESCRIPTION

This section covers reinforced fiberglass pipe and fittings intended to be used for the conveyance of sewage and industrial waste.

653.02 – MATERIALS

653.02.01 – SUBMITTALS

Submittals shall be furnished in accordance with Section 650.02.

653.02.02 – GENERAL

All pipes, joints and fittings shall be manufactured in accordance with the requirements of ASTM D-3262 or as modified herein. Pipes shall be supplied in sizes twelve (12) inches and larger.

Pipes shall be centrifugally cast, fiberglass-reinforced polyester resin as manufactured by Hobas USA, Inc. or approved equal.

Prior to manufacturing, the pipe supplier shall provide the Engineer with test reports certifying that the pipe has been tested in accordance with, and exceeds all minimum requirements of ASTM D-2992, ASTM D-3262 and ASTM D-3681. Manufacturer's "in house" testing reports WILL NOT be acceptable as a substitute for independent laboratory testing.

653.02.03 – MINIMUM PIPE STIFFNESS

The pipe stiffness shall be a minimum of forty-six (46 psi) pounds per square inch when measured in

accordance with ASTM D-2412 for all installations except jacking. Other pipe stiffnesses may be used when called for on the plans or as directed by the Engineer.

653.02.04 – MATERIAL COMPONENTS

A) **Resin System** - The manufacturer shall use only approved polyester or epoxy resin systems for which he can provide a proven history of performance for the intended application. The historical data shall have been acquired from a composite material of similar construction and composition as the proposed product.

B) **Glass Reinforcements** - The reinforcing glass fibers used to manufacture the components shall be of highest quality commercial grade of E-glass filaments with binder and sizing compatible with impregnating resins.

C) **Fillers** - Sand may be used as fillers providing that sand shall be a minimum ninety-eight (98%) percent silica with a maximum moisture content of 0.2 percent.

D) **Additives** - Resin additives, such as pigments, dyes, and other coloring agents, if used, shall in no way be detrimental to the performance of the product nor shall they impair visual inspection of the finished product.

E) **Internal Liner Resin** - The internal liner resin shall be suitable for service as sewer pipe, and shall be inert to exposure to sulfuric acid as produced by biological activity from hydrogen sulfide gases. Provide the certified test results from an independent laboratory that the pipe exceeds the requirements of ASTM D-3681.

653.02.05 – DIMENSIONS

A) **General** - Pipe outside diameters shall be in accordance with AWWA Standards C-151 and C-950 and as shown below. The minimum wall thickness(es) shown are for a minimum pipe stiffness of forty-six (46 psi) pounds per square inch.

Nom. Pipe Dia. (inches)	Pipe O.D. (inches)	Min. Wall Thickness (inches)
12	13.20	0.30
14	15.30	0.34
16	17.40	0.38
18	19.50	0.42
20	21.60	0.46
24	25.80	0.54
30	32.00	0.66
36	38.30	0.78
42	44.50	0.90
48	50.80	1.02
54	57.10	1.14
60	62.90	1.26
66	69.20	1.38
72	75.40	1.50
78	81.60	1.62
84	87.00	1.74
90	94.30	1.86
96	100.60	1.98
102	108.00	2.13

Pipe shall be supplied in nominal lengths of ten (10') feet or twenty (20') feet for Jacking, and twenty (20') feet for all other installations. For sliplining installations, where radius curves in the existing pipe or limitations in the entry pit dimensions restrict the pipe to shorter lengths, nominal sections of ten (10') feet or six and two-thirds (6 2/3") feet shall be used. Actual laying length shall be the nominal plus or minus (±) two (2") inches. Except for special order lengths, all pipes shall be furnished in the nominal lengths specified herein. All pipe ends shall be square to the pipe axis plus or minus (±) one-fourth inch (1/4"), or plus or minus (±) five-tenths (0.5%) percent of the nominal diameter (whichever is greater).

B) **Jacking Installations** - Minimum pipe wall thickness measured at the bottom of the spigot gasket groove where the wall cross-section has been reduced, is determined from the maximum allowable jacking load and shall not be less than as shown in the table below:

TABLE 653.02.01 – Jacking Installations Wall Thickness

Nom. Pipe Dia. (inches)	Pipe O.D. (inches)	Min. Wall Thickness (inches)
12	13.20	0.39
14	15.30	0.41
16	17.40	0.42
18	19.50	0.44
20	21.60	0.46
24	25.80	0.60
30	32.00	0.68
36	38.30	0.81
42	44.50	1.03
48	50.80	1.10
54	57.10	1.22
60	62.90	1.29
66	69.20	1.32
72	75.40	1.34
78	81.60	1.54
84	87.00	1.76
90	94.30	1.78
96	100.60	1.88

C) **Sliplining Installations** - Pipes used for sliplining installations shall meet the following general requirements:

1) For existing pipes with a nominal inside diameter (I.D.) less than or equal to thirty-three (=33”) inches, the outside diameter (O.D.) of the sliplining pipe shall not be more than three (3”) inches smaller than the nominal I.D. of the existing pipe.

2) For existing pipes with a nominal I.D. greater than thirty-three (>33”) inches, the O.D. of the sliplining pipe shall not be more than six (6”) inches smaller than the nominal I.D. of the existing pipe.

3) In addition, sliplining pipes shall meet the following requirements:

Exist. Sewer Line Nominal Inside Diameter (inches)	RFP Liner O.D. (inches)	Wall Thickness (inches)
15	13.20	0.30
18	15.30	0.34
21	19.50	0.42
24	21.60	0.46
27	25.80	0.54
30	27.00	0.60
33	30.00	0.66

Exist. Sewer Line Nominal Inside Diameter (inches)	RFP Liner O.D. (inches)	Wall Thickness (inches)
36	32.00	0.66
42	38.30	0.78
48	44.50	0.90
54	50.80	1.02
60	57.10	1.14
66	62.90	1.26
72	69.90	1.38
78	75.40	1.50
84	81.60	1.62
90	87.00	1.74
96	94.30	1.86
102	100.60	1.98

653.02.06 - JOINTS

A) General - Unless otherwise specified, the pipe shall be field connected with fiberglass sleeve couplings that utilize elastomeric sealing gaskets for all installations except jacking and sliplining installations. The joints shall meet the performance requirements of ASTM D-4161.

B) Sliplining Installations - Unless otherwise specified, the pipe shall be field connected with low-profile fiberglass bell and spigot joints. The joints shall meet the performance requirements of ASTM D-4161.

C) Jacking Installations - Unless otherwise specified, the pipe shall be field connected with sleeve couplings or bell spigot joints that utilize elastomeric sealing gaskets as the sole means to maintain joint water tightness. The joint shall have the same outside diameter (O.D.) as the pipe, so when the pipes are assembled, the joints are flush with the outside surface.

653.02.07 – GASKETS AND LUBRICANTS

Gaskets and lubricants shall conform to the requirements of Section 651.02.04, Parts “D” and “E”.

653.02.08 – FITTINGS

Where applicable, flanges, elbows, reducers, tees, wyes, laterals, and other fittings shall, when installed, be capable of withstanding all operation conditions. Acceptable configurations include contact molded or mitered fiberglass properly protected standard ductile iron, fusion bonded epoxy coated steel and stainless steel constructions.

The tolerance of the angle of an elbow and the angle between the main and leg of a wye or tee shall be plus or minus (±) two (2°) degrees. The tolerance on the laying length of a fitting shall be plus or minus (±) two (2”) inches.

653.06 – METHOD OF MEASUREMENT

Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

653.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REINFORCED FIBERGLASS PIPE (RFP) (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 654 – STEEL CASING PIPE

654.01 – DESCRIPTION

This section covers steel pipe intended to be used as a carrier pipe for sanitary sewer aerial crossings or casing pipe for boring and micro and small diameter tunneling installations.

654.02 – MATERIALS

654.02.01 – SUBMITTALS

When requested, the Contractor shall submit the following, provided that all applicable requirements are met, and that visual inspection at destination shows the workmanship and condition of material to be satisfactory.

A) Type "A" certification for pipe and coating
B) Shop drawings of pipe, joints and seams
C) Documentation of manufacturer's on-going quality control program.

654.02.02 – GENERAL

A) General - Steel pipe shall conform to ASTM A-139, Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and Over). The steel material shall be new, smooth wall, carbon steel, Grade B, with minimum sixty thousand (60,000 psi) pounds per square inch tensile strength, and minimum thirty-five thousand (35,000 psi) pounds per square inch yield strength.

The pipe shall be straight seam pipe, seamless pipe, or spiral weld pipe. For spiral weld pipe, the spiral shall be one hundred (100%) percent welded, and the weld's height over the outside wall surface shall be equal to or less than three-sixteenths (3/16”) inch. All steel pipe shall be square cut and shall have a roundness such that the difference between the major and minor outside diameters shall not exceed one (1%) percent of the specified nominal outside diameter or one-fourth (1/4”) inch, whichever is less. The outside circumference must be within plus or minus (±) one (1%) percent of the nominal circumference or within plus or minus (±) one-half (1/2”) inch, which is less. The pipe shall have a maximum allowable straightness deviation in any ten (10’) foot length of one-eighth (1/8”) inch. Steel pipe joints shall be continuously welded with an approved butt weld. The welds shall attain the full strength of the pipe and shall result in a fully watertight section. The welded joints shall conform to the requirements of AWWA C-206.

B) Boring Installations

1) Casing Pipe Size - Steel casing pipe shall have the following suggested inside diameters:

Pipe Nominal Size (inches)	Casing Pipe Inside Diameter (inches)
4	8 to 10
6	10 to 12
8	14 to 16
10	16 to 18
12	18 to 20
15	20 to 22

18	24 to 26
24	31 to 33
27	33 to 36
30	36 to 42
36	42 to 48
42	54 to 60
48	60 to 66

2) Casing Pipe Thickness - Steel casing pipe shall the following minimum thickness(es), in inches, for the indicated maximum depth of cover(s), in feet:

OUTSIDE DIAMETER	**UNDER HIGHWAY**		**UNDER RAILROAD**		
(inches)	**Wall Thickness (inches)**	**Maximum Cover (feet)**	**BNSF (Uncoated) Wall Thickness (inches)**	**Union Pacific Wall Thickness (inches)**	**Maximum Cover (feet)**
? 12 ¾	0.188	30	0.250	0.25	30
16	0..250	30	0.281	0.3125	30
18	0.250	30	0.322	0.322	30
20	0.250	30	0.344	0.344	30
24	0.250	30	0.406	0.406	30
30	0.322	30	0.469	0.469	30
36	0.375	30	0.531	0.531	30
42	0.375	25	0.563	0.563	30
48	0.438	25	0.625	0.625	25
54	0.438	25	0.719	Over 48" Must Be Approved by U.P.R.R.CO.	20
60	0.438	25	0.781		20
66	0.438	20	0.875		20

C) Micro and Small Diameter Tunneling - The steel casing pipe minimum wall thickness for micro and small diameter tunneling shall be one-fourth (1/4") inch.

D) Aerial Crossings - The minimum thickness for steel carrier pipe shall be three-sixteenths (3/16) inch and one-fourth (1/4") inch for diameters of forty-two (42") inches and less, and greater than forty-two (42") inches, respectively.

654.02.04 – EXTERIOR PROTECTIVE COATING

Exposed exterior surfaces shall have protective coating, shop applied coal-tar enamel, conforming to the requirements of AWWA C-203. The coating thickness shall be forty (40) mils, applied in two (2) coats.

654.06 – METHOD OF MEASUREMENT

Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

654.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

STEEL CASING PIPE (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 655 – DEFORMED HIGH DENSITY POLYETHYLENE PIPE

655.01 – DESCRIPTION

This section covers reconstruction and rehabilitation of sanitary sewer lines by installation of a deformed High Density Polyethylene (HDPE) extruded pipe. The process shall use steam and air pressure to progressively inflate the deformed HDPE pipe to conform to the existing pipe wall.

655.02 – MATERIALS

Materials shall meet the requirements of Section 651.02 except that it shall be Class B as defined in ASTM D-1248. The minimum cell classification shall be PE 346434D, white color, as defined in ASTM D-3350.

655.02.01 – MINIMUM THICKNESS

Unless otherwise specified, the installed HDPE pipe shall have the following minimum thickness (es), in inches, shown below, meeting the requirements stated in these specifications and design assumptions outlined in Section 617.02.03.

Pipe Nominal Size (inch)	Depth of Cover (feet)				
	? 10'	> 10' or ? 15'	> 15' or ? 20'	> 20' or ? 25'	> 25' or ? 30'
8	0.307	0.358	0.409	0.450	0.487
10	0.383	0.448	0.511	0.562	0.608
12	0.460	0.538	0.613	0.675	0.730
15	0.575	0.672	0.766	0.844	0.912
18	0.690	0.806	0.919	1.012	1.097
21	0.805	0.941	1.072	1.181	1.277
24	0.920	1.075	1.226	1.350	1.460

655.06 – METHOD OF MEASUREMENT

Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

655.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

DEFORMED HIGH DENSITY POLYETHYLENE PIPE (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 656 – FOLDED POLYVINYL CHLORIDE (PVC) PIPE

656.01 – DESCRIPTION

This section covers reconstruction and rehabilitation of sanitary sewer lines by the insertion of a heated, folded PVC pipe which is then pressurized internally causing it to sequentially unfold and expand against the interior surface of the existing pipe.

656.02 – MATERIALS

The installed folded PVC pipe shall meet the performance requirements of ASTM D-3034. In addition, the PVC Compound used, shall conform to the properties outlined in ASTM D-1784 Classification 12454-B or 12454-C and as outlined below:

PROPERTY	ASTM METHOD	MINIMUM VALUE
Pipe Stiffness	D-2412	46 psi
Pipe Impact Strength	D-2444	220 lb/ft
Pipe Flattening	D-3034	60% Deflection
Initial Flexural Modulus	D-790	360,000 psi
Long-Term Flexural Modulus	*	180,000 psi
Tensile Strength	D-638	6,000 psi

* Note: The long-term values are considered to be for a continuous load duration of fifty (50) years for design loading conditions and shall be certified by the manufacturer.

656.02.01 – MINIMUM THICKNESS

Unless otherwise specified, the installed PVC pipe shall have the following minimum thickness(es), in inches, shown below, meeting the requirements stated in these specifications and design assumptions outlined in Section 617.02.03.

Pipe Nominal Size (inch)	Depth of Cover (feet)				
	? 10'	> 10' or ? 15'	> 15' or ? 20'	> 20' or ? 25'	> 25' or ? 30'
8	0.165	0.193	0.220	0.243	0.262
10	0.207	0.242	0.275	0.303	0.328
12	0.248	0.290	0.330	0.364	0.393
15	0.310	0.362	0.413	0.455	0.493

656.06 – METHOD OF MEASUREMENT

Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

656.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

FOLDED POLYVINYL CHLORIDE (PVC) PIPE (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 657 – RESIN IMPREGNATED TUBE

657.01 – DESCRIPTION

This section covers reconstruction and rehabilitation of sanitary sewer lines by the installation of a resin impregnated flexible felt tube (i.e. Cured-In-Place Pipe, CIPP), inverted into an existing sewer line. Resin impregnated tube shall conform to the requirements of ASTM F-1216.

657.02 – MATERIALS

A) **Tube** - The tube shall be compatible with the resin system and shall consist of one or more layers of flexible felt or an equivalent woven or nonwoven material. The material shall be able to stretch to fit irregular pipe sections and conform to changes in alignment. Allowance shall be made in the fabrication of the tube so that the installed CIPP fits snugly to the interior circumference of the existing pipe while allowing for stretching during inversion.

B) **Resin** - The resin shall be a thermoset and catalyst type, or an epoxy resin and hardener that is compatible with the inversion process.

C) **Minimum Physical Properties** - The cured resin impregnated tube shall meet the minimum physical properties as specified below:

Property	ASTM Method	? Minimum Value (psi)	+ Minimum Value (psi)
Initial Flexural Strength	D-790	4,500	4,000
Long-term Flexural Strength	*	2,250	2,000
Initial Flexural Modulus	D-790	250,000	400,000
Long-term Flexural Modulus	*	125,000	200,000

Notes:
?Materials with initial flexural modulus of 250,000 psi
+Materials with initial flexural modulus of 400,000 psi
*The long-term values are considered to be for a continuous load duration of fifty (50) years for design loading conditions and shall be certified by the manufacturer.

D) **Chemical Resistance** - The resin impregnated tube shall be fabricated from materials with when cured shall be chemically resistant to withstand internal exposure to domestic sewage. Chemical resistance testing shall be preformed in accordance with Appendix X2. of ASTM F-1216 and meet all the requirements specified therein.

657.02.01 – MINIMUM THICKNESS

Unless otherwise specified, for the materials indicated, the installed resin impregnated tube shall have the following minimum thickness(es), in inches, shown below, meeting the requirements stated in Section 657.02 and design assumptions outlined in Section 657.02. Should the Contractor propose a resin system that differs from Section 617.02.03, he shall submit the proposed physical properties for design and calculated minimum thickness for review and approval by the Engineer. The Engineer shall be the sole judge as to the appropriate minimum thickness to be furnished and the use of the product.

Pipe Nominal Size (inches)	Depth of Cover (feet)									
	? 10'		> 10' or ? 15'		> 15' or ? 20'		> 20' or ? 25'		> 25' or ? 30'	
	? Minimum Thickness (inches)	+ Minimum Thickness (inches)	? Minimum Thickness (inches)	+ Minimum Thickness (inches)	? Minimum Thickness (inches)	+ Minimum Thickness (inches)	? Minimum Thickness (inches)	+ Minimum Thickness (inches)	? Minimum Thickness (inches)	+ Minimum Thickness (inches)
8	0.187	0.153	0.218	0.187	0.249	0.213	0.274	0.235	0.297	0.254
10	0.233	0.191	0.273	0.234	0.311	0.266	0.343	0.293	0.371	0.317
12	0.280	0.229	0.328	0.280	0.373	0.319	0.411	0.352	0.445	0.380
15	0.350	0.286	0.410	0.350	0.467	0.400	0.514	0.439	0.556	0.475
18	0.420	0.344	0.491	0.420	0.560	0.479	0.617	0.627	0.667	0.670
21	0.490	0.401	0.673	0.490	0.653	0.558	0.719	0.615	0.777	0.665
24	0.560	0.458	0.655	0.560	0.746	0.888	0.822	0.703	0.889	0.760
27	0.630	0.515	0.736	0.630	0.839	0.718	0.925	0.791	1.000	0.855
30	0.700	0.573	0.818	0.700	0.933	0.798	1.027	0.879	1.111	0.960
33	0.770	0.630	0.900	0.770	1.026	0.877	1.130	0.966	1.222	1.045
36	0.840	0.687	0.982	0.840	1.119	0.957	1.233	1.054	1.333	1.140
42	0.980	0.801	1.145	0.980	1.306	1.117	1.438	1.230	1.655	1.330
48	1.120	0.916	1.309	1.119	1.492	1.276	1.644	1.406	1.777	1.520
54	1.260	1.030	1.473	1.259	1.679	1.436	1.849	1.581	2.000	1.710
60	1.400	1.145	1.636	1.400	1.865	1.595	2.054	1.757	2.221	1.900
66	1.540	1.260	1.800	1.540	2.052	1.754	2.260	1.932	2.443	2.100
72	1.680	1.373	1.963	1.679	2.238	1.914	2.465	2.108	2.665	2.280
78	1.820	1.490	2.127	1.819	2.423	2.073	2.671	2.284	2.888	2.470
84	1.960	1.602	2.291	1.959	2.611	2.233	2.876	2.459	3.110	2.660
90	2.100	1.717	2.454	2.100	2.798	2.392	3.082	2.635	3.332	2.850
96	2.240	1.831	2.618	2.239	2.984	2.552	3.284	2.811	3.554	3.040

Notes:
?Materials with initial flexural modulus of 250,000 psi
+Materials with initial flexural modulus of 400,000 psi

657.06 – METHOD OF MEASUREMENT

Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

657.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

RESIN IMPREGNATED TUBE (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and Incidentals, and for performing the work in accordance with these specifications.

SECTION 658 – SPECIAL SANITARY SEWER PIPE

658.01 – GENERAL

This section covers installation of sewer pipes, as specified herein, at locations called for on the plans, as required to satisfy minimum horizontal and vertical clearance requirements, from waterline, wells, and petroleum storage tanks, as established by the Oklahoma Department of Environmental Quality (DEQ).

658.02 – PIPE MATERIALS

Acceptable pipe materials and fittings shall meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Flexible	Ductile-Iron Pipe (DIP)	650
	Polyvinyl Chloride (PVC) Pipe	652

658.04 – CONSTRUCTION METHODS

Pipe installation shall be in accordance with the requirements and in conformance with the applicable sections of these specifications. If joining dissimilar pipe materials, concrete collars, as per "Standard Detail for Pipe Encasement and Collar", shall be used.

658.06 – METHOD OF MEASUREMENT

Payment for "Special Sanitary Sewer Pipe" shall be made at the unit price bid per lineal foot installed for each size. The price established shall be full compensation for all materials including pipe, concrete collars when necessary, labor, tools, equipment, and incidentals necessary to complete this item of work. Payment shall not include the cost of trench excavation and backfill nor foundation and embedment materials.

"Special Sanitary Sewer Pipe" shall be measured along the pipe, through manhole, junction boxes and other small structures.

658.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SPECIAL SANITARY SEWER PIPE (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 659 - PIPE ENCASEMENT AND COLLAR

659.01 - DESCRIPTION

This section covers protection of sewer lines by concrete pipe encasement and collar where called for on the plans, or as directed by the Engineer.

659.04 - CONSTRUCTION REQUIREMENTS

A) **General** - Pipe encasement and collar shall be constructed in accordance with the "Standard Detail for Pipe Encasement and Collar".

B) **Pipe Encasement** - Pipe encasement shall be placed to the limits shown on the plans.

C) **Collar** - Collar shall be concrete encasement placed to a minimum twelve (12") inches on either side of the joint.

659.06 – METHOD OF MEASUREMENT

Payment for "Pipe Encasement" and "Collar" shall be made at the unit price bid per cubic yard of concrete. The price established shall be full compensation for labor, materials, including concrete, tools, equipment, and incidentals necessary to complete this item of work.

SECTION 660 – AERIAL CROSSING

660.01 – DESCRIPTION

This section covers construction of aerial sewer crossing as shown on the plans. Each crossing involves excavation and backfill, construction of reinforced concrete bases and piers, carrier pipe, sewer pipe, and all incidental work.

660.02 – MATERIALS

A) **Sewer Pipes** - All pipes shall conform to the requirements of Section 610.

B) **Carrier Pipe** - Acceptable carrier pipe material shall meet the requirements of the appropriate section listed below:

Carrier Pipe Material	Section
Steel Casing Pipe	654.02

C) **Formed Reinforced Concrete**

Unless otherwise specified, all concrete used in construction of sanitary sewers and their appurtenances shall have a minimum twenty-eight (28) day compressive strength of thirty-five hundred (3,500 psi) pounds per square inch. All steel reinforcement used shall be grade sixty (60) with a minimum yield strength of sixty (60,000 psi) pounds per square inch.

660.04 – CONSTRUCTION METHODS

A) **General** - Construction of aerial crossing shall be as called for on the plans and in accordance with the "Standard Detail for Aerial Crossing".

B) **Skid Supports** - Skid supports shall comply with the requirements of Section 252.04, Part “C”.

C) **Plugging Pipe Ends** - Plugging Pipe Ends shall comply with the requirement of Section 252.04, Part “D”.

660.06 – METHOD OF MEASUREMENT

A) Payment for "Aerial Crossing" shall be made at the unit price bid per lineal foot of pipe for each size. The price established shall be full compensation for materials including carrier pipe, sanitary sewer pipe, skid support, plugging pipe, tie-down straps, anchor bolts, and all tools, labor, equipment, and incidentals necessary to complete this item of work.

B) Payment for Concrete Collar with Spread Footing” shall be made at the unit price bid per each. The price established shall be full compensation for excavation and backfill, compacted rock foundation, materials including reinforced concrete for footing and collar, labor, tools, equipment, and incidentals necessary to complete this item of work.

C) Payment for "Pier" shall be made at the unit price bid per vertical foot for each pier shaft for either Type I or Type II. The price established shall be full compensation for excavation materials, including reinforced concrete for piers, labor, tools, equipment, and incidentals necessary to complete this item of work. Measurement for payment shall be made from the top of the collar to the bottom of the pier.

660.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

AERIAL CROSSING (SIZE)	L.F.
FOOTING	EA.
PIERS (TYPE)	V.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 690 – SANITARY SEWER CONSTRUCTION STANDARD BID ITEMS

690.01 – DESCRIPTION

This section covers Standard Bid Items used in the contract documents for the construction of sanitary sewers and their appurtenances. Additional bid items may be called out in the Special Provisions, other sections of the Standard Specifications, or as directed by the Engineer for additional work covered and change orders.

SECTION	DESCRIPTION	UNIT
611	SEWER SERVICE CONNECTION	EA.
611	RISER PIPE	L.F.
612	SEWER SERVICE LINE	L.F.
613	PLUGGING ABANDONED SEWER	EA.
614	ABANDONING SEWER/ABANDONING MANHOLE	C.Y.
615	PIPE BURSTING (SIZE)	L.F.
616	SLIPLINING (SIZE)	L.F.
617	FORMED-IN-PLACE PIPE (SIZE)	L.F.
618	SEWER FLOW CONTROL	L.S.
619	CLEANING SEWER LINE	L.F.
620	SMOKE TESTING	L.F.
622	POINT REPAIR	EA.
623	DEFLECTION TEST (SIZE)	L.S.
623	DEFLECTION TEST (SIZE)	L.F.
624	TELEVISION INSPECTION	STA.
624	TELEVISION INSPECTION (CCTV)	L.F.
625	SEWER LEAK TEST (SIZE)	L.S.
625	SEWER LEAK TEST (SIZE)	L.F.
626	SANITARY SEWER MANHOLE	EA.
626	EXTRA DEPTH MANHOLE WALL(SIZE)	V.F.
627	MANHOLE TESTING	EA.
628	SANITARY SEWER MANHOLE REHABILITATION	V.F.
630	MANHOLE WATERPROOFING	EA.
631	MANHOLE JOINT WATERPROOFING	EA.
632	MANHOLE RING WATERPROOFING	EA.
633	MANHOLE COVER WATERPROOFING	EA.
635	INVERT AND BENCH RECONSTRUCTION	EA.
647	REINFORCED CONCRETE PIPE (SIZE)	L.F.
649	VITRIFIED CLAY SEWER PIPE (VCP)(SIZE)	L.F.
650	DUCTILE IRON PIPE (DIP)(SIZE)	L.F.
651	HIGH DENSITY POLYETHYLENE (HDPE) PIPE (SIZE)	L.F.
652	POLYVINYL CHLORIDE (PVC) (SIZE)	L.F.
653	REINFORCED FIBERGLASS PIPE (RFP) (SIZE)	L.F.
654	STEEL CASING PIPE (SIZE)	L.F.
655	DEFORMED HIGH DENSITY POLYETHYLENE PIPE (SIZE)	L.F.
656	FOLDED POLYVINYL CHLORIDE (PVC) PIPE (SIZE)	L.F.
657	RESIN IMPREGNATED TUBE (SIZE)	L.F.
658	SPECIAL SANITARY SEWER PIPE (SIZE)	L.F.
660	AERIAL CROSSING (SIZE)	L.F.
660	FOOTING	EA.

SECTION	DESCRIPTION	UNIT
660	PIERS	V.F.
610	SANITARY SEWER PIPE (SIZE)	L.F.

TABLE OF CONTENTS
SECTION 700

SECTION 700 – TRAFFIC CONTROL

SECTION 701 - CONSTRUCTION REQUIREMENTS

701.01 – DESCRIPTION

This section covers general construction requirements for traffic control devices and appurtenances.

702.01 – MATERIALS

Materials certifications shall conform to section 106.12 a through c of the Oklahoma Department of Transportation Standard Specifications for Highway Construction 1999 or latest revision thereof.

Certifications must be mailed in quadruplicate to :

City of Oklahoma City
Traffic Management Division
420 West Main Street, Suite 600
Oklahoma City, OK 73102

Certifications will be checked for conformance with the applicable Specifications and an approved copy will be returned to the Contractor.

All materials furnished under certification shall be tagged, stenciled, stamped, or otherwise marked by lot number, order number or other appropriate identification which can be readily recognized and checked against the certification. Materials accepted on certification shall not be incorporated in the work until the certificates have been approved by the Engineer.

703.03 – CONSTRUCTION METHODS

701.03.02 – SIGNAL REPLACEMENT

Where existing signals are in operation, they shall remain in operation until the new signals are substantially complete and capable of operating in either pre-timed, recall or fully actuated modes. Exceptions may be made with permission of the Engineer.

701.03.03 – TRAFFIC SIGNAL START UP

The Contractor must notify the Traffic Management Division a minimum of two (2) working days prior to the start of operation of all new, upgraded or otherwise modified traffic signals.

SECTION 710 – ACTUATED SIGNAL CONTROLLER

710.01 – DESCRIPTION

This section covers the minimum design and operation requirements for two (2) through sixteen (16) phase solid state vehicle actuated traffic signal controllers, cabinets and accessory equipment. All traffic signal controllers, cabinets, and accessory equipment shall meet the requirements of NEMA Publication No. TS2-1992 or its latest revision in addition to the requirements of this specification. Catalog sheets shall be provided to the Engineer on items bid after award of the Contract.

710.02 – MATERIALS

710.02.01 – CONTROLLER UNIT, GENERAL

Interface, physical, functional and environmental standards shall meet the requirements specified by NEMA Publication No. TS2-1992 or its latest revision for Type 2 controller units. The controller unit shall be modular in design. Modules shall be easily removable without the use of special tools. The controller shall be capable of storing all timing in RAM with the power off and without the use of batteries. It shall be possible to upload or download all data through a standard RS232 port to a laptop computer. All controller features shall be in accordance with NEMA Publication TS2-1992 including all of the following:

A) All standard timings
B) Overlaps
C) Preemption operation
D) Diamond phasing
E) Sequential phase operation
F) Split dual ring operation
G) Converting all phases to overlaps

710.02.02 – CONTROLLER DISPLAY

The controller display shall provide simultaneous (i.e., concurrent) presentation, where concurrent states exist, of all of the following states/functions:

Phase Information:

A) Phase or phases in service (one per phase)
B) Phase or phases next to be serviced (one per phase)
C) Presence of vehicle call (one per phase)
D) Presence of pedestrian call (one per phase) The following shall be displayed simultaneously for all phases.

Status of Active Phase in the Ring:

E) Initial
F) Extension
G) Yellow change
H) Red clearance
I) Walk
J) Pedestrian clearance
K) Reason for Green termination
    1) Gap-out
    2) Maximum time-out
    3) Force-off
L) Rest state (dwell)

M) Processor Monitor Indicator (one per controller)

Items A through L shall be displayed by a liquid crystal display (LCD). Item M may be displayed on an LCD or by a discrete indicator. Controller display shall turn off automatically within 5 minutes of last keyboard entry.

710.02.03 – TIMING DISPLAY

The timing display shall use an LCD and shall indicate the current vehicle phase and active interval with a countdown in whole seconds of the time remaining on the active interval. If maximum recall is "on" for the current phase, maximum timing countdown shall be displayed. All displays shall be viewable in direct sunlight.

710.02.04 – PROGRAMMING

The controller shall provide for all control decisions to be performed by a microprocessor. All control functions shall be menu selectable by keyboard entry.

710.02.05 – INTERVAL KEYBOARD ADVANCE

When reading the stored timing for any interval, it shall be possible to read the timing on the next interval in sequence on the same phase with a maximum of one keystroke.

710.02.06 – TIMING INTERVAL

The timing for all phases of each interval shall be displayed at the same time on one screen.

Timing entry shall be maintained for a minimum of 30 days with the removal of power from the

controller without the use of a discrete battery.

710.02.07 – PROGRAMMABLE FUNCTIONS

All programmable functions and variables shall be accessible through :

A) an integral keypad on the face of the unit, and

B) via Port 2 RS-232C Interface and a personal computer

710.02.08 – CONDITIONAL SERVICE

The controller shall provide conditional service operation. This function, when enabled, causes the controller to monitor the time remaining on any even numbered phase which is opposed by an even numbered phase that has gapped out. If the time remaining is sufficient to allow at least a minimum service of its associated odd numbered phase, the controller shall cause the gapped out phase to terminate and shall re-service the odd numbered phase. The opposing odd numbered phase shall not be serviced at this time. It shall be possible to select each barrier separately.

710.02.09 – OVERLAPS

All overlaps shall be generated internally and meet the specifications of NEMA publication No. TS2-1992 or its latest revision. Overlaps shall be keyboard programmable.

710.02.10 – DIAMOND OPERATION

It shall be possible to set up the controller to operate the intersection as a diamond intersection through the keyboard alone utilizing any of the following phasing schemes. This shall be a standard built in function of the controller unit.

A) Lead-Lead
B) Lag-Lead
C) Lead-Lag
D) Lag-Lag
E) TTI-Lead

The phasing schemes listed are identical to those developed by the Texas Transportation Institute, (TTI) and utilized in TTI's PASSER-III software.

710.02.11 – TIME BASE CONTROL

The controller unit shall include provisions for internal Time Base Control meeting the requirements of NEMA Publication TS2-1992 Section 3.8, or its latest revision.

710.02.12 – ACTUATED COORDINATION

The controller unit shall include an internal coordinator. The coordinator shall accept Timing Plan (Dial/Split) and Offset commands from traditional (pre-timed) interconnect systems, from a companion Time Base program, and/or an Internal System Interface.

710.02.13 – PREEMPTION OPERATION

The controller shall provide for preemption operation for emergency vehicles and railroads. A minimum of six (6) separate preempts shall be provided. When both emergency vehicle and railroad preemption are utilized in the same system, railroad preemption shall take priority over emergency vehicle preemption. Preemption shall be a standard built in function of the controller unit.

710.02.14 – PROCESSOR MONITOR

The controller shall have a Processor Monitor to monitor microprocessor operation in accordance with NEMA Publication TS2-1992 Section 3.9.3.1.2 or its latest revision. If failure occurs in the microprocessor, the processor monitor shall initiate flashing operation and the processor monitor indicator on the face of the controller unit shall illuminate.

710.02.15 – DIAGNOSTIC TESTER

The controller unit shall have, as optional equipment, a diagnostic tester for performing comprehensive troubleshooting tests. Displays on the tester or on the controller unit shall indicate a valid completion of the test or an error code that can be translated to locate a component failure.

SECTION 711 – CABINET AND ACCESSORIES

711.01 – DESCRIPTION

The cabinet and all accessories equipment shall meet the requirements of NEMA Publication TS2-1992 or its latest revision in addition to the requirements of this specification. All auxiliary equipment shall be furnished in the price bid for controllers.

711.02 – MATERIALS

711.02.01 – CABINET MATERIALS

Cabinets shall be fabricated of either sheet aluminum or cast aluminum. Sheet aluminum cabinets shall meet the requirements of NEMA Publication TS2-1992 SECTION 7.2.2.1, or its latest revision. Cast aluminum cabinets shall meet the requirements of NEMA Publication TS2-1992 SECTION 7.2.2.2, or its latest revision. Cabinet finish and surface preparation shall meet the requirements of NEMA Publication TS2-1992 SECTION 7.7.3, or its latest revision.

711.02.02 – MINIMUM CABINET DIMENSIONS

The controller cabinet shall conform to the dimensions listed in Table 7.3-1 of NEMA Publication TS2-1992 SECTION 7.3 or its latest revision.

711.02.03 – CABINET SHELVES

The cabinet shall be provided with a sufficient number and sizes of substantial metal shelves or brackets to support the controller unit and auxiliary equipment. The equipment and shelves shall be arranged so that it is possible to remove any piece of auxiliary equipment from the cabinet without removing any other piece of auxiliary equipment.

711.02.04 – CABINET MOUNTING

Cabinets shall be either base-mounted or pedestal mounted as shown on the Plans. Pedestal-mounted cabinets shall meet the requirements of NEMA Publication TS2-1992 SECTION 7.8.2. or its latest revision. Base-mounted cabinets shall meet the requirements of NEMA Publication TS2-1992 SECTION 7.8.3. or its latest revision.

711.02.05 – VENTILATION SYSTEM

The controller cabinet shall be equipped with a ventilation system which meets the requirements of NEMA Publication TS2-1992 SECTION 7.9 or its latest revision. All air intakes into the cabinet shall be equipped with filters meeting the requirements of SECTION 7.9.2.3 of NEMA TS2-1992.

711.02.06 – MAIN DOOR

Cabinets shall be provided with a full front door that provides complete access to the interior of the cabinet. The cabinet door shall meet all the requirements of NEMA Publication TS2-1992 Sections 7.5.1 through 7.5.6 or its latest revision.

711.02.07 – MAINTENANCE AND POLICE PANELS

The cabinet shall be provided with a maintenance panel inside the main door and a police panel accessible from a separate door attached to the main door. Maintenance and Police Panels are described in the sections below.

711.02.08 – MAINTENANCE PANEL

The Maintenance Panel shall be located on the inside of the cabinet door and shall contain the following switches:

A) Auto/Flash Switch
B) Controller Power Switch
C) Stop Timing Switch
D) Detector Test Switches (push button type, one for each vehicle and pedestrian phase)

711.02.09 – POLICE PANEL

The Police Panel shall be located in the Police Compartment which shall be accessible from a door located on the outside of the main door. The Police Compartment and Door shall meet the requirements of NEMA Publication TS2-1992 SECTION 7.5.7 or its latest revision. The Police Panel shall contain one Auto/Flash switch.

711.02.10 – PRINT HOLDER

A heavy-duty clear plastic print holder shall be securely attached to the inside door of the cabinet to provide storage for the cabinet wiring diagrams. The minimum dimensions for the print holder shall be nine (9) by twelve (12) inches.

711.02.11 – CABINET ELECTRICAL DESIGN

Cabinet wiring shall be in accordance with these Specifications and NEMA Publication TS2-1992 Section 5 or its latest revision.

711.02.12 – POWER REQUIREMENTS

The controller and all auxiliary equipment housed within the cabinet assembly shall be designed to operate from 89-135 VAC 60 $\pm$ 3 Hertz single-phase alternating current. Distribution of the AC Power throughout the cabinet shall not occur until the AC+ has first passed through all of the power protection devices or as explicitly permitted by this Specification or by NEMA Publication TS2-1992 or its latest revision.

711.02.13 – AC+ POWER PROTECTION DEVICES

The power protection devices shall include a minimum 30 amp main AC+ power circuit breaker, a minimum fifteen (15) amp auxiliary AC+ power circuit breaker, radio interference suppressor, and lightning and surge protectors. These devices shall be in addition to any protection devices furnished with the controllers and auxiliary equipment housed within the cabinet.

711.02.14 – TERMINALS AND FACILITIES INTERFACE

The Terminals and Facilities Interface shall be designed to meet the requirements of NEMA Publication TS2-1992 Section 5.3.2 or its latest revision.

711.02.15 – GROUNDING SYSTEM

The grounding system shall meet the requirements of NEMA Publication TS2-1992 Section 5.4.2.1, or its latest revision.

711.02.16 – CIRCUIT BREAKERS

The AC+ field service shall be connected to circuit breakers as shown in Figure 5.4.2-1 of NEMA Publication TS2-1992 Section 5.4.2.1. Circuit breakers shall meet the requirements of NEMA Publication TS2-1992 Section 5.4.2.2. The circuit breakers shall be capable of manual operation and clearly marked to indicate the ON and OFF positions. The circuit breaker shall have an adequate rating (amps) to handle the present and future cabinet and signal load.

711.02.17 – RADIO INTERFERENCE SUPPRESSION

The cabinet shall be equipped with a Radio Interference Suppressor meeting the requirements of

NEMA Publication TS2-1992 Section 5.4.2.5, or its latest revision.

711.02.18 – SURGE PROTECTION

An Innovative Technology model #HS-P-SP-120A-60A-RH Protector transient voltage surge suppressor or equivalent shall be installed between the AC power and cabinet mounted on the side of the cabinet immediately adjacent to the AC terminal block.

711.02.19 – WIRING AND INSULATION

The cabinet load bay shall be hard wired. Printed circuit runs will not be accepted.

All terminals shall be permanently identified in accordance with the cabinet wiring diagram.

Wiring of the cabinet load bay shall meet the requirements of NEMA Publication TS2-1992 Section 5.2 or its latest revision.

711.02.20 – AC+ CONVENIENCE OUTLET

A convenience receptacle shall be provided meeting the requirements of NEMA Publication TS2-1992 Section 5.4.2.6 or its latest revision.

711.02.21 – ILLUMINATION

The cabinet shall be furnished with a fluorescent lamp meeting the requirements of NEMA Publication TS2-1992 Section 5.4.2.7.1 or its latest revision. The "On-Off" switch for the lighting fixture shall be a door actuated switch that turns the light on when the door is open and off when the door is closed.

711.02.22 – DETECTOR RACK

Inductive loop vehicle detectors shall be rack mounted. The detector rack shall meet the requirements of NEMA Publication TS2-1992 Sections 5.3.4 through 5.3.4.5 or there latest revision in addition to the following :

A) The detector rack chassis shall be hinged on one side allowing the unit to swing out a minimum of 90 degrees for access to the units edge connector wiring.
B) The remote reset circuits shall be fully operational.
C) All delay inhibits shall be wired to the associated phase green.

711.02.23 – SOLID STATE LOAD SWITCHES

Load switches shall meet the requirements of NEMA Publication TS2-1992 Section 6.2 through 6.2.4 or its latest revision.

711.02.24 – LOAD SWITCH SOCKETS

Load switch sockets shall meet the requirements of NEMA Publication TS2-1992 Section 5.3.2.1 or its latest revision.

711.02.25 – SOLID STATE FLASHER

The flasher shall be solid state and have two (2) output circuits. It shall be rated at fifteen (15) amps per circuit and conform to NEMA Publication No. TS2-1992 Section 6.3 or its latest revision.

711.02.26 – FLASH TRANSFER RELAYS

The flash transfer relay shall meet the requirements of NEMA Publication TS2-1992 Section 6.4 or its latest revision.

711.02.27 – MALFUNCTION MANAGEMENT UNIT (CONFLICT MONITOR)

The Malfunction Management Unit (MMU) shall meet the requirements of NEMA Publication No. TS2-1992 Section 4 or its latest revision. In the event of conflicting signals, it shall place the intersection in flash and the controller in stop timing. The monitor shall have conflict memory indicators to aid in tracing the cause of a conflicting signal indication or loss of signal condition.

711.02.28 – BUS INTERFACE UNIT

The Bus Interface Unit shall meet the requirements of NEMA Publication TS2-1992 Section 8 or its latest revision.

711.05 – TESTING

711.05.01 – DOCUMENTATION

The cabinet shall be supplied with three (3) copies of the cabinet wiring and schematic diagrams. Each termination point shall indicate all connections to and from that point.

711.05.02 – REFERENCES

The vendor shall provide references from three (3) cities where the traffic controller has been in use for two (2) or more years.

711.07 – BASIS OF PAYMENT

Vehicle actuated traffic signal controller units, complete with the cabinet and all auxiliary equipment described in this section, shall be measured by the unit complete and in place. Vehicle actuated traffic signal controllers shall be paid for at the contract unit price for :

VEHICLE ACTUATED TRAFFIC SIGNAL CONTROLLER EA.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals, including concrete foundation and/or pedestal, necessary to complete the work as specified.

SECTION 712 – SOLID STATE DIGITAL INDUCTIVE LOOP VEHICLE DETECTOR

712.01 – DESCRIPTION

This section covers the minimum performance and design requirements of a card rack mounted digital inductive loop vehicle detector. Catalog sheets shall be provided to the Engineer on items bid after award of the Contract.

712.02 – MATERIALS

712.02.01 – GENERAL REQUIREMENTS

Physical and functional standards shall conform to this Specification and to NEMA Publication No. TS2-1992 Section 6.5 or its latest revision. The detector shall be completely self tuning with automatic tracking. The loop inductance range shall be 30 to 2000 microhenries. The loop input terminals shall be buffered by an isolation transformer. The detector shall have internal lightning protection devices to provide total circuit protection. There shall be three selectable frequencies to provide frequency separation to eliminate crosstalk. Three sensitivity selections shall be provided, with a high sensitivity of 0.02 percent change in loop inductance. There shall be a presence time control to select the rate at which detector tracking circuits cause the unit to tune out a stationary vehicle over the loop. The output indicator shall be a high intensity light emitting diode. The detector shall provide a continuous call output whenever power is removed. The operating temperature range shall be -30 degrees Fahrenheit (°F) to +180° F. The operating power range shall be 95 - 135 VAC 60 hz.

712.02.02 – DELAY AND EXTENSION TIMING

When specified on the plans, the detector shall be supplied with programmable delay and extension timing features. The call delay time shall be adjustable from 0 to 31 seconds in one second steps. The call extension time shall be adjustable from 0 to 15 seconds in 0.25 second steps. Activation of the Delay/Extension Feature shall meet the requirements of NEMA Publication TS2-1992 Section 6.5.2.9.7, or its latest revision.

712.02.03 – REFERENCES

The supplier shall provide references from three (3) cities where the detector has been in use for two (2) or more years.

712.07 – BASIS OF PAYMENT

Solid state digital inductive loop vehicle detectors installed shall be measured by the unit complete and in place, wired and connected to the controller. Solid state digital inductive loop vehicle detectors shall be paid for at the contract unit price for :

SOLID STATE DIGITAL INDUCTIVE LOOP VEHICLE DETECTOR EA.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

SECTION 713 – TRAFFIC SIGNAL CONDUIT

713.01 – DESCRIPTION

This section covers the minimum construction and materials requirements for conduit used to enclose traffic signal conductors. All traffic signal conduit shall conform to Section 739 of the Oklahoma Department of Transportation Standard Specifications for Highway Construction 1999 or latest revision thereof unless otherwise noted in these Specifications.

713.02 – MATERIALS

713.02.01 – GENERAL

Traffic signal conduit shall be of the types given below. All fittings, entrance caps, and cements used shall be compatible with the conduit material for which they are used and comply with current traffic signal industry standards.

A) GALVANIZED STEEL - Rigid galvanized steel conduit shall comply with the requirements AASHTO M 272.

B) RIGID PLASTIC - Rigid plastic conduit shall comply with the requirements of AASHTO M 272. Rigid plastic conduit shall be schedule 40 polyvinyl chloride (PVC) plastic conduit, unless otherwise specified on the Plans.

C) FLEXIBLE PLASTIC - Flexible plastic conduit shall comply with the requirements of NEMA TC7 and shall be smooth wall coilable duct of high density polyethylene (HDPE) meeting the requirements of ASTM D 1248, Type III Class C, Grade P33, Category 5, Schedule 40, unless otherwise specified on the Plans.

D) CABLE-IN-DUCT - Cable-in-duct conduit shall be factory assembled. The duct shall be HDPE and comply with paragraph (C) above and be the size shown on the Plans. The conductors shall be the type, size, and number shown on the Plans. Identification of the conductors shall be accomplished by color coding the insulation by means of a continuous longitudinal colored stripe or various solid colors of insulation, in addition to the standard color markings.

713.02.02 – MATERIALS CERTIFICATION

Traffic signal conduit shall be accepted if all pieces are clearly marked with the UL label or a type D certification is provided by the manufacturer.

713.07 – BASIS OF PAYMENT

Traffic signal conduit of the size, type and method of installation specified shall be measured by the linear foot and shall include all fittings, outlets, entrance caps, pull wires, expansion devices and any other hardware necessary to complete the conduit system.

Accepted traffic signal conduit will be paid for at the contract unit price for :

(SIZE) GALVANIZED STEEL CONDUIT (INSTALLATION METHOD)	L.F.
(SIZE) RIGID PLASTIC CONDUIT (INSTALLATION METHOD)	L.F.
(SIZE) FLEXIBLE PLASTIC CONDUIT (INSTALLATION METHOD)	L.F.
(SIZE) CABLE-IN-DUCT	L.F.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

SECTION 714 - ELECTRICAL CONDUCTORS

714.01 – DESCRIPTION

This section covers the materials and installation requirements for electrical conductors used for traffic lighting and signal electric cable, shielded loop detector lead-in cable, loop detector wire and communications cable.

714.02 – MATERIALS

Conductor shall meet the requirements listed below:

A) Traffic and Signal Electrical Cable. Traffic and signal electrical cable shall be straight conductor 600 volt cable with a polyethylene outer jacket for aerial and duct installation, and shall meet International Municipal Signal Association (IMSA) Specification No. 20-1. The conductors shall be solid copper No. 14 AWG. Electrical conductors for lighting shall be of the type shown on the Plans.

B) Shielded Loop Detector Lead-In Cable. Shielded loop detector lead-in cable shall comply with the requirements of IMSA No. 50-2. The conductors shall be stranded copper No. 14 AWG with a polyethylene outer jacket.

C) Standard Loop Detector Wire. Loop detector wire shall comply with requirements of IMSA No. 51-3. The conductors shall be No. 14 AWG stranded copper wire in a polyethylene outer jacket.

D) Loop-In-Duct Detector Wire. When Loop-In-Duct detector wire is specified on the Plans, it shall comply with the requirements of IMSA No. 51-5. The conductors shall be ducted No. 14 AWG stranded copper wire.

E) Signal and control Cable. Control cable for communications shall comply with the requirements of IMSA specification 20/6.

714.04 – CONSTRUCTION METHODS

A) Traffic and Signal Electrical Cable. Traffic and signal electrical cable shall be installed from the heads and luminaries on each traffic signal pole to the traffic signal controller or power source. The electrical cable from the traffic signal pole to the controller shall be in conduit. The electrical cable to be furnished shall have a sufficient number of conductors and at least one spare conductor as shown on the Plans.

B) Shielded Loop Detector Lead-In Cables and signal and control cable. Shielded loop detector lead-in cables shall be placed in conduit from each loop detector pull box location to the traffic signal controller. At each of the loop detector pull box locations, the loop wire or the sensing element lead shall be spliced to the loop detector lead-in cable as shown on the Plans. Signal and control cable shall be placed in conduit between traffic signal controllers as shown on the plans.

C) Loop Detector Wire. Loop detectors shall be located as shown on the Plans, the exact location being marked by chalk, spray paint or some other suitable marking device for inspection by the Engineer prior to being cut. The loop slots, including corner cuts, shall be cut in the pavement a minimum of two (2) inches deep and one-quarter (1/4) inch wide unless otherwise specified on the Plans. The slot shall be cleaned and dried with compressed air to remove all water and debris. All

loop wires in any given slot shall be wound in the same direction a minimum of two (2) turns and a maximum of three (3) turns per loop. All loop wire shall be one continuous length to the pull box where it shall be connected to the lead-in cable. The run of loop wire between the loop and the pull box shall be twisted a minimum of five (5) turns per foot. A blunt instrument shall be used for placing the wire into the slot to prevent damage to the wires insulation. All loops connected to the same detector channel shall have their polarity reversed with respect to their adjacent loop. Loop wires shall be identified in the pull box as to loop number and the direction the loop is wound (i.e. clockwise, counter-clockwise). All connections that are made from loop wire to the lead-in cable shall be made only in the pull box. The connection shall be soldered with a 60/40 alloy, rosin core solder. A grease filled connector sealing pack shall be placed over the connection after soldering is completed. After the loop wire has been carefully placed in the slot and the circuitry checked by the Contractor, the slot shall be sealed with a sealer as shown on the Plans. A minimum of one (1) inch of sealer shall be over the top most wire in the slot. Loop sealant shall encapsulate loop wires in the saw cut. The process of cleaning the slot, installing the loop wire, checking the circuit, and sealing the slot shall be completed within the same working day to prevent the buildup of foreign matter in the slot after cleaning and prior to sealing.

714.07 – BASIS OF PAYMENT

Electrical conductor shall be measured by the linear foot for the various types specified and installed including all connectors, splices and incidentals necessary to complete the traffic signal and lighting system as provided on the Plans.

Accepted electrical conductors will be paid for at the contract unit price for :

(No. of conductors) CONDUCTOR TRAFFIC SIGNAL ELECTRICAL CABLE	L.F.
TWO CONDUCTOR SHIELDED LOOP DETECTOR LEAD-IN CABLE	L.F.
LOOP DETECTOR WIRE(AWG No.)(Wire Type)	L.F.
(No. of conductors)(AWG No.) ELECTRICAL CONDUCTOR	L.F.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

SECTION 715 – POLYCARBONATE TWELVE (12) INCH TRAFFIC SIGNAL HEAD

715.01 – DESCRIPTION

This section covers the minimum design and operating requirements for adjustable face polycarbonate traffic signal heads that can be arranged in different combinations to provide vehicle signal displays in accordance with the Manual On Uniform Traffic Control Devices (MUTCD). Catalog sheets shall be provided on items bid.

715.02 – MATERIALS

715.02.01 – GENERAL REQUIREMENTS

Traffic signal heads shall conform to the ITE standard for Adjustable Face Vehicular Traffic Control Signal Heads. All traffic signal heads shall be mounted vertically, rigid, and not free swinging. Traffic signal placement shall conform to the requirements of the MUTCD.

715.02.02 – PHYSICAL AND MECHANICAL REQUIREMENTS

The housing of each signal section shall be one piece polycarbonate resin of the specified color, especially stabilized for atmospheric ultra-violet exposure, injection molded complete with integral top, bottom, and sides, having a minimum thickness of 0.1 inches.

One (1) section of each signal head shall be equipped with a five (5) position terminal block for termination of field wiring.

The top and bottom of each housing shall have an opening to accommodate standard one and one-half

(1 1/2) inch pipe fittings and brackets.

Signal sections shall be joined together in a manner that provides both mechanical integrity and prevents intrusion of dust and weather.

Each signal section shall be capable of being rotated 360 degrees about its axis and shall be capable of being locked at five (5) degree intervals. Serrations shall be integral with the signal section and designed to permit interlocking of adjacent sections.

715.02.03 – HOUSING, DOOR AND VISOR

Each signal section shall be constructed to accommodate a twelve (12) inch nominal dimension optical unit. The door of each signal section shall be hinged to the housing to permit access to the section for relamping. Each signal section shall be provided with a tunnel visor. The visor shall be a minimum of nine and one-half (9 1/2) inches in length with a minimum downward tilt of three and one-half (3 1/2) degrees. Each visor shall be secured to its door in a manner that will prevent its removal by wind. All exterior metal fasteners, including hinge pins, shall be made from stainless steel. Gasket material for the optical unit shall withstand temperatures up to 250° F without permanent deformation and discoloration, without adversely affecting the lens, reflector or lamp.

715.02.05 – COLOR

Nonmetallic materials shall have the color completely impregnated in the material. The exterior color of the entire signal head, including the outside of visors, shall be yellow. The inside of visors shall be flat black in color.

715.02.06 LIGHT EMITTING DIODE (LED) TRAFFIC SIGNAL LENSES

Light emitting diode (LED) lamp modules with spade tab connections shall meet the requirements in the Institute of Traffic Engineers (I.T.E.) standard entitled “Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Circular Signal Supplement” (VTCSH-LED). LED lenses shall be Dialight, GelCore, Duralight or an approved equal.

When lit, all LED modules shall appear to drivers to be incandescent bulb type signals. Incandescent bulb type traffic signals are not acceptable.

The warranty from defective workmanship and materials shall be five (5) years from the date of the project’s final acceptance by the Oklahoma City Council. During the project's maintenance bond period, the contractor shall remove and replace defective LED modules within two (2) working days of receiving notice from the City’s Street and Drainage Maintenance Division. For reasons of immediate public safety, the City may remove and replace the module(s) and the contractor will be notified to furnish the city with replacement unit(s) meeting current ITE requirements. After the end of the maintenance bond period, all failed modules will be removed and replaced by the City and the contractor will be required to furnish the city with direct replacement unit(s) meeting current ITE requirements.

715.07 – BASIS OF PAYMENT

Polycarbonate 12-inch traffic signal heads shall be measured by the unit complete and in place including wiring. The contract unit price includes backplates, signal mounting brackets and geometrically programmed louvers (if specified), as described in sections 719, 720 and 721, of these specifications, respectively. Traffic signal heads shall be paid for at the contract unit price for :

ONE (1) SECTION TRAFFIC SIGNAL HEAD	EA.
THREE (3) SECTION TRAFFIC SIGNAL HEAD	EA.
FOUR (4) SECTION TRAFFIC SIGNAL HEAD	EA.
FIVE (5) SECTION TRAFFIC SIGNAL HEAD	EA.

which will be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

SECTION 716 – RESERVED

SECTION 717 - PEDESTRIAN SIGNAL HEAD

717.01 – DESCRIPTION

This section covers the minimum design and materials requirements for an adjustable face pedestrian signal head. The pedestrian signal head shall conform to the latest Institute of Transportation Engineers Standard.

717.02 – MATERIALS

717.02.01 – GENERAL PHYSICAL AND MECHANICAL REQUIREMENTS

Signal sections shall be joined together in a manner that provides both mechanical integrity and maximum protection against intrusion of dust and weather.

Each signal face shall be capable of being rotated 360 degrees about its axis and shall be capable of being locked at five (5) degree intervals. Serration's shall be integral with the signal section and designed to permit interlocking of adjacent sections.

717.02.02 – HOUSING, DOOR AND VISOR

Each signal section shall be constructed to accommodate a 12-inch nominal dimension optical unit. The door of each signal section shall be hinged to the housing to permit access to the section for relamping. Each signal section shall be provided with a tunnel visor. Each housing and door shall be made of polycarbonate resin and shall be ultraviolet and heat stabilized. The housing and door shall conform to ASTM Specifications. All exterior metal fasteners, including hinge pins, shall be made from stainless steel. Gasketing material for the optical unit shall withstand temperatures up to 250° F without permanent deformation and discoloration, and without adversely affecting the lens, reflector or lamp.

717.02.03 – COLOR

All nonmetallic materials shall have the color completely impregnated in the material. The exterior color of the entire signal head, including the outside of visors, shall be yellow. The inside of visors shall be a flat black in color.

717.02.04 – LENSES

Lenses shall be made of glass and shall conform to the latest ITE specifications. The "Upraised Hand" lens shall be Portland orange and the "Walking Person" lens shall be lunar white. The letter height shall be four and one-half (4 1/2) inches and the stroke width shall be a minimum of 7/16 inches.

717.02.05 – REFLECTORS

Reflectors shall be specular aluminum with a protective anodic coating.

717.02.06 – ELECTRICAL

Traffic signal lamps shall be 67 watt, 120 volt lamps, and have a minimum rated life of 8000 hours. The lamp receptacles shall be of heat resisting material designed to properly position a traffic signal lamp with means for correct filament positioning. The receptacle shall be provided with a lamp grip to prevent the lamp from working loose due to vibration. Provision shall be made on either the lamp receptacle or the reflector holder to permit rotation of the lamp so that the opening between filament ends is up.

Each lamp receptacle shall be provided with two (2) color-coded No. 18 or larger lead wires with sufficient length to reach the terminal block with the reflector fully open. Each lead shall have a terminal attached to its end. Connection of the lead to the terminal block in the signal shall not require any tools other than a screwdriver. A suitable terminal block for connection of the wires from the signal circuits shall be provided in the signal housing.

717.04 – CONSTRUCTION METHODS

Pedestrian signal heads shall be installed at a height of eight (8) feet measured from the pole base plate to the bottom of the lower pedestrian signal section. Pedestrian signal heads shall be installed on the corner of the pole that most nearly aligns them with the crosswalk or as specified on the Plans.

717.07 – BASIS OF PAYMENT

Pedestrian signal heads shall be measured by the unit, complete and in place including wiring and all mounting hardware, as described in SECTION 720 - Signal Mounting Bracket. The number of ways (separate signal displays within a single unit) and mounting configuration for all signal heads shall be as shown on the Plan. Pedestrian signal heads shall be paid for at the contract unit price for :

PEDESTRIAN SIGNAL HEAD EA.

which will be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

SECTION 718 – MODULAR PEDESTRIAN SIGNAL HEAD

718.01 – DESCRIPTION

This section covers the minimum design and materials requirements for an adjustable face modular (i.e. clamshell) pedestrian signal head. The pedestrian signal head shall conform to the latest Institute of Transportation Engineers Standard.

718.02 – MATERIALS

718.02.01 – GENERAL PHYSICAL REQUIREMENTS

The modular pedestrian signal shall be manufactured from a one piece die cast housing with a single face. It shall display the “Upraised Hand” message in the top portion of its face and the “Walking Person” message in the bottom portion. Its visor shall be a flat grid type. The assembled unit shall provide a completely dust tight and weather tight unit when installed.

718.02.02 – HOUSING, DOOR AND VISOR

The housing of the unit shall be a one piece corrosion resistant aluminum alloy die casting. It shall have an integrally cast top, bottom, sides, and back. It shall provide four integrally cast hinge lug pairs, two at the top and two at the bottom. These shall be provided for operation of the swing door unit.

The door frame shall be a one piece corrosion resistant aluminum alloy die casting. It shall have two hinge lugs cast at the bottom and two latch slots cast at the top of the door frame. The door shall be attached to the case with two stainless steel spring pins. Two stainless steel hinged bolts with captive stainless steel wingnuts and washers shall be attached to the case by stainless steel spring pins to complete the latching system. The visor for the unit shall be a flat grid type designed to eliminate glare from ambient light. The visor grid shall be installed parallel to the face of the "DONT WALK - WALK" message. The visor shall be attached by means of stainless steel screws. The visor shall be made of black polycarbonate with a flat finish on both sides.

718.02.03 – COLOR

The exterior color of the entire signal head except for the visor shall be Federal yellow. The entire visors including the outside shall be flat black.

718.02.04 – LENSES

Light emitting diode (LED) lamp modules with spade tab connections shall meet the requirements in the Institute of Traffic Engineers (I.T.E.) standard entitled “Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Circular Signal Supplement” (VTCSH-LED). LED lenses shall be Dialight, GelCore, Duralight or an approved equal. The “Upraised Hand” lens shall be Portland orange and the “Walking Person” lens shall be lunar white. The letter height shall be four and one-half (4 1/2) inches

and the stroke width shall be a minimum of 7/16 inches.

718.04 – CONSTRUCTION METHODS

Pedestrian signal heads shall be installed at a height of eight (8) feet measured from the pole base plate to the bottom of the lower pedestrian signal section. Pedestrian signal heads shall be installed on the corner of the pole that most nearly aligns them with the crosswalk or as specified on the Plans.

718.07 – BASIS OF PAYMENT

Modular pedestrian signal heads shall be measured by the unit, complete and in place including wiring and all mounting hardware, as described in SECTION 720 - Signal Mounting Bracket. The number of ways (separate signal displays within a single unit) and mounting configuration for all signal heads shall be as shown on the Plan. Modular pedestrian signal heads shall be paid for at the contract unit price for :

MODULAR PEDESTRIAN SIGNAL HEAD EA.

which will be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

SECTION 719 – TRAFFIC SIGNAL BACKPLATE

719.01 – DESCRIPTION

This section covers the material requirements for Type I and Type II traffic signal backplates.

719.02 – MATERIALS

719.02.01 – GENERAL REQUIREMENTS

Traffic signal backplates shall be premanufactured, one piece construction units specifically profiled to fit the signal head(s) furnished under this contract. Backplates shall extend outward from all parts of the signal face assembly a minimum distance of five (5) inches. All corners shall be rounded to have a one and one-half (1 1/2) inch radius. Backplates shall be secured to the traffic signal heads with stainless steel machine screws and lock nuts.

Type I backplates shall be constructed from polycarbonate sheet material and shall conform to the requirements of ASTM D 638, D 695, D 790, and D 1822.

Type II backplates shall be vacuum formed from acrylonitrile-butadiene-styrene (ABS) material conforming to ASTM D 1788.

719.02.02 – FINISH

Backplates shall be black in color with a haircell finish on the front side and smooth finish on the back side. The backplate shall be treated for ultra-violet retardation.

719.07 – BASIS OF PAYMENT

Payment for backplates shall be included in the contract price for traffic signal heads.

SECTION 720 - SIGNAL MOUNTING BRACKET

720.01 – DESCRIPTION

This section covers the minimum design and material requirements for traffic and pedestrian signal mounting brackets. Signal brackets shall be designed to hold signal heads in a vertical arrangement.

720.02 – MATERIALS

Traffic signal mounting brackets shall be of the type and construction as listed below :

A) MAST ARM MOUNTING BRACKETS

Mast arm mounting brackets shall attach to both the top and bottom of the signal head. The bracket shall be capable of adjusting the signal head in both the horizontal and vertical planes relative to the bracket. The bracket shall be adjustable about the mast arm. The mounting bracket shall be constructed with aluminum pipe and fittings (plastic fittings are not acceptable).

B) SIDE POLE MOUNTING BRACKET

The side pole mounting bracket shall consist of an upper and lower arm assembly with standard band-on mounting hub plates for banding on a tubular pole. The upper arm assembly shall include one and one-half (1 1/2) by ten (10) inch nipple, serrated ell, neoprene gasket, and cast nipple. The lower arm assembly shall include one and one-half (1 1/2) by ten (10) inch nipple, serrated tee and cast nipple. The mounting bracket shall be constructed with aluminum pipe and fittings (plastic fittings are not acceptable) and shall have a spun aluminum alodine finish.

C) POST TOP MOUNTING BRACKETS

One-way post top mounting brackets shall consist of a vertical terminal compartment, upper and lower arm assemblies, and a one and one-half (1 1/2) by thirty-seven (37) inch center support tube for mounting three (3) section twelve (12) inch traffic signal heads on a four and one-half (4 1/2) inch outside diameter pedestal pole. The upper arm assembly shall include a standard upper arm which will slide over the support tube and a tri-bolt arrangement for attaching to the signal housing. The lower arm assembly shall include a one and one-half (1 1/2) inch by five (5) inch nipple, serrated tee and cast nipple. The mounting bracket shall be constructed entirely of aluminum (plastic fittings are not acceptable) and shall be painted Federal yellow.

720.06 – METHOD OF MEASUREMENT

Payment for signal brackets shall be included in the contract price for traffic signal heads and pedestrian signal heads.

SECTION 721 – GEOMETRICALLY PROGRAMMED LOUVER

721.01 – DESCRIPTION

This section covers the minimum design and materials requirements for a twelve (12) inch louver assembly designed to direct the light beam from a traffic signal section to a predetermined viewing range. The physical and functional standards of the louver shall conform to the latest Institute of Transportation Engineers Standards.

721.02 – MATERIALS

721.02.01 – GENERAL REQUIREMENTS

The louver shall be designed to fit into a twelve (12) inch nominal dimension signal. The louver shall provide an absolute exact visual cut-off, and a full round ball display with minimum sat effect throughout the selected view range. In addition, the louver shall have a minimum glow outside the view range. The louver shall allow the view angle within each signal section to be adjusted to a designated area. The louver shall allow for controlling either the horizontal or vertical view range within the signal visor. The louver shall be of lightweight material, easily installed with minimum labor, and maintenance free.

721.02.02 – HOUSING

The housing shall be consist of a two-piece assembly injection molded from black UV inhibited ABS plastic. Two brass inserts shall be molded into the bottom half allowing the assembly to be fastened together with two stainless steel screws.

The housing's outside diameter shall be eleven and one-half (11 1/2) inches and have spherical contour which allows the light beam from the signal section to be directed up to ten (10) degrees in all

directions from the centerline of the visor/lens system.

The inside surface shall have a multiplicity of grooves for positioning light directing baffles. The remaining inside surface shall be grooved to prevent surface reflections of light.

Two (2) sponge neoprene o-rings shall be positioned in grooves on the outside surface to prevent light leakage between the housing and the visor.

The housing design shall allow the baffle positions to be changed in order to adjust the view angle.

721.02.03 – BAFFLES

Baffles shall be injected molded from flat black, ten (10) percent glass filled UV inhibited virgin polycarbonate. Each baffle shall be a thin opaque disc with a multiple of parallel evenly spaced apertures (openings). Each structural member forming the aperture shall have a cross section which allows for good stiffness and structural integrity, but shall have a thin edge to prevent reflection outside the desired viewing range. All baffles shall be identical in design and interchangeable within the housing. The plane of each baffle shall be 90 degrees to the centerline axis of the housing.

721.06 – METHOD OF MEASUREMENT

Payment for geometrically programmed louvers shall be included in the contract price for traffic signal heads.

SECTION 722 - PEDESTRIAN PUSH BUTTON

722.01 – DESCRIPTION

This section covers the material and installation requirements for pedestrian push buttons.

722.02 – MATERIALS

The pedestrian push button housing shall be cast aluminum and shall be suitable for mounting on a rounded surface. The body shall have a wire entrance hole at the back. A neoprene gasket shall provide a weather tight fit between the cover and body. The push button switch shall be waterproof. The cover shall be attached with recess hex head stainless steel screws. The push button housing shall be painted Federal yellow.

The pedestrian push button shall be constructed to be tamper proof. It shall be designed such that it will be virtually impossible to receive any electrical shock under any weather condition.

722.04 – CONSTRUCTION METHODS

The pedestrian push button and sign shall be attached to the traffic signal pole or pipe in the location shown on the Plans and at a height of 40 inches measured from the bottom of the unit to the pole base plate. It shall be attached to the pole or pipe in a rigid and secure manner. Holes which are drilled in the field during installation shall be regalvanized, metalized, or painted with an approved zinc dust-oxide paint.

722.07 – BASIS OF PAYMENT

Pedestrian push buttons shall be measured by the unit complete and in place, including an MUTCD designation R10-4 or R10-4b sign and all hardware.

Accepted pedestrian push buttons will be paid for at the contract unit price for:

PEDESTRIAN PUSH BUTTON AND SIGN EA.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

SECTION 723 – ACCESSIBLE PEDESTRIAN PUSH BUTTON STATION

723.01 – DESCRIPTION

This section covers the material and installation requirements for accessible pedestrian push button stations. Push button stations shall consist of a modular unit containing both the push button and an MUTCD designation R10-3b sign.

Accessible pedestrian push button stations shall provide users with visual, tactile and audible information at the intersection crossing where installed. Each station shall include the following features:

Audible locating tone to guide pedestrians to accessible pedestrian push button stations. Automatically adjusting audible output to compensate for ambient sound levels.

Light emitting diode (LED) visual indicator showing the user that the service call from the push button station has been sent to the traffic signal controller.

Audible and vibrotactile confirmation to the user that the service call from the push button station has been sent to the traffic signal controller. The push button station shall vibrate at the start of the walk interval.

Audible message played for the user indicating the direction of travel.

Audible voice message indicating when a street can be crossed and identifying the street by name. The message shall play at the start of the walk interval and countdown the number of seconds remaining to cross the street during the pedestrian clearance phase.

The accessible push button stations shall meet the following minimum requirements:

723.02 – MATERIALS

The accessible pedestrian push button station housing shall be cast aluminum and shall be suitable for mounting on a rounded surface. The body shall have a wire entrance hole at the back. A neoprene gasket shall provide a weather tight fit between the cover and body. The push button switch shall be waterproof. The cover shall be attached with recess hex head stainless steel screws. The push button station housing shall be painted Federal yellow.

The pedestrian push button and sign shall be constructed to be tamper proof. It shall be designed such that it will be virtually impossible to receive any electrical shock under any weather condition.

723.04 – CONSTRUCTION METHODS

Accessible pedestrian push button stations and sign shall be attached to the traffic signal pole or pipe in the location shown on the Plans. Push buttons attached to the signal pole at points no lower than 15 inches nor higher than 40 inches as measured from the center of the push button to the grade adjacent to the pole where the user activating the push button would be positioned. It shall be attached to the pole or pipe in a rigid and secure manner. Holes, which are drilled in the field during installation, shall be regalvanized, metalized, or painted with approved zinc dust-oxide paint.

723.07 – BASIS OF PAYMENT

Accessible pedestrian push button stations shall be measured by the unit complete in place, connected, including signs and all hardware. Accepted accessible pedestrian push button stations will be paid for at the contract unit price for:

ACCESSIBLE PEDESTRIAN PUSH BUTTON STATION EA.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

SECTION 724 – POLES AND MAST ARMS

724.01 – DESCRIPTION

This section covers the minimum requirements for traffic signal poles, mast arms and pedestal poles.

724.02 – MATERIALS

The design of traffic signal poles and mast arms shall be the responsibility of the manufacturer. Materials used shall meet the requirements specified in AASHTO Standard Specifications for Structural Supports of Highway Signs, Luminaires, and Traffic Signals.

Poles and mast arms shall be designed for a minimum of 80 mile per hour winds with a gust factor of 1.2 and shall meet all other design requirements of AASHTO Standard Specifications for Structural Supports of Highway Sign, Luminaires, and Traffic Signal Poles.

Anchor base poles shall be leveled with nuts or shims. If double nut leveling is used, the space between the concrete foundation and the pole base shall be filled with a nonshrink grout.

Each pole shall be furnished with a reinforced handhole and weatherproof cover, unless otherwise specified on the Plans. Handholds shall be oval in shape, four (4) inches wide, at least six (6) inches long, with the bottom of the hole eight (8) inches from the pole base, unless otherwise specified on the Plans. Handhole covers shall be one piece formed from ABS plastic, shall be a pearl gray color, and shall be suitable for exposure to harsh sunlight and extreme weather. Cover shall latch with two screw thaches and shall fit tightly to the enclosure ring to create a rainproof seal. Latch screws shall be ¼ - 20 stainless flat socket head screws with tamper proof fetures. A removable pole cap shall be installed on each shaft. All metal poles shall be provided with a grounding connection inside the base of the shaft and shall be grounded as shown on the Plans. Mast arms and poles shall be selected from preapproved shop drawings of poles and mast arms which have been standardized for maximum loading. All mast arms shall provide for a seventeen (17) foot clearance measured from the bottom of the traffic signals heads. All luminaires mounted to signal poles shall provide a light fixture mounting height of 32 feet unless otherwise specified on the Plans.

Pedestal poles shall meet the following requirements:

Aluminum Alloy	6063-T6
Tensile Strength, KSI	30
Yield Strength, KSI	25
Elongation	10%
Minimum Wall Thickness	0.237 inches
Outside Diameter	4.05 inches

Threading and deburring of the pedestal pole shall be in accordance with the basic dimensions of the American National Standard Taper Pipe Threads, NPT(ANSI B2.1).

The threaded pedestal flange base shall be heavy-duty galvanized iron with a seven and one-quarter (7 1/4) inch bolt circle. Anchor bolts shall be provided with two (2) nuts and two (2) washers per bolt for double nut leveling of the pole.

All holes made in poles or mast arms after galvanizing shall be regalvanized, metalized, or painted with an approved zinc dust-oxide paint.

Traffic signal pole and mast arm sizes and locations shall be as shown on the Plans.

724.07 – BASIS OF PAYMENT

Traffic signal poles, mast arms, luminaire arms and pedestal poles, of various types, sizes, and lengths shall be measured by each unit installed.

The accepted poles, mast arms, luminaire arms and pedestal poles shall be paid for at the contract unit price for :

POLE AND SPECIFIED NO. OF MAST ARM(S)	EA.
POLE AND SPECIFIED NO. OF MAST ARM (S) AND LUMINAIRE ARM	EA.
PEDESTAL POLE WITH SPECIFIED MOUNTING HEIGHT	EA.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified, excluding reinforced concrete footings, which are classified separately for payment.

SECTION 725 – TRAFFIC SIGNAL POLE CONCRETE FOOTINGS

725.01 – DESCRIPTION

This section covers the construction material and installation requirements for reinforced p.c. concrete traffic signal pole footings. Footings shall be of the type(s) shown on the Plans. The footing dimensions and steel reinforcement requirements shall conform to the latest revision of the Oklahoma Department of Transportation Traffic Standard detail sheet CDF-1-05, Typical Conduit and Signal Pole Footing Details.

725.02 – MATERIALS

Concrete footings shall be placed in reasonably close conformity to the dimensions shown on the Plans and shall conform to the following material requirements:

A) Portland cement shall conform to the requirements of AASHTO M 85 and AASHTO M 240.
B) Aggregate shall conform to the requirements of ASTM C 330.
C) Reinforcement shall conform to the requirements of AASHTO M 55 or AASHTO M 221.p
D) Portland cement Concrete shall comply with the requirements of AASHTO T 23 and AASHTO T22. P.C. concrete shall have a minimum compressive strength of 3,000 pounds per square inch at 28 days.
E) Anchor bolts and nuts shall conform to AASHTO M 183.
F) Galvanizing (bolts, nuts and washers) shall conform to AASHTO M 233.
G) Electrical conduit shall conform to the requirements for Traffic Signal Conduit in SECTION 712 of these specifications.

725.04 – CONSTRUCTION METHODS

Concrete footings shall constructed in accordance with the most current revision of ODOT standard specifications section 509 – Structural Concrete, and shall be of the size(s) indicated and in the locations shown on the Plans. When an obstruction prevents the construction of a footing at the planned location, the Contractor shall construct the footing at the location established by the Engineer.

The design, number and layout of anchor bolts required shall be the responsibility of the manufacturer. Materials used shall meet the requirements specified in AASHTO Standard Specifications for Structural Supports of Highway Signs, Luminaires, and Traffic Signals. Anchor bolts and nuts shall be in accordance with the requirements of the preapproved shop drawings for poles and mast arms, which are standardized for maximum loading.

725.07 – BASIS OF PAYMENT

Concrete footings of the type(s) shown on the Plans shall be measured by the cubic yards of structural concrete and pounds of reinforcing steel required. The contract price for concrete footings includes anchor bolts, nuts, washers, ground rod, conduit, excavation and backfilling, necessary to construct the footings as shown on the Plans or as directed by the Engineer.

Accepted footings shall be paid for at the contract unit price for:

STRUCTURAL CONCRETE	C.Y.
REINFORCING STEEL	LBS.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

SECTION 726 – PULL BOXES

726.01 – DESCRIPTION

This section covers the material and installation requirements for pull boxes. Pull boxes shall be size I or II as shown on the Plans. The dimensions of size I and II pull boxes shall conform to those given in the latest revision of the Oklahoma Department of Transportation Traffic Standards.

726.02 – MATERIALS

Portland Cement Concrete and polymer concrete pull boxes shall be placed in reasonably close conformity to the dimensions shown on the Plans and shall conform to the following material requirements:

A) Portland Cement shall conform to the requirements of AASHTO M 85 and AASHTO M 240.
B) Aggregate shall conform to the requirements of ASTM C 330.
C) Reinforcement shall conform to the requirements of AASHTO M 55 or AASHTO M 221.
D) Concrete shall comply with the requirements of AASHTO T 23 and AASHTO T22. Concrete shall have a minimum compressive strength of 3,000 pounds per square inch.
E) Gray Iron Casting Covers shall conform to AASHTO M 105.

726.03 - POLYMER CONCRETE PULL BOX REQUIREMENTS

Polymer concrete pull boxes have a polymer concrete cover, frame and body and a minimum load rating of 20,000 pounds. Polymer concrete pull boxes shall be Armorcast, Quazite or an approved equal. Fiberglass and/or plastic pull boxes or composites of same will not be accepted.

726.04 – CONSTRUCTION METHODS

Pull boxes shall be the sizes shown on the Plans. The general location of pull boxes shall be shown on the Plans. Field adjustment of pull box locations to fit existing conditions shall be permitted with approval of the Engineer.

The tops of pull boxes installed in sidewalks or other surfaced areas shall be flush with the finished surface. Pull boxes in unsurfaced areas shall be flush with the top of the ground or no more than one (1) inch above the top of the ground.

Pull boxes not installed in a surfaced area shall be installed with a concrete apron. The dimensions of the apron shall conform to those given in the latest revision of the Oklahoma Department of Transportation Traffic Standards.

Pull boxes shall be installed on a bed of crushed rock as shown on the Plans. Rock depth and size shall conform to the latest revision of the Oklahoma Department of Transportation Traffic Standards.

When called for on the Plans, pull box extensions shall be provided. The extensions shall be made of the same materials as the pull box and shall be attached to the pull box in a manner that will maintain the required depth without separation of the assembly.

Pull box covers shall be marked with the legend "Highway Lighting" or "Street Lighting" when used for lighting conductors and "Traffic Signal" when used for traffic signal conductors with or without lighting conductors. The legend shall be cast into the cover face. The words "High Voltage" shall be added when the conductor voltage is greater than 600 volts.

The cover shall be equipped with a recessed molded lifting eye and recessed hold down bolts. The

cover shall have a nonskid surface.

If called for on the Plans, a copperweld ground rod shall be installed as shown on the Plans.

726.07 – BASIS OF PAYMENT

Concrete pull boxes of the size and type shown on the Plans shall be measured by each unit installed and shall include cover, extension, ground rod, concrete apron, crushed rock, excavation, and backfilling, necessary to construct and install the pull boxes as shown on the Plans or as directed by the Engineer.

Accepted pull boxes will be paid for at the contract unit price for:

PULL BOX TYPE I	EA.
PULL BOX TYPE II	EA.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

SECTION 727 – ROADWAY LUMINARIE

727.01 – DESCRIPTION

This section covers the minimum design and material requirements for high intensity discharge luminaries to provide roadway lighting.

The luminaire shall be a horizontal or vertical burning, high pressure sodium (HPS), outdoor luminaire complete with housing, appropriate mounting, built in ballast, adjustable mogul socket, lamp, gasketed reflector, and glass refractor.

727.02 – MATERIALS

A) HOUSING

The housing shall be precision die-cast aluminum and be of adequate size to contain the ballast components, reflector, lamp and socket, terminal board, and slip fitter allowing all the electrical components to operate within their designed temperature range.

B) REFRACTOR AND DOOR

The refractor shall be manufactured of pressed, heat resistant, crystal clear borosilicate glass, annealed, homogenous and free form imperfections and striations. Refracting prisms shall be incorporated in the refractor to assure maximum utilization of the light generated and provide the required photometric distribution.

The refractor door shall be precision die-cast aluminum with clips for proper positioning of the refractor. The door shall be easily detached from the housing by operating the spring loaded latch or latches and separating the hinges while wearing linemen's gloves.

C) MOUNTING

Luminaires for mast arm mounting shall be equipped with a slipfitter design to accept one and one-quarter (1 1/4) inch to two (2) inch schedule 40 pipe and provide a method of leveling the luminaire and vertical adjustment $\pm$ five (5) degrees using externally accessible bolts. The slipfitter shall be equipped with a pipe stop. Luminaires for post top mounting shall be equipped with a slipfitter designed to accept a two and three-eighths (2 3/8) inch to three (3) inch O.D. pole or tenon.

D) REFLECTOR

The reflector shall be of specular finished, hydro-formed, anodic coated aluminum with a minimum coat thickness of 0.00015 inches and weighing seven and one-half (7 1/2) milligrams per square inch to provide a minimum reflecting of 82 percent. The reflector shall have a reverse flange mounted within the housing to assure a firm surface for proper gasket sealing when the refractor

door is closed.

E) GASKETS

The gaskets between the refractor door and housing and at the socket entrance to the reflector shall be made of heat resistant, non-moisture absorbing, polyester, silicon rubber or dacron felt. The gasket shall be continuous or one piece and installed with no butt ends or gaps that will allow contaminants to enter the reflector cavity.

F) LAMP SOCKET AND SUPPORT

The lamp socket shall be a completely porcelain enclosed, mogul type with internal lamp grips to assure electrical contact under conditions of normal vibration. The socket shall have welded internal connections and be in compliance with the latest revisions of Edison Electric Institute (EEI) Publication No. TDJ-147. The socket support shall contain identifying marks so the socket may be easily adjusted, both horizontally and vertically to provide the specified IES light distribution.

G) BALLAST

The ballast shall be a high power factor bobbin wound, ISO-regulator constant wattage type, capable of operating the high intensity discharge lamp specified from a single phase, grounded, 120/240 Volt nominal, multiple system. The ballast shall regulate lamp watts within the following line voltage variations:

RATED WATTS	LINE VOLTAGE
High Pressure Sodium	
± 12%	± 10%

The ballast, capacitor, and starting aid module, if required, shall be prewired to the lamp socket and terminal board and be designed for easy removal and installation by using quick disconnect features. The ballast shall be designed to start the lamp at minus twenty (20) °F.

H) TERMINAL BOARD

The terminal board shall be of phenolic molded plastic or porcelain with protective barriers between terminals. The screw terminals shall be captive type, compatible with aluminum or copper conductors and capable of accepting up to a No. 6 AWG conductor.

I) HARDWARE

All nuts, bolts, screws, clips, washers, springs, and attaching hardware shall be fabricated from non-corrosive alloys. Cadmium plating will not be considered adequate weatherproofing. All threaded surfaces used in aluminum housing shall be lubricated with silicone grease.

727.02.01 – ELECTRICAL

All electrical components shall be insulated to a minimum of ten (10) KV BIL.

Termination connectors shall meet or exceed twice the rate current value for EEI-TDJ162 Class A Heat Cycle Test.

All wire shall be UL approved and the insulation capable of withstanding the designed operating temperatures of the luminaire, with a minimum insulation of 125 degrees Centigrade (°C) required.

727.02.02 – FINISH

The luminaire finish shall be Munsel #5BG-ASA#70 or an approved equal.

727.02.03 – PHOTO CELL AND RECEPTACLE

If required on the Plans, the luminaire shall be equipped with the following :

A) The photoelectric control shall be a detachable type cadmium sulfide photocell of 105-285 Volt,

50/60 Hertz AC, outdoor control complete, in accordance with EEI-NEMA Standard TDJ-146. It shall have a built in time delay of three (3) to five (5) seconds, relay load contacts rated 1000 Watts or 1800 Volt-Ampere reactive, a single-pole, single-throw, contact normally closed for "Fail Safe" operation, positive lightning and surge protection enclosed in a high impact acrylic housing which has a neoprene base plate gasket and 3-pole polarized twist-lock plug. Turn-on shall occur at approximately two (2) footcandles and turn-off at approximately five (5) footcandles. Turn-on and turn-off shall be adjustable.

B) The three pole locking receptacle shall be in accordance with the latest EEI and NEMA standards and shall be prewired to the terminal board.

727.02.04 – ADDITIONAL REQUIREMENTS

A) Each luminaire shall be supplied with a permanently attached name plate inside the housing and/or on the ballast. This label shall indicate the manufacturer, Catalog No., Lamp type, wattage, line voltage rating and connection diagram.

B) Each luminaire shall be marked in accordance with EEI-NEMA standards for "Field Identification of High-Intensity Discharge Lamps in Luminaries used in Roadway Lighting Equipment", EEI Publication No. TDJ-150 and NEMA Publication No. OD150.

C) If required on the Plans, each luminaire shall be equipped with a cut-off visor. Cut-off shall occur full circumference of the luminaire at approximately 75 degrees from the vertical axis. The visor shall be similar in color to the luminaire.

D) The contractor shall supply photometric data from the luminaire manufacturer for comparing light quality and quantity prior to receiving installation approval from the Engineer.

727.07 – BASIS OF PAYMENT

Luminaires will be measured by the unit, complete in place including wiring and all hardware. The accepted luminaires will be paid for at the contract unit price for:

ROADWAY LUMINAIRE (250 WATT HPS) EA.

which will be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

SECTION 728 – SCHOOL FLASHERS

728.01 – DESCRIPTION

This section covers the material and construction requirements for school flashers used to supplement school speed limit signs.

728.02 – MATERIALS

728.02.01 – GENERAL

School flashers shall conform to the following requirements:

A) Signs. Signs used with school flashers shall be a M.U.T.C.D. designation S5-1, 24 inches by 48 inches and shall inform to the requirements of SECTION 729.

B) Flasher Assembly. The flasher assembly shall meet the requirements of SECTION 711.

C) Flasher Beacons. The flasher beacons shall utilize a yellow lens twelve (12) inches in diameter fitted with a cut-away visor. All other aspects of the flasher beacons shall conform to the requirements of SECTION 715.

D) Programmable Time Clock. The programmable time clock shall be a Paragon EC72D, or approved equal. It shall be completely solid state. Programming of time of day, day of week, date, and year, shall be accomplished through an integral keypad. The functions of the keypad keys shall be clearly

marked. Change over between daylight time and standard time shall be made automatically at the appropriate times as defined by United States Law. Timing shall be synchronous with the power line. In the absence of power, a backup power source shall be used to maintain timing accuracy within ± 3 seconds per 24 hours.

E) Pedestal Pole. The pedestal pole shall meet the requirements listed below:

Aluminum Alloy	6063-T6
Tensile Strength, KSI	30
Yield Strength, KSI	25
Elongation	10%
Minimum Wall Thickness	0.237 inches
Outside Diameter	4.05 inches
Length	13 feet

Threading and deburring of the pedestal pole shall be in accordance with the basic dimensions of the American National Standard Taper Pipe Threads, NPT(ANSI B2.1).

F) Flange Base. The threaded pedestal flange base shall be heavy-duty galvanized iron with a seven and one-quarter (7 1/4) inch bolt circle. Anchor bolts shall be provided with two (2) nuts and two (2) washers per bolt for double nut leveling of the pole.

728.02.02 – GROUNDING

On all school flasher assemblies, the AC neutral wire shall be bonded to the equipment grounding conductor.

728.04 – CONSTRUCTION METHODS

School flashers shall be located as shown on the Plans. However, the center of the flasher pole shall not be closer than five (5) feet from the face of curb or edge of the roadway shoulder.

The distance from the pole base to the top of the lower beacon shall be seven (7) feet. The distance from the pole base to the top of the upper flasher shall be thirteen (13) feet.

728.07 – BASIS OF PAYMENT

School flashers shall be measured by the unit, complete in place, wired and connected to the power supply as shown on the Plans and in accordance with these Specifications. Accepted school flashers will be paid for at the contract unit price for:

SCHOOL FLASHERS EA.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

SECTION 729 – SIGNS

729.01 – GENERAL REQUIREMENTS

This section covers the minimum requirements for furnishing and erecting signs complete in place, in accordance with these Specifications and in reasonably close conformity with the dimensions and lines shown on the Plans or established by the Engineer. Included signs are sheet aluminum and extruded aluminum panels, all with a reflective or non-reflective sheeting background and with steel or aluminum sign bracket arms, bolts and fittings. All signs shall be fabricated and installed in conformance with the latest edition of the MUTCD.

729.02 – MATERIALS

Materials used in the fabrication of signs shall meet the requirements of sections 730 and 731.

729.04 – CONSTRUCTION METHODS

Sign blanks shall be thoroughly cleaned prior to application of sheeting material in accordance with the manufacturers recommendations.

Signs shall be installed such that the sign face is vertical and at a horizontal angle of approximately 87 degrees toward the direction of travel or as shown on the Plans. Signs shall be installed so that the bottom of the sign is seven (7) feet above the roadway surface. Signs shall be placed five (5) feet behind curbed roadway sections or as shown on the Plans. Signs on roads with out curbs shall be placed six (6) feet from the edge of pavement on residential streets and eight (8) to fifteen (15) feet from the edge of pavement on other streets or as shown on the Plans. Signs shall be installed so as to minimize specular reflection. If it is found after inspection that specular reflection is apparent on any sign, its positioning shall be adjusted by the Contractor at his expense to eliminate or minimize this condition.

729.07 – BASIS OF PAYMENT

Signs shall be measured by the square foot of area of the vertical front face with no deduction for rounding off sign corners. Accepted signs will be paid for at the contract unit price for:

SHEET ALUMINUM SIGNS	S.F.
EXTRUDED ALUMINUM PANEL SIGNS	S.F.
MAST ARM MOUNTED SIGNS	S.F.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

SECTION 730 – ALUMINUM SIGN BLANKS

730.01 – DESCRIPTION

This section covers the minimum requirements for aluminum sign blanks to be used for traffic control devices.

730.02 – MATERIALS

730.02.01 – GENERAL

All items bid under these specifications must be nationally advertised and must have been made available to the trade for not less than two (2) years.

All material furnished shall be guaranteed to be in accordance with the manufacturer's specifications and shall perform the function for which they were designed and manufactured. The Contractor shall obtain and assign to the City all manufacturer's warranties, guarantees, and/or exchange policies for defective items provided.

All sign blanks shall be free of buckles, warps, dents, cockles, burrs, or other defects.

All sign blanks shall be of stable flat sheet material, mill finished and furnished in domestic aluminum alloy 6061-T6, or 5052-H38, governed by A.S.T.M. specification B209-61, or latest revision thereof. Thickness, dimensions, hole sizes, and hole locations shall be shown on the Plans.

730.02.02 – METAL TREATMENT

All blanks shall be treated as follows:

A) Degreasing
   1) Vapor Degreasing - By total immersion of the sign blank in a saturated vapor, or trichloroethylene. Trademark printing shall be removed.
   2) Alkaline Degreasing - By total immersion of the sign blank in a tank containing alkaline solutions, controlled and titrated to the solution manufacturers specification. Rinse thoroughly with running water.

B) Etching
   1) Acid Etch - Etch well in 6-8% phosphoric acid solution at 100% F, or proprietary acid etching solution. Rinse thoroughly with running water.
   2) Alkaline Etch - Etch well in an alkaline etching material that is controlled by titration. Use time, temperature and concentration specified by the solution manufacturer. Rinse thoroughly and remove smut and rinse again.

C) Conversion Coating, or "Anodized" Finish
   1) Procedure - Treat with a light, tight amorphous type coating in accordance with the coating manufacturer's recommendations. Rinse thoroughly, then dry by use of forced hot air drier.

D) Contaminants

1) Condition - All metals shall be free of finger prints, grease, oils, or other contaminants.

A type A or type B certification is required for acceptance of aluminum sign materials.

SECTION 731 – REFLECTIVE SHEETING

731.01 – DESCRIPTION

This section covers the minimum requirements for sheeting used in the fabrication of sign faces. Types of sheeting shall be as described below. Reflective sheeting shall meet the requirements of Federal Specification FP-92 or its latest revision and the requirements further noted in this Specification.

All sheeting shall be type III unless otherwise specified on the Plans with the exception of sheeting used in construction traffic control. Sheeting used in construction traffic control shall be TYPE II-A.

731.02 – MATERIALS

The reflective sheeting used in the fabrication of reflectorized sign faces shall be of the types listed in Federal Publication FP-85 and are described below:

TYPE II - Type II is an enclosed lens type sheeting which consists of spherical lens elements embedded beneath the surface of a smooth, transparent, flexible plastic, resulting in a nonexposed lens, optical reflecting system.

TYPE II-A - Type II-A is the same system as Type II with the exception of a higher quantity and quality of lens elements being employed.

TYPE III - Type III is an encapsulated lens type sheeting which consists of spherical lens elements adhered to a synthetic resin and encapsulated by a flexible, transparent, water proof, plastic having a smooth surface.

TYPE IV - Type IV is made of cubically shaped prismatic retroreflective elements integrally bonded to a transparent, flexible, smooth, tough, and weather resistant polymeric film.

A type A certification will be required for acceptance of sheeting material.

SECTION 732 – GALVANIZED STEEL SIGN POSTS

732.01 – DESCRIPTION

This section covers the minimum requirements for galvanized steel pipe sign posts. Sign posts shall be provided and constructed in accordance with these Specifications and in reasonably close conformity with the dimensions and locations shown on the plans or established by the Engineer.

732.02 – MATERIALS

Sign posts shall be made from new galvanized steel pipe conforming to the size and dimensions shown on the Plans and shall meet the requirements of ASTM A 53. All posts shall be standard weight schedule 40 steel pipe in twelve (12) foot lengths unless otherwise designated. Galvanizing shall be done after fabrication and punching and drilling of holes unless approved by the Engineer. Holes made after galvanizing shall be regalvanized, metalized, or painted with an approved zinc dust-oxide paint.

Sign posts shall be protected by a clear film, non-oil base chemical coating and shall provide conformity with the following requirements:

A) Meet ASTM Specifications D-522, B117, and D-1720.

B) Provide weathering resistance as follows: QUV weathering 50% gloss retention at 60% after 500 hours without loss of integrity or adhesion. Color shall be retained with a minimum of chalking.

C) Demonstrate a chemical resistance by having no effect on the coating when immersed in the following substances: Gasoline, motor oil, alcohol, 30 percent sodium hydroxide solution, 30 percent hydrochloric acid solution, 30 percent nitric acid solution, 30 percent sulfuric acid solution.

A type A certification will be required for acceptance of steel pipe sign posts.

732.04 – CONSTRUCTION METHODS

In the event it is necessary to cut a post in the field, the cut end shall be placed in the concrete foundation. Any part of the sign posts from which the galvanized and/or clear film protective coating is knocked, chipped or scratched off exposing bare metal during transit, installation or alteration shall be regalvanized, metalized or painted with an approved zinc dust-oxide paint and clear film coated.

732.07 – BASIS OF PAYMENT

Sign posts shall be measured by the linear foot for each size erected in place as shown on the Plans or as directed by the Engineer. Accepted sign posts will be paid for at the contract unit price for :

GALVANIZED STEEL SIGN POST L.F.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals including concrete footings necessary to complete the work as specified.

SECTION 733 – SQUARE STEEL SIGN POSTS

733.01 – DESCRIPTION

This section covers the minimum requirements for square steel sign posts. The sign posts shall be provided and constructed in accordance with these Specifications and in reasonably close conformity with the dimensions and locations shown on the Plans or established by the Engineer.

733.02 – MATERIALS

Square steel sign posts shall be made from hot-rolled strip steel (structural quality) and shall conform to ASTM Specification A446, Grade A.

The cross section of the post shall be square and formed into size required on the Plans. The finished posts shall be straight and have a smooth uniform finish. It shall be possible to telescope the post with each consecutive larger or smaller size of square tube, freely and for not less than ten feet of their length without the necessity of matching any particular face to any other face.

All holes and ends shall be free from burrs and shall be cut square. Hole diameter shall be 7/16 inch plus or minus 1/64 inch on one (1) inch centers, running on all four sides for the entire length of the post. Holes shall be on the center line of each side in true alignment and opposite to each other. Holes shall be pre-punched or quick punched.

All posts shall be weather protected by galvanizing conforming to ASTM Specification A525. Galvanizing shall be done after fabrication and punching of holes unless approved by the Engineer. Holes made after galvanizing shall be regalvanized, metalized, or painted with an approved zinc dust-oxide paint.

Square steel sign posts shall be protected by a clear film, non-oil base chemical coating and shall provide conformity with the following requirements:

A) Meet ASTM Specifications D-522, B117, and D-1720.

B) Provide weathering resistance as follows: QUV weathering 50% gloss retention at 60% after 500 hours without loss of integrity or adhesion. Color shall be retained with a minimum of chalking.

C) Demonstrate a chemical resistance by having no effect on the coating when immersed in the following substances: Gasoline, motor oil, alcohol, 30 percent sodium hydroxide solution, 30 percent hydrochloric acid solution, 30 percent nitric acid solution, 30 percent sulfuric acid solution.

A type A certification will be required for acceptance of square steel sign posts.

733.04 – CONSTRUCTION METHODS

Any parts of the square steel sign posts from which the galvanizing is knocked, chipped, or scratched off exposing bare metal in transit, installation, or alteration shall be regalvanized, metalized or painted with an approved zinc dust-oxide paint.

733.07 – BASIS OF PAYMENT

Square steel sign posts shall be measured by the linear foot for each size erected in place as shown on the Plans or as directed by the Engineer. Accepted sign posts will be paid for at the contract unit price for:

SQUARE STEEL SIGN POST L.F.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

SECTION 734 – TRAFFIC STRIPE (PAINT)

734.01 – DESCRIPTION

This section covers the material and application requirements for placing white and yellow painted traffic stripes containing glass beads.

734.02 – MATERIALS

Painted traffic stripes shall be applied by the drop method and shall conform to these Specifications, The Uniform Manual on Traffic Control Devices for Streets and Highways, and be in reasonably close conformity with the locations, lines and dimensions shown on the Plans or established by the Engineer.

The white and yellow paint shall be formulated and manufactured from first-grade raw materials, and shall be free from defects and imperfections that might adversely affect the serviceability of the finished product. The paint shall be suitable for spray application and use as a reflecting traffic guide on concrete and bituminous roadway surfaces. Glass beads used to produce retroreflection shall conform to the requirements of SECTION 737 of these Specifications.

734.03 – EQUIPMENT

The paint machine shall be capable of applying an even clean-cut line without excessive drifting of paint and without dripping or stringing fine lines of paint on end sections. The paint machine shall have the automatic cutoff controls for the bead dispenser and the paint dispenser synchronized.

734.04 – CONSTRUCTION METHODS

The contractor shall be required to clean all dirt, grease, and other foreign materials off the road surface prior to application of traffic stripes to ensure maximum adhesion.

The paint shall be applied to the pavement surface at a wet film thickness of approximately 0.015 inch.

The glass beads shall be uniformly distributed over the wet paint at a reasonably accurate rate of six (6) pounds per gallon of paint, unless a different rate is specified by the Engineer. The glass beads shall be

dispensed immediately upon the completed line by means of an automatic bead dispenser working in synchronization with the paint dispenser.

The completed line shall be of a uniform cross section. The completed lines shall be of the dimensions and spacing as shown on the Plans or as specified by the Engineer.

The paint traffic stripe shall not be applied when there is moisture on the pavement that would cause a poor bond between the paint and the pavement. Paint traffic stripe shall not be applied when the atmospheric temperature is at or below 40° F.

734.07 – BASIS OF PAYMENT

Traffic stripe (paint) shall be measured by the linear foot of four (4) inch wide traffic stripe placed or the equivalent four (4) inch stripe necessary when a wider or narrower stripe is specified of the Plans or approved by the Engineer. Accepted traffic stripe (paint) will be paid for at the contract unit price for :

TRAFFIC STRIPE (PAINT) L.F.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

SECTION 735 – TRAFFIC STRIPE (THERMOPLASTIC)

735.01 – DESCRIPTION

This section covers the materials and application requirements for placing white and yellow reflectorized thermoplastic compound on roadway surfaces.

Thermoplastic traffic stripe shall be applied by extrusion die method and shall conform to these Specifications, The Uniform Manual on Traffic Control Devices for Streets and Highways, and be in reasonably close conformity with the locations, lines, and dimensions shown on the Plans or established by the Engineer.

735.02 – MATERIALS

The white and yellow thermoplastic traffic stripe shall be formulated and manufactured from first-grade raw materials, and shall be free from defects and imperfections that might adversely affect the serviceability of the finished product. The thermoplastic traffic stripe shall provide a durable, reflectorized, traffic guide on concrete and bituminous roadway surfaces. Glass beads used to produce retroreflection shall conform to SECTION 737 of these Specifications.

The hot applied thermoplastic compound shall meet the requirements of AASHTO M 249.

A type A certification will be required for acceptance of thermoplastic pavement marking materials.

735.03 – EQUIPMENT

The thermoplastic material shall be applied to the pavement surface by the extrusion die method where the pavement surface forms one side of the die. Extrusion of material above the pavement surface shall not be permitted.

All parts of the application equipment which mix, convey, or shape the thermoplastic material shall maintain the material at the plastic temperature, and assure the continuous uniformity in the dimensions of the stripe providing clean and sharp dimensions. The equipment shall be capable of applying a uniform film thickness between 3/32 inch and 3/16 inch.

The equipment shall apply the glass beads to the surface of the stripe at a rate of approximately one (1) pound per one hundred (100) feet of four (4) inch wide stripe. The beads shall be applied in such a manner that at least half the diameter of the larger gradations sizes are firmly embedded into the thermoplastic material.

735.04 – CONSTRUCTION METHODS

The contractor shall be required to clean all dirt, grease, curing compound, or other foreign materials from the pavement surface prior to application of thermoplastic materials.

On all asphalt surfaces in place over six (6) months and all Portland cement concrete surfaces of any age, a liquid seal coat shall be applied to the area that is to be striped. The seal coat shall be compatible with the thermoplastic material used and the pavement surface to which it is applied.

Thermoplastic shall not be applied over longitudinal joints unless approved by the Engineer.

Thermoplastic material shall be applied by the extrusion die method at a temperature between 400 and 450° F measured at the pavement surface and in accordance with manufacturer's recommendations. The application shall only take place on clean, dry pavement having a minimum surface temperature of 55° F. The drying time shall be defined as the minimum elapsed time after application when the stripe shall have and retain the characteristics required and after which time normal traffic will leave no impression or imprint on the new stripe. The drying time shall be a maximum of two (2) minutes at 50° F and 70 percent relative humidity when applied at a thickness of 3/16 inch. The drying time shall be reduced to one (1) minute for these conditions when applied at a thickness of 3/32 inch.

Thermoplastic material used in accordance with these Specifications shall be compounded and applied such that the good reflectance, adhesion, durability, impact resistance, weather resistance, and discoloration resistance is retained for the life of the stripe.

735.07 – BASIS OF PAYMENT

Traffic stripe (thermoplastic) shall be measured by the linear foot of four (4) inch wide traffic stripe placed or the equivalent four (4) inch stripe necessary when a wider or narrower stripe is specified on the Plans or approved by the Engineer. Words, symbols, and arrows shall be measured by the unit. Accepted traffic stripe (thermoplastic) will be paid for at the contract unit price for:

TRAFFIC STRIPE (PLASTIC) (4 INCH WIDE)	L.F.
TRAFFIC STRIPE (PLASTIC) (ARROWS)(SINGLE)	EA.
TRAFFIC STRIPE (PLASTIC) (ARROW)(DOUBLE)	EA.
TRAFFIC STRIPE (PLASTIC) (WORDS)	EA.
TRAFFIC STRIPE (PLASTIC) (SYMBOLS)	EA.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

SECTION 736 – TRAFFIC STRIPE (PLASTIC TAPE)

736.01 – DESCRIPTION

This section covers the material and application requirements for placing white and yellow preformed plastic traffic striping tape.

Preformed plastic traffic stripes shall conform to these Specifications, The Uniform Manual on Traffic Control Devices for Streets and Highways, and be in reasonably close conformity with the locations, lines and dimensions shown on the Plans or established by the Engineer.

736.02 – MATERIALS

The preformed plastic pavement marking material shall consist of white or yellow films with pigments, selected and blended to conform to standard highway colors through the expected life of the film. Glass beads shall be incorporated to provide immediate and continuing retroreflection. The material shall also conform to the items listed below.

A) Material: General purpose high durability retroreflective pliant polymer film for preformed longitudinal, transverse and words/symbol markings subjected to high traffic volumes and severe wear conditions such as repeated shear action from crossover or encroachment on edge and

channelization lines, and stop, start, or turn movements. The preformed plastic shall be capable of being adhered to asphalt concrete or Portland cement concrete by a precoated pressure sensitive adhesive.

B) Skid Resistance: The surface of the retroreflective pliant polymer film shall provide an initial minimum skid resistance value of 45 BPN when tested according to ASTM E 303.74.

C) Tensile Strength: The film shall have a minimum tensile strength of 150 pounds per square inch of cross-section when tested according to ASTM D 638-76 using a jaw speed of 10 to 12 inches per minute.

D) Elongation: A sample 6" x 1" shall be tested at a jaw speed of 10 to 12 inches per minute. The sample shall have a minimum elongation of 75% at break when tested by the method according to ASTM D 638-76.

E) Thickness: The film without adhesive shall have a minimum thickness of 60 mils.

F) Reflectance: The white and yellow films shall have the following initial minimum reflectance values at 0.2 degrees and 0.5 degrees observation angles and 86.0 degrees entrance angle as measured in accordance with the testing procedures of Federal Test Method Standard 370. The photometric quantity to be used measured shall be specific luminance (SL), and shall be expressed as millicandelas per square foot per foot-candle (mcd sf fc).

	White		Yellow	
Observation Angle (degrees)	0.2	0.5	0.2	0.5
SL (mcd sf fc)	550	380	410	250

The test distance shall be 50 feet and the sample size shall be a 2.0 x 2.5 foot rectangle. The angular aperture of both the photoreceptor and light projector shall be six (6) minutes of arc. The reference center shall be the geometric center of the sample and reference center shall be taken perpendicular to the test sample.

G) Glass Beads: Glass beads shall be uniformly distributed throughout the material and shall conform to SECTION 737 of these Specifications.

H) Reflectivity Retention: The following test shall be employed to measure reflectivity retention. Taber abrase simulation test. No more than 15% of the beads shall be lost due to popout and the predominate mode of failure shall be "wear down" of the beads.

I) Conformability and Re-Sealing: The performed marking shall be capable of being adhered to asphalt concrete or Portland cement concrete by a precoated pressure sensitive adhesive. The preformed marking film shall mold itself to pavement contours by the action of traffic. The film shall have resealing characteristics such that it is capable of fusing with itself and previously applied marking material of the same composition.

J) Durability and Wear Resistance: The material, when properly applied, shall provide a neat, durable marking that will not flow or distort due to temperature provided the pavement surface remains stable. The material shall provide a cushioned resilient substrate that reduces bead crushing and loss. The material shall be weather resistant and, through normal traffic wear, shall show no appreciable fading, lifting, or shrinkage throughout the life of the markings, and shall show no significant tearing, roll back, or other signs of poor adhesion.

K) Pressure Sensitive Adhesive with a Removable Plastic Liner: The white or yellow sheeting shall be pre-coated on the reverse side with a pressure sensitive adhesive and be protected by an easily removable plastic liner to facilitate processing. The sheeting is intended for hand positioning of irregular shaped markings such as pre-cut symbols, arrows, and legends, etc.

A type A certification will be required for acceptance of plastic tape pavement marking materials.

736.04 – CONSTRUCTION METHODS

The contractor shall be required to clean all dirt, grease, curing compound, or other foreign materials from the pavement surface prior to application of preformed plastic pavement marking materials.

On all asphalt surfaces in place over six (6) months and all Portland cement concrete surfaces of any age, a liquid seal coat shall be applied to the area that is to be striped. The seal coat shall be compatible with the plastic pavement marking material used and the pavement surface to which it is applied.

Plastic pavement marking shall not be applied over longitudinal joints unless approved by the Engineer.

Preformed plastic pavement marking material shall be applied in accordance with the manufactures recommendations and procedures. Application shall be during weather conditions allowed by the manufacturer. However, the material shall not be applied when the surface temperature of the roadway is below 45° F and rising.

736.07 – BASIS OF PAYMENT

Traffic stripe (plastic tape) shall be measured by the linear foot of four (4) inch wide traffic stripe placed or the equivalent four (4) inch stripe necessary when a wider or narrower stripe is specified on the Plans or approved by the Engineer. Words, symbols, and arrows shall be measured by the unit. Accepted traffic stripe (plastic tape) will be paid for at the contract unit price for:

TRAFFIC STRIPE (PLASTIC TAPE) (4 INCH WIDE)	L.F.
TRAFFIC STRIPE (PLASTIC TAPE) (ARROW)(SINGLE)	EA.
TRAFFIC STRIPE (PLASTIC TAPE) (ARROWS)(DOUBLE)	EA.
TRAFFIC STRIPE (PLASTIC TAPE) (WORDS)	EA.
TRAFFIC STRIPE (PLASTIC TAPE) (SYMBOLS)	EA.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

SECTION 737 – GLASS BEADS USED IN TRAFFIC PAVEMENT MARKING MATERIAL

737.01 – DESCRIPTION

This section covers transparent glass spheres (glass beads) applied to traffic paint, thermoplastic compound, and plastic pavement marking tape for the production of a reflective surface creating improved night visibility of the markings.

737.02 – MATERIALS

Glass beads used in traffic paint and thermoplastic compound shall be transparent, clean, colorless glass, smooth and spherically shaped, free from milkiness, pits, or excessive air bubbles. The glass beads shall conform to the requirements of AASHTO M 274, Type I unless specified differently below.

A) Gradation - The beads shall meet the gradation requirements for type as given in Table 737.03.01:

Table 737.03.01 Gradation of Glass Beads

Sieve Designation		
Standard (mm)	Alternate (Type 1 No.)	Mass Percent Passing
0.850	20	98-100
0.600	30	75-85
0.425	40	50-70
0.300	50	15-35
0.180	80	---
0.150	100	0-5

B) Shape - The glass beads shall have a minimum of 70% true spheres.

C) Crushing Resistance - The crushing resistance of beads retained on a No. 40 sieve (0.425 mm) shall be 30 pounds (133N) minimum.

C) Refractive Index - The glass beads shall have a minimum refractive index of 1.50.

D) Moisture Resistance - The glass beads shall be supplied with a moisture resistant coating.

A type A certification will be required for acceptance of glass beads.

SECTION 738 – PAVEMENT MARKERS

738.01 – REQUIREMENTS

Pavement markers shall meet the requirements of the Oklahoma Department of Transportation Standard Specifications for Highway Construction Sections 736 and 857, 1999 Edition or its latest revision.

Pavement markers shall be installed in the locations shown on the Plans.

738.07 – BASIS OF PAYMENT

Pavement markers shall be measured by the unit complete in place. Accepted pavement markers will be paid for at the contract unit price for:

PAVEMENT MARKERS, CLASS A TYPE 1	EA.
PAVEMENT MARKERS, CLASS A TYPE 2	EA.
PAVEMENT MARKERS, CLASS B (YELLOW)	EA.
PAVEMENT MARKERS, CLASS B (WHITE)	EA.
PAVEMENT MARKERS, CLASS C TYPE 1	EA.
PAVEMENT MARKERS, CLASS C TYPE 2	EA.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

SECTION 790 – TRAFFIC CONSTRUCTION STANDARD BID ITEMS

790.01 – DESCRIPTION

This section covers Standard Bid Items used in the contract documents for construction. Additional bid items may be called out in the Special Provisions, other sections of the Standard Specifications, or as directed by the Engineer for additional work covered and change orders.

SECTION	DESCRIPTION	UNIT
711	VEHICLE ACTUATED TRAFFIC SIGNAL CONTROLLER	EA.
712	SOLID STATE DIGITAL INDUCTIVE LOOP VEHICLE DETECTOR	EA.
713	(SIZE) GALVANIZED STEEL CONDUIT (INSTALLATION METHOD)	L.F.
713	(SIZE) RIGID PLASTIC CONDUIT (INSTALLATION METHOD)	L.F.
713	(SIZE) FLEXIBLE PLASTIC CONDUIT (INSTALLATION METHOD)	L.F.
713	(SIZE) CABLE-IN-DUCT	L.F.
714	(NO. OF CONDUCTORS) CONDUCTOR TRAFFIC SIGNAL ELECTRICAL CABLE	L.F.
714	TWO CONDUCTOR SHIELDED LOOP DETECTOR LEAD-IN CABLE	L.F.
714	LOOP DETECTOR WIRE(AWG NO.)(WIRE TYPE)	L.F.
714	(NO. OF CONDUCTORS)(AWG NO.) ELECTRICAL CONDUCTOR	L.F.
714	SIGNAL AND CONTROL CABLE	L.F.
715	ONE (1) SECTION TRAFFIC SIGNAL HEAD	EA.
715	THREE (3) SECTION TRAFFIC SIGNAL HEAD	EA.

715	FOUR (4) SECTION TRAFFIC SIGNAL HEAD	EA.
715	FIVE (5) SECTION TRAFFIC SIGNAL HEAD	EA.
716	THREE (3) SECTION OPTICALLY PROGRAMMED TRAFFIC SIGNAL HEAD	EA.
716	FOUR (4) SECTION OPTICALLY PROGRAMMED TRAFFIC SIGNAL HEAD	EA.
716	FIVE (5) SECTION OPTICALLY PROGRAMMED TRAFFIC SIGNAL HEAD	EA.
717	PEDESTRIAN SIGNAL HEAD	EA.
718	MODULAR PEDESTRIAN SIGNAL HEAD	EA.
722	PEDESTRIAN PUSH BUTTON AND SIGN	EA.
723	PEDESTRIAN PUSH BUTTON STATION	EA.
724	POLE AND SPECIFIED NO. OF MAST ARM(S)	EA.
724	POLE AND SPECIFIED NO. OF MAST ARM (S) AND LUMINAIRE ARM	EA.
724	PEDESTAL POLE WITH SPECIFIED MOUNTING HEIGHT	EA.
725	STRUCTURAL CONCRETE	C.Y.
725	REINFORCING STEEL	LBS.
726	PULL BOX TYPE I	EA.
726	PULL BOX TYPE II	EA.
727	ROADWAY LUMINAIRE (250 WATT HPS)	EA.
728	SCHOOL FLASHERS	EA.
729	SHEET ALUMINUM SIGNS	S.F.
729	EXTRUDED ALUMINUM PANEL SIGNS	S.F.
729	MAST ARM MOUNTED SIGNS	S.F.
732	GALVANIZED STEEL SIGN POST	L.F.
733	SQUARE STEEL SIGN POST	L.F.
734	TRAFFIC STRIPE (PAINT)	L.F.
735	TRAFFIC STRIPE (PLASTIC) (4 INCH WIDE)	L.F.
735	TRAFFIC STRIPE (PLASTIC) (ARROWS)(SINGLE)	EA.
735	TRAFFIC STRIPE (PLASTIC) (ARROW)(DOUBLE)	EA.
735	TRAFFIC STRIPE (PLASTIC) (WORDS)	EA.
735	TRAFFIC STRIPE (PLASTIC) (SYMBOLS)	EA.
736	TRAFFIC STRIPE (PLASTIC TAPE) (4 INCH WIDE)	L.F.
736	TRAFFIC STRIPE (PLASTIC TAPE) (ARROW)(SINGLE)	EA.
736	TRAFFIC STRIPE (PLASTIC TAPE) (ARROWS)(DOUBLE)	EA.
736	TRAFFIC STRIPE (PLASTIC TAPE) (WORDS)	EA.
736	TRAFFIC STRIPE (PLASTIC TAPE) (SYMBOLS)	EA.
738	PAVEMENT MARKERS, CLASS A TYPE 1	EA.
738	PAVEMENT MARKERS, CLASS A TYPE 2	EA.
738	PAVEMENT MARKERS, CLASS B (YELLOW)	EA.
738	PAVEMENT MARKERS, CLASS B (WHITE)	EA.
738	PAVEMENT MARKERS, CLASS C TYPE 1	EA.
738	PAVEMENT MARKERS, CLASS C TYPE 2	EA.

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SECTION 800

SECTION 800 – INCIDENTAL CONSTRUCTION

SECTION 801 – CONSTRUCTION STAKING (CONSTRUCTION SURVEY)

801.01 – DESCRIPTION

The Contractor is responsible for furnishing, placing and maintaining all construction stakes necessary for the proper prosecution and inspection of the Work.

801.04 – CONSTRUCTION METHODS

A) Prior to commencing Work, the City Engineer will furnish the Contractor permanent horizontal alignment and vertical control points throughout the Work and permanent benchmarks within two hundred feet (200') of the beginning and the end of the Work limits. The City Engineer will also provide bridge centerline horizontal and vertical control points if applicable to the project.

B) The Contractor shall provide field forces and shall set all additional stakes needed, such as offset stakes, reference point stakes, slope stakes, pavement and curb line and grade stakes, stakes for bridges, sewers, roadway drainage, pipe underdrains, paved gutter, fence, culverts of other structures and any other horizontal or vertical controls necessary to secure a correct layout of the work. The Contractor shall also perform all layout work and shall set stakes necessary for carrying out utility changes when such utility changes are required during the Work.

Stakes for line and grade shall be adequate to maintain the specified tolerances for the Work. The station number and distance from the centerline of construction shall be marked on all grade stakes. The City Engineer may at any time check for the correctness of the Contractor's staking by using a spot check method. When significant errors occur, the Contractor shall re-survey to the satisfaction of the City Engineer. Any inspection or checking of the Contractor's layout by the City Engineer and the acceptance of all or any part shall not relieve the Contractor of its responsibility for the Work.

When grading quantities are specified to be paid as plan quantity, the Contractor will be required to furnish original cross-sections. When the grading quantities are specified to be paid by field measurement, the Contractor shall furnish both original and final cross-section field notes.

The Contractor shall have the sole responsibility for the preservation of all horizontal alignment and vertical control stakes, benchmarks and construction stakes. The Contractor shall, at its own expense, replace any horizontal alignment, vertical control, construction stakes and benchmarks when damaged, lost, displaced or removed.

The Contractor shall furnish the original copy of all survey records to the City Engineer for calculation of quantities and permanent file. These records shall be furnished as they are completed during the Work. The records shall be permanently bound in field books and formatted in a manner commonly accepted by the surveying profession.

C) As-Built Survey – The Contractor shall perform an as-built survey. This survey shall be turned over to the Engineer of Record. This survey shall be used for final as-built record drawings and calculations of final quantities.

801.06 – METHOD OF MEASUREMENT

Measurement for all construction stakes will be made on a lump sum basis.

All construction staking Work performed shall be paid for at the Contract lump sum Bid price. The Bid price shall be full compensation for furnishing all labor, materials, tools, equipment and incidentals

necessary to complete the Work. Payments will be made on the following schedule:

A) up to 25% - First monthly claim for compensation
B) up to 50% - When 10% of the Work is complete
C) up to 75% - When 50% of the Work is complete
D) up to 95% - When 75% of the Work is complete
E) up to 100% - When 100% of the Work is complete

Payment for unauthorized Work will not be made.

801.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

CONSTRUCTION STAKING (CONSTRUCTION SURVEY) L.S.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 802 – CONSTRUCTION SIGNING AND TRAFFIC CONTROL

802.01 – GENERAL

All signs, barricades, warning lights, and other traffic control devices used for construction traffic control shall meet the requirements of the latest edition of the Manual on Uniform Traffic Control Devices For Streets and Highways as pertains to shape, size, color, mounting height, and placement. All sign sheeting materials shall meet or exceed the requirements of SECTION 700.

802.04 – CONSTRUCTION METHODS

If not included in the Plans, the Contractor shall submit a Traffic Control Plan to the Traffic Management Division prior to the start of construction. The Traffic Control Plan shall include types and locations of all traffic control devices to be used for the construction zone, and detour plans when applicable. If construction involves more than one phase requiring relocation of traffic control devices, traffic control plans shall be submitted for each phase. Field adjustment of the Traffic Control Plan shall be permitted with approval of the Engineer.

802.06 – METHOD OF MEASUREMENT

All signs, barricades, warning lights, and other traffic control devices used for construction traffic control shall be measured as a lump sum. Accepted signs, barricades, warning lights, and other traffic control devices used for construction traffic control will be paid for at the contract price. Which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

802.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

CONSTRUCTION SIGNING AND TRAFFIC CONTROL L.S.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 809 - MOBILIZATION

809.01 - DESCRIPTON

This work shall consist of construction preparatory operations, including the movement of personnel and equipment to the project site and for the establishment of the Contractor’s offices, buildings, and

other facilities necessary to begin work on a substantial phase of the Contractor.

809.02 – METHOD OF MEASUREMENT

Measurement for mobilization will be made on a lump sum basis.

809.03 - BASIS OF PAYMENT

Mobilization, measured as provided above, will be paid for at the contract price as follows:

Mobilization	LUMP SUM

Such payment shall be full compensation for performing the work specified and the furnishing of all materials, labor, tools, equipment, and incidentals necessary to mobilize and subsequently demobilize the construction preparatory operations.

Payment for this item will be made in one installment on the first estimate following completion of substantial mobilization.

The lump sum price paid for mobilization shall not exceed five percent (5%) of the total contract amount.

In the event the lump sum bid for mobilization exceeds the amount stated herein, the difference (remainder) will not be paid.

SECTION 810 – CLEARING AND GRUBBING

810.01 – DESCRIPTION

This section covers the removal and disposal of trees, stumps, brush, roots, vegetation, logs, rubbish, and other objectionable matter from the designated area, except such objects as are designated to remain or to be removed in accordance with other sections of these specifications.

810.04 – CONSTRUCTION METHODS

The entire right-of-way shall be cleared of all trees, brush, logs, rubbish, except such trees and shrubs as may be designated by the Engineer for preservation. Trees and shrubs designated to be left in place shall be carefully trimmed as directed and shall be protected from scarring, barking or other injuries during construction operations. The limbs shall be treated by painting the exposed ends with an approved asphaltic material. Areas required for embankment construction; for roadway, and structural excavations; and for borrow sites and material sources shall be cleared and grubbed. On areas required for roadway, channel, or structural excavation, all stumps, roots, etc., (except for designated trees and shrubs) shall be removed to a depth of at least two (2) feet below the lower elevation of the excavation. On areas required for embankment construction, all stumps, roots, etc., (except for designated trees and shrubs) shall be removed to a depth of at least two (2) feet below the existing ground surface. All holes remaining after clearing and grubbing shall be backfilled and tamped as directed by the Engineer and the entire area bladed to prevent ponding of water and to provide drainage; except in areas to be immediately excavated the Engineer may direct that the holes not be backfilled. When permitted by the plans, trees and stumps may be cut off as close to natural ground as practicable on areas which are to be covered by at least three feet (3') of embankment. Areas required for borrow sites and material sources, stumps, roots, etc., (except for designated trees and shrubs) shall be removed to the complete extent necessary to prevent objectionable matter to become mixed with the material to be used in construction.

All cleared and grubbed material shall be disposed of in a matter satisfactory to the Engineer.

810.06 – METHOD OF MEASUREMENT

Unless the plans and contract include the items of clearing and grubbing and provide for payment

therefore, the work prescribed under this item shall not be paid for directly but shall be considered subsidiary work pertaining to Unclassified Excavation; except that grubbing and clearing of trees six inches (6”) or greater in diameter, measured forty-eight inches (48”) above the natural ground level.

If the plans and contract include the item of clearing and grubbing and provide for payment therefore, this work shall be measured by the acre at the locations designated on the plans or directed by the Engineer. Measurement of large trees for payment shall be as defined above.

The amount of completed and accepted work, measured as provided above, shall be paid for at the contract unit price bid per acre for "Clearing and Grubbing" if so designated on the plans and in the contract, and per each for "Tree Removal", which prices shall be full compensation for furnishing all labor, materials, equipment, tools, and incidentals necessary to complete the work.

810.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

CLEARING AND GRUBBING L.S.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 811 – REMOVAL OF EXISTING STRUCTURES

811.01 – DESCRIPTION

This section covers the removal and disposal of old structures or portions of old structures as noted on the plans and will include all excavation and backfilling necessary to complete the removal. The work shall be done in accordance with the provisions of these specifications.

811.04 – CONSTRUCTION METHODS

A) Culverts or Storm Sewers - Pipe shall be removed by careful excavation of all dirt on top and sides in such manner that the pipe will not be damaged. Those pipes which are deemed unsatisfactory for reuse by the Engineer may be removed in any manner the Contractor may select.

B) Concrete Structures - Concrete structures or concrete portions of structures may be removed by blasting, if approved by the Engineer.

Concrete portions of structures below the permanent groundline, which will not interfere in any manner with the proposed construction, may be left in place but removal shall be carried at least two (2) feet below the permanent groundline and neatly squared off. Reinforcement shall be cut off close to the concrete. The bottom of such structures shall be perforated or broken to prevent the entrapment of water.

C) Steel Structures - Steel structures or steel portions of structures shall be dismantled in sections as determined by the Engineer. The sections shall be of such weight and dimensions as will permit convenient handling, hauling, and storing. Rivets and bolts connecting steel railing members, steel beams or beam spans and steel stringers of truss spans shall be removed by cutting the heads with a "cold cut" and punching or drilling from the hole, or by such other method as will not injure the members for reuse and will meet the approval of the Engineer. The removal of rivets and bolts from connections of truss members, bracing members, and other similar members in the structure will not be required unless specifically called for on the plans or special provisions and the Contractor shall have the option of dismantling these members by flame cutting the members immediately adjacent to the connections. Flame cutting will not be permitted, however, when plans or special provisions call for the structure unit to be salvaged in such manner as to permit reerection. In such case, all members shall be carefully matchmarked with paint in accordance with diagram furnished by the Engineer prior to dismantling, and all rivets and bolts shall be removed from the connections

in the manner specified in the first portion of this paragraph.

D) Timber Structures - Timber structures or timber portions of structures shall be removed in such a manner that the damage to the timber will be minimum. All bolts and nails shall be removed from such lumber as deemed salvable by the Engineer.

   Unless specified otherwise on the plans, timber piles shall be either pulled or cut off at a point not less than two (2) feet below groundline, with the choice between these two methods resting with the Contractor.

E) Brick or Stone Structures - Brick or stone structures or stone portions of structures shall be removed by blasting, if approved by the Engineer, and/or sledging the masonry into sizes not larger than one (1) cubic foot.

   Portions of such structures below the permanent groundline which will not in any manner interfere with the proposed construction may be left in place, but removal shall be carried at least two (2) feet below the permanent groundline and neatly squared off.

811.02.01 – SALVAGE

All materials such as pipe, timbers, railings, etc., which the Engineer deems as salvable for reuse, and all structural steel shall be carefully placed in neat piles along the right-of-way at convenient loading points which will not interfere with traffic or construction. All of these materials shall be the property of the City.

The I-beams, stringers, etc., which are specified to be dismantled without damage for reuse, and all steel members when matchmarked and dismantled for reuse, shall be blocked off the ground in an upright position to protect the members against further damage.

Materials which are not deemed salvable by the Engineer shall become the property of the Contractor and shall be removed to suitable disposal sites off of the right-of-way and disposed of by the Contractor in a manner satisfactory to the Engineer.

Where temporary structures are necessary for a detour adjacent to the present structure, the Contractor will be permitted to use the material in the old structure for the detour structure, but he shall dismantle and stack or dispose of the material as required above as soon as the new structure is opened for traffic.

811.02.02 – BACKFILL

All excavation made in connection with this item and all openings below the natural groundline caused by the removal of old structures or portions thereof shall be backfilled to the level of the original groundline, unless provided otherwise on the plans.

The portion of the backfill which will support any portion of the roadbed or embankment shall be placed in layers of the same depth as those required for placing embankment. Material in each layer shall be wetted uniformly if required and shall be compacted to the density required in the adjoining embankment. In places inaccessible to blading and rolling equipment, mechanical or hand tamps, or rammers shall be used to obtain the required compaction.

That portion of the backfill which will not support any portion of the roadbed or embankment shall be placed as directed by the Engineer in such manner and to such state of compaction as will preclude objectionable amounts of settlement.

811.06 – METHOD OF MEASUREMENT

The work as provided for by this section shall be measured as each individual structure to be removed, except that storm sewers may be measured as each structure or may be measured by the linear foot. When measured by either method, removal shall include all appurtenances thereto.

The work as prescribed for in this section shall be paid for at the unit price bid each for the various types of structures as shown on the proposal or per linear foot when pipe is to be removed. This price shall be full compensation for all work, labor, tools, equipment, excavation, backfilling, materials, and incidentals necessary to complete the work.

811.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

STRUCTURE REMOVAL (TYPE) L.S.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 812 – REMOVAL OF PAVING, SIDEWALKS, DRIVEWAYS, CURBS, ETC.

812.01 – DESCRIPTION

This section covers the removal of existing paving, sidewalks, driveways, curbs, or items of similar nature, composed of concrete, asphalt, brick, or any other material, and the disposal of same all in accordance with these specifications and as shown on the plans or as directed by the Engineer. For purpose of classification, all gutters, whether combined or separate from curb, shall be considered as paving.

812.04 – CONSTRUCTION METHODS

A) General - In removal of any paving, sidewalks, driveways, curbs, gutters, etc., care shall be taken to leave a straight, smooth edge, perpendicular to the surface of the portion left in place at the location given by the Engineer. Any breakage outside the lines given by the Engineer shall be replaced by the Contractor at his expense.

B) Disposal of Materials Removed - All materials designated by the Engineer as salvageable, including broken concrete bricks, manhole frames and grates, catch basin frames and grates, and all sewer and culvert pipe, shall be hauled and stored as directed by the Engineer. Gravel surfacing shall, as nearly as practicable, be removed separately from dirt or other materials, and where desired for use on other streets or alleys, shall be disposed of at sites designated by the Engineer.

812.06 – METHOD OF MEASUREMENT

The various items of this section when classified for payment as contract pay items, will be measured by the unit designated on the plans or as set out in the proposal.

The various items of this section when classified for payment will be measured as provided above and will be paid for at the contract unit price for:

A) Existing paving removed;
B) Existing asphalt wearing surface removed, variable thickness;
C) Concrete sidewalk removed;
D) Existing driveway removed;
E) Existing concrete or limestone curb removed;

as the case may be and such payment shall be full compensation for all materials, equipment, tools, labor and incidentals necessary for completing the removal and disposal of the item specified.

812.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REMOVE PAVEMENT (TYPE) (THICKNESS)	S.Y.
REMOVE SIDEWALK (WIDTH)	S.Y.
REMOVE CURB AND GUTTER	L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 813 – REMOVE (AND REPLACE) DRIVEWAY

813.01 – DESCRIPTION

This section covers the reconstruction of driveways where called for on the plans.

813.04 – CONSTRUCTION METHODS

Unless otherwise specified this work shall include:

A) Concrete driveways - all construction shall be in accordance with the "Standard Details for Driveways". Driveways shall be constructed joint to joint unless otherwise called for.

B) Asphalt driveways - all construction shall be three inches (3”) of Type "A" mix laid on six inches (6”) of prepared subgrade as a minimum otherwise match existing.

C) Gravel driveways - all construction shall be four inches (4”) of crushed stone laid on six inches (6”) of prepared subgrade.

Subgrade shall be prepared and compacted to a minimum of 95% Standard Proctor Test (ASTM D-698). Crushed stone shall meet the gradation requirements Section 215.02 and ASTM C-33, No. 67, and be compacted in accordance with Section 212.04.04 B).

813.06 – METHOD OF MEASURMENT

Payment for "Removing and Replacing Driveway" shall be made at the unit price bid per square yard for each driveway type. The prices established shall be full compensation for the removal and replacement of driveways and per Section 813.04 where applicable, including saw cut, support of adjacent slabs, materials, labor, tools, equipment and all incidentals necessary to complete this item of work.

813.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REMOVE DRIVEWAY	S.Y.
REMOVE AND REPLACE DRIVEWAY	S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 814 – PAVEMENT CUT AND PERMANENT REPAIR

814.01 – DESCRIPTION

This section covers the construction of a reinforced concrete slab over trench in paved areas, or where called for on the plans.

814.04 – CONSTRUCTION METHODS

All construction shall be in accordance with the "Standard Detail for Paving Cut and Permanent Repair". Where concrete repair is specified, the repair shall be from joint to joint.

814.06 – METHOD OF MEASUREMENT

Payment for "Paving Cut and Permanent Repair" shall be made at the unit price bid per square yard for each pavement type. The price established shall be full compensation for saw cut, removal of existing pavement, sand backfill, reinforced concrete slab, tools, labor, equipment, and incidentals necessary to complete this item of work. Curb and gutter shall be paid for separately.

814.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

PAVEMENT CUT AND PERMENANT REPAIR (TYPE)	S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 815 – REMOVE (AND REPLACE) ALLEY PAVING

815.01 – DESCRIPTION

This section covers removing and replacing of alleys, and miscellaneous paved areas in which the item "Paving Cut and Permanent Repair" is not applicable.

815.04 – CONSTRUCTION METHODS

A) Concrete Alley - The affected area of concrete alley shall be replaced in accordance with the "Standard Details for Concrete Alley Paving". Alleys shall be constructed joint to joint unless otherwise called for.

B) Asphalt Alley - The affected area of Asphalt Alley shall be replaced with a minimum pavement section consisting of three inches (3”) of Type "A" Mix over six inches (6”) of prepared (compacted) subgrade.

C) Gravel Alley - The affected area of gravel alley shall be replaced with a minimum pavement section consisting of four inches (4”) of crushed stone over six inches (6”) of prepared (compacted) subgrade.

Each layer of the replacement section shall be equal to the existing section layer and not be less than the minimum section described above. Subgrade shall be prepared and compacted to a minimum of 95% Standard Proctor Test (ASTM D-698). Crushed stone shall meet the gradation requirements Section 215.02 and ASTM C-33, No. 67, and be compacted in accordance with Section 212.04.04 B).

815.06 – METHOD OF MEASUREMENT

Payment for "Removing and Replacing Alley Paving" shall be made at the unit price bid per square yard for each alley paving type. The price established shall be full compensation for removal and replacement of pavement, including excavation and backfill, compaction, and support of adjacent slab.

815.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REMOVE ALLEY PAVING (TYPE)	S.Y.
REMOVE AND REPLACE ALLEY PAVING (TYPE)	S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 816 – REMOVE (AND REPLACE) SIDEWALK PAVEMENT

816.01 – DESCRIPTION

This section covers removing and replacing sidewalks.

816.04 – CONSTRUCTION METHODS

The affected concrete sidewalks shall be replaced in accordance with the "Standard Details for Sidewalk Pavement". The removal and replacement of sidewalks shall be from joint to joint unless otherwise designated on the plans.

816.06 – METHOD OF MEASUREMENT

Payment for "Replacing Sidewalk Pavement" shall be made at the unit price bid per square yard. The price established shall be full compensation for replacement of sidewalk, excavation, backfill, compaction, support of adjacent slab, tools, labor, equipment, materials and incidentals necessary to complete this item of work.

816.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REMOVE SIDEWALK (WIDTH)	S.Y.
REMOVE AND REPLACE SIDEWALK (WIDTH)	S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 817 – REMOVE AND REPLACE PARKING LOT PAVING

817.01 – DESCRIPTION

This section covers removing and replacing of existing concrete, asphalt, and gravel parking lots.

817.04 – CONSTRUCTION METHODS

A) Concrete Parking Lots - The affected area of concrete parking lot shall be replaced with a minimum pavement section consisting of six inches (6”) of concrete pavement, over four inches (4”) of crushed stone base over six inches (6”) of prepared (compacted) subgrade. Removal and replacement of concrete parking lot pavement shall be from joint to joint unless otherwise designated on the plans.

B) Asphalt Parking Lots - The affected area of asphalt parking lot shall be replaced with a minimum pavement section consisting of one and one-fourth inches (1 ¼ “) of surface course Type "B" Mix and two and three-fourths inches (2 ¾”) of Type "A" Mix with four inches (4”) of crushed stone base over six inches (6”) of prepared (compacted) subgrade.

C) Gravel Parking Lots - The affected area of gravel parking lot shall be replaced with a minimum pavement section consisting of four inches (4”) of crushed stone over six inches (6”) of prepared (compacted) subgrade.

Each layer of the replacement section shall be equal to the existing parking lot pavement section layer and not be less than the minimum sections described above. Subgrade shall be prepared and compacted to a minimum of 95% Standard Proctor Test (ASTM D-698). Subgrade shall be prepared and compacted to a minimum of 95% Standard Proctor Test (ASTM D-698). Crushed stone shall meet the gradation requirements Section 215.02 and ASTM C-33, No. 67, and be compacted in accordance with Section 212.04.04 B).

817.06 – METHOD OF MEASUREMENT

Payment for "Removing and Replacing Parking Lot Paving" shall be made at the unit price bid per square yard for each pavement type. The price established shall be full compensation for complete repair and replacement of the parking lot, including the removal and proper disposal of spoil and the support of adjacent slabs.

Concrete parking lot paving shall also include curb and gutter if applicable. For other types, curb and

gutter shall be paid for separately.

817.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REMOVE AND REPLACE PARKING LOT PAVEMENT (TYPE) S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 818 – INCIDENTAL PAVING REPAIR AND REPLACEMENT

818.01 – DESCRIPTION

This section covers the construction of edges or portions of pavement adjacent to new work; the repair and replacement of paving cuts required for sewer or other ditch construction including the construction of edges or portions for adjacent pavement; the repair and replacement of base failures in pavement including the reconstruction of edges of adjacent slab using Portland Cement Concrete; the repair and replacement of base failures in pavement including the reconstruction of edges of adjacent pavement using asphalt concrete; and preparation of pavement for resurfacing.

818.02 – MATERIALS

All materials shall conform to the requirements of Section 900 - Materials for the type or class of materials involved.

818.04 – CONSTRUCTION METHODS

A) Reconstruction of Edges of existing pavement adjacent to new Portland Cement Concrete paving construction shall be accomplished as follows:

Upon completion of the excavation or slab removal required by the new construction, the subgrade under the edge of the existing slab shall be undercut for a distance and depth as shown on the plans and the resulting void poured as a unit with the new slab. The edges of the new slab shall be vibrated sufficiently to insure flow of concrete into that undercut area.

B) Repair and Replacement of Paving Cut required for sewer or other ditch construction shall be accomplished as follows:

After backfilling operations are complete, the subgrade under the slab edges adjacent to the trench shall be undercut for a distance and depth as shown on the plans. Where reinforcement is required it shall conform to Section 941 of these specifications and be placed as shown on the plans. The cut shall then be filled with concrete to the depth indicated on the plans. The concrete shall conform to Section 932 of these specifications. The edges of the replacement slab shall be vibrated to insure flow of concrete into the undercut area.

C) Repair and Replacement of Base Failures in Pavement by the use of Portland Concrete shall be accomplished by removing the slab over and around the area of the failure as directed by the Engineer, or indicated by the plans.

When soft or spongy foundation material is encountered it shall be removed to a depth indicated by the Engineer and replaced with a soil having AASHTO Classification of A-2 or better. The backfill material shall be moistened and compacted in lifts not to exceed six inches (6”) to a density of ninety-five percent (95%) Standard Proctor.

When, in the opinion of the Engineer, the subgrade repair is of sufficient area to justify the use of a roller the subgrade shall be rolled with an approved power roller or sufficient weight and design to achieve the required density.

D) Repair and Replacement of Base Failures in Existing Pavement by use of Asphalt Concrete shall be accomplished in those areas as directed by the Engineer and as indicated on the plans.

The area to be patched shall be removed to a depth of the thickness of pavement currently existing except that the minimum depth for residential streets shall be six inches (6") and the minimum for all other streets shall be eight inches (8").

If soft and spongy material is encountered below the depth of patch such material shall be removed as directed by the Engineer. The material below the depth of the patch will be replaced with soil having an AASHTO Classification of A-2 or better (it shall be the option of the Contractor that the additional backfill material may be Hot Sand Asphalt meeting the requirements of these specifications).

When, in the opinion of the Engineer, the subgrade repair is of sufficient area to justify the use of a roller the subgrade shall be rolled with an approved power roller of sufficient weight and design to achieve the required density.

The area which is removed shall be in straight lines, either parallel or perpendicular, to the centerline of the road. The face of all sides of the patch shall be vertical.

The material to be used for patching shall be that material which is specified for the surface course mix used on the project.

E) Existing Pavement shall be prepared for resurfacing as follows:

The surface of the pavement shall be thoroughly cleaned of all dirt, dust or other loose, or inert materials by sweeping with approved brooms and flushing with water, using an approved hose and nozzle prior to resurfacing. The hose shall be of sufficient length to reach to entire width and length of the area to be cleaned. The cleaning shall be continued until the surface is in a condition satisfactory to the Engineer. Care shall be taken and the necessary arrangements made to prevent the water used in flushing the pavement from coming in contact with or interfering with any new work already in place or being placed. Where the existing paving is of two course construction and the surface course is removed, the area from which the surface course was removed shall be thoroughly cleaned of all particles of old surface course and, if directed by the Engineer, the area shall be flushed and broomed prior to resurfacing as indicated above.

818.06 – METHOD OF MEASUREMENT

A) Reconstruction - There will be no measurement of reconstruction of edges or portions of pavement adjacent to new work as such. Reconstruction of edges of existing paving adjacent to new paving construction will not be paid for as such, but the cost of reconstructing the edges of the existing pavement shall be included in the price bid for "Thickened Edge for Concrete Paving", including support for existing paving. The price bid per linear foot for thickened edge for concrete paving including support for existing paving in place shall be payment in full for all excavation, labor, material and equipment and performing all work required for the construction of the thickened edge and support for existing paving.

B) Repair and Replacement of Paving Cuts for sewer ditch or other ditch construction including the construction of edges or adjacent slab will be measured by the square yard. There will be no measurement of excavation or fine grading. Repair and Replacement of Paving Cuts required for sewer or ditch construction will be paid for by the unit price bid per square yard. Such compensation shall be payment in full for all labor, material, equipment, and excavation required to complete the repair and replacement of paving cuts for sewer or other ditch construction including support of adjacent slab.

C) Repair and Replacement of Base Failures in Portland Concrete pavement including the reconstruction of edges of adjacent slab will be measured by the square yard. Repair and Replacement of Base Failures in Portland Concrete pavement including the reconstruction of edges

of adjacent slab, will be paid for by the square yard and shall include the following items:

1) Existing paving removed;
2) Removal and disposal of unsatisfactory subgrade material;
3) Soil for replacing unsatisfactory subgrade materials;
4) Fine grading;
5) High Early Strength Portland Cement Concrete for base repair.

Such compensation as outlined above shall be payment in full for furnishing all materials, equipment, labor, excavation, and incidental items necessary to complete in accordance with the plans and specifications.

D) Repair and Replacement of Base Failure using Asphalt Concrete shall be measured by the square yard. Repair and Replacement of Base Failures using Asphalt Concrete, including the reconstruction of edges of adjacent slab, will be paid for at the unit price bid for "Base Repair" and shall include the following items:

1) Removal of existing flexible pavement;
2) Necessary earth excavation, if any, to obtain eight inch (8") depth from the surface of the existing pavement;
3) Pavement shall be replaced as shown on Typical Sections. All asphalt concrete used in this repair shall conform to the job formula for Type "M" Asphalt Concrete;
4) Hot Sand Asphalt.

Existing paving removed will be paid for at the price bid per square yard as provided in these specifications. Removal and disposal of unsatisfactory subgrade material will be paid for at the price bid per cubic yard for this item. A-2 soil for replacing unsatisfactory subgrade material will be paid for at the price bid per cubic yard for this material in place, compacted and accepted.

Such compensation as outlined above shall be payment in full for furnishing all materials, equipment, labor, excavation, and incidental items necessary to complete in accordance with the plans and specifications the repair and replacement of base failures in pavement, including the reconstruction of edges of adjacent slab.

818.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

BASE REPAIR (PAVEMENT TYPE) S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 819 – ADJUSTMENT OF EXISTING STRUCTURES

819.01 – DESCRIPTION

This section will cover the necessary adjustment, alteration or resetting to the required grade and alignment of existing structures, equipment or appurtenances which are not to be removed or abandoned and which are not the property of a private company, firm or corporation required to move their own property.

819.04 – CONSTRUCTION METHODS

General - The materials and workmanship necessary in raising, lowering and otherwise adjusting or resetting existing structures shall conform to the requirements of the City's standard specifications for the class of work involved, unless otherwise provided for in these specifications. Whole bricks,

salvaged in good condition from structures, may be used in rebuilding such structures provided the bricks are cleaned to the satisfaction of the Engineer. Existing structures shall be rebuilt accurately to correct grade and alignment and such work shall be completed in advance of the construction of new work abutting when required by the Engineer.

A) Waterlines, Valves, Meters, Fire Hydrants, etc. - The Contractor shall make complete arrangements with the City's Water Department for lowering or relocating of all waterlines and resetting of water valves and meters, and fire hydrants. Where the Contractor is to perform the actual work such work shall conform strictly to the requirements of the City's Water Department.

B) Electric Traffic Signals - The Contractor shall make proper arrangements with the City for the moving and resetting of any electric traffic signals, conduits, cables, etc. Where the Contractor is to perform the actual work, such work shall conform strictly to the requirements of the City.

C) Manholes and Inlets

1) Materials - Manholes or inlet rings, plates, grates and covers, and brick in good condition, removed from the manholes and inlets in the process of adjustment may be reused. All additional materials necessary for the completion of work (adjustment of existing structures) shall be included in price bid.

2) General - Utility manhole frames within the area to be paved or graded will be set by the City to finished surface grade at no cost to the Contractor. Sewer and storm drain manhole frames within the area to be paved or graded shall be set to finished grade by the Contractor.

   Manholes or inlet rings, covers, plates, and grates shall be removed carefully and the contact areas shall be cleaned of all mortar and grease. Rings, covers, plates, or grates broken in the process of removal and cleaning shall be replaced in kind by the Contractor at his expense.

   Where the tops of manholes are to be lowered to a new grade, the walls shall be removed and rebuilt to an elevation far enough below the new grade so that the maximum batter of the walls does not exceed four inches (4”) per foot.

   Where manholes are to be built up a distance of one foot (1’) or less to a new grade, the walls may be carried up vertically.

   Where the walls are to be built up a distance exceeding one foot (1’), the existing walls shall first be removed to the bottom of the batter section of the walls or to such elevation that the inside diameter of the manhole is not less than three feet (3’) six inches (6”). The manhole shall then be rebuilt in conformity with the size and shape of requirements for new manholes.

3) Manholes in HMAC Pavement - Except as otherwise authorized by the Engineer, manhole frames within the pavement area shall not be set to final grade until the pavement has been completed. The manhole frames and covers shall be removed and the manhole structure covered with a steel plate unless the existing cover is sufficiently below grade so as not to form an obstruction during the construction of the subgrade or base and the spreading and rolling of the asphalt concrete. The manhole openings shall be temporarily covered by suitable means. After the pavement has been completed, the necessary portions of the subgrade, base, and pavement shall be neatly cut away, the manhole built up, and the frames set to a grade flush with the surface of the adjacent pavement. The surrounding area from which the pavement, base or subgrade has been removed shall be backfilled to within two inches (2”) of the surface with PC Concrete. The remaining two inches (2”) shall be backfilled with asphalt concrete wearing surface and compacted. The work shall be so performed as to present a neat and thoroughly workmanlike appearance upon completion.

4) Manholes in Concrete Pavement - Existing manhole castings and covers shall be adjusted to the grade of the new pavement at least three (3) days before placement of the new pavement, using brick, mortar, and/or concrete for raising or lowering the manhole.

5) Inlets - Inlets which are to be adjusted shall be adjusted to the grade shown on the plans. All additional materials necessary for the completion of work (adjustment of existing structures) shall be included in price bid.

D) Parking Meters - Where parking meters are to be moved in areas where the sidewalk is to be removed, the concrete shall be carefully removed from around the base of the meter post and the parking meter then transported by the Contractor to a storage point designated by the Engineer.

Where parking meters are to be moved in areas where the existing sidewalk is to be left in place, the parking meter post shall be cut at a distance above the sidewalk to be designated by the Engineer and the meter then transported to a storage point to be designated by the Engineer. All parking meters will be reinstalled by the City and the cost of such installation will not be included in the contract.

819.06 – METHOD OF MEASUREMENT

Where payment is to be made on the unit price basis, vertical measurements of structures raised or lowered to grade will include only the actual net distance the structure is raised or lowered and will not include sections of wall removed and rebuilt. There will be no measurement of basement repair as such, however, the concrete used in the repair will be measured in cubic yards and the steel in pounds. Where adjustment of manholes exceeds one foot (1'), or manholes are to be offset, measurement will be made by L.F. for sections of wall removed and rebuilt.

Payment will be made at the contract price, or the unit price, or lump sum price basis, as the case may be, for the adjustment of the particular class of structure involved, other than repair of basements. Basement repair will not be paid for as such but the cost of the repair will be included in the price bid per cubic yard for "Formed Reinforced Concrete in Special Structures", and the price bid per pound for "Reinforcing Steel" used in the repair. Such price or prices shall be compensation in full for all labor, materials, tools, equipment and incidentals necessary to complete the work in accordance with the plans and these specifications.

819.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

ADJUST EXISTING STRUCTURE (TYPE) EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 820 – MACHINE SAW CUT

820.01 – DESCRIPTION

This section will cover the sawing of bituminous or concrete pavement, curb, gutter, sidewalk or driveways.

820.03 – EQUIPMENT

The saw shall be power driven, shall be manufactured especially for the purpose of sawing concrete, shall be suitable for the work to be performed, and shall be maintained in good operating condition.

Saw blades shall make a clean, smooth cut, producing a groove one-eighth inch (1/8") to one-fourth inch (1/4 ") wide and to the full depth required by these specifications or as shown on the plans.

The saw, with its control devices, shall be mounted on a sturdy frame supported on rubber tired wheels or portable handheld saws which can meet the requirements of this section.

820.04 – CONSTRUCTION METHODS

A) General - Sawing shall be in accordance with the requirements of this item unless shown otherwise on the plans or in the special provisions.

B) Removing Pavement, Curb, Gutter, Sidewalk and/or Driveways - Pavement and appurtenances shall be removed to neatly sawed edges. Saw cuts shall be made to a minimum depth of one and one-half inches (1/2”). The edges of pavement and appurtenances which are damaged subsequent to sawing shall again be saw cut to neat straight lines for the purpose of removing the damaged areas. Such saw cuts shall be either parallel to the original saw cuts or shall be cut on an angle which departs from the original saw cut not more than one inch (1”) in each six inches (6”).

   Concrete sidewalk or driveway to be removed shall be neatly sawed in straight lines either parallel to the curb or at right angles to the alignment of the sidewalk. No section to be replaced shall be smaller than thirty inches (30”) in either length or width unless otherwise approved by the Engineer.

   Curb and gutter shall be sawed on a neat line at right angles to the curb face.

C) Weakened Plane Joints (Contraction Joints) - Weakened plane joints shall be saw cut at the locations shown on the plans or as directed by the Engineer. The groove shall be cut to a minimum depth of one and one-half inches (1 ½”). Any portion of the membrane curing compound which has been disturbed by sawing operations shall be restored by spraying the areas with additional membrane curing compound.

820.06 – METHOD OF MEASUREMENT

Machine saw cut shall be measured for payment by the linear foot.

Such compensation as outlined above shall be payment in full for all labor, equipment, and materials necessary to complete the item of work.

820.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SAWCUT PAVEMENT (TYPE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 821 – PLANING PAVEMENT

821.01 – DESCRIPTION

This section covers planing and existing pavement surfaces with equipment meeting the requirements hereinafter specified which shall cold plane the surface irregularities such as to provide a smooth riding surface and, in some cases, remove the pavement to predetermined grades. The planed and finished surface shall be free from gouges, grooves, ridges, sooting, oil film and other imperfections of workmanship and shall have a mosaic appearance that clearly shows seventy-five (75) percent of the surface aggregate sheared by the cutting blades having a desirable bonding surface.

821.03 – EQUIPMENT

The planing work shall be performed with a pavement planing machine of the following type:

Cold Planing - This planing machine shall be designed and built for this type of work. The equipment shall be self-propelled with sufficient power, traction and stability to maintain accurate depth of cut and slope. The machine shall be equipped with automatic grade and slope controls capable of producing a finished profile within one-fourth inch (1/4”) of reference elevation.

The machine shall be equipped with an integral loading and reclaiming means to immediately remove

material being cut from the surface of the roadway and discharge the cuttings into a truck, all in one operation or adequate back-up equipment (sweepers, loaders, water truck, etc.) and personnel will be provided to insure that all cuttings are removed from street surface daily. Stock piling of planed material will not be permitted on the project site. The machine shall be capable of producing a minimum coverage of two thousand (2,000) square yards per hour while removing a minimum of one-fourth (1/4") to one-half (1/2") inch of the existing pavement per pass and shall be equipped with means to control dust created by the cutting action and be able to cut flush to all curbs, inlets, manholes or other obstructions within the paved area. In the case of producing a finished, textured surface, the speed of the machine shall be variable in order to leave the desired grid pattern. The texture produced for finished pavement shall be a grid surface with discontinuous longitudinal striations.

821.04 – CONSTRUCTION METHODS

The temperatures at which the work is performed, the nature and condition of the equipment, and the manner of performing the work shall be such that the pavement is not torn, gouged, shoved, broken, sooted, oil coated, burned or otherwise injured by the planing operation. Sufficient passes, or cuts shall be made such that all irregularities of high spots are eliminated and that one hundred percent (100%) of the surface area has been planed to the desired grade or to the satisfaction of the Engineer. Where the pavement is to be resurfaced, a one and one-half inch (1 ½") shoulder shall be cut along the gutter line to eliminate the necessity of feathering the edge of the new surface. As a general rule, an average cut over the street of one inch (1") will be required.

821.06 – METHOD OF MEASUREMENT

Pavement planing performed and provided above shall be measured by the square yard of variable depth up to a maximum of one and one-half inch (1 1/2") below the surface. An additional pay item will be provided for areas requiring extra depth in increments of one inch (1").

Payment for the planing of pavement shall be made at the unit price bid per square yard which shall include all labor, equipment, materials, supplies, mobilization, and traffic control.

821.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

PLANE PAVEMENT (UPTO 1 ½ INCH)	S.Y.
PLANE PAVEMENT (GREATER THAN 1 ½ INCH)	S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 822 – PAVEMENT REINFORCING FABRIC

822.01 – DESCRIPTION

This section covers the application of pavement reinforcement fabric in accordance with these specifications and in reasonably close conformity with the locations and dimensions shown on the plans or established by the Engineer.

822.02 – MATERIALS

Material shall meet the requirements of Section 988.

822.03 – EQUIPMENT

Equipment and tools necessary for performing all parts of the work shall be on the job site prior to commencement of work and shall be maintained in first class operating condition.

Distributors shall be designed, equipped, and maintained so that bituminous material at even heat may

be applied uniformly on variable widths of surface up to twenty-six (26) feet at readily determined and controlled rates from 0.1 - 1.0 gallons per square yard with uniform pressure and with an allowable variation from any specified rate not to exceed 0.03 gallon per square yard. A check of distribution rate and uniformity of distribution shall be made when directed by the Engineer.

Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically and shall be equipped with a hand spray with single nozzle and positive shut off valve.

Fabric laydown equipment shall be capable of handling full or partial rolls of fabric and shall be capable of laying the fabric smoothly without wrinkles and/or folds. When manual laydown is required a length of standard one inch (1") pipe, together with suitable roll tension devices shall be used for proper roll handling.

Miscellaneous equipment shall include stiff bristle brooms to smooth the fabric, scissors or blades to cut the fabric, and brushes as required for use in applying asphalt binder to fabric overlap at spliced joints.

822.04 – CONSTRUCTION METHODS

A) Surface Preparation - The surface on which the fabric is to be placed shall be free of dirt, dust, water, oil or other foreign matter.

B) Application of Bituminous Binder - The bituminous binder material shall be heated and uniformly spray applied over the area to be fabric covered. Double rate application shall be applied along an overlap area.

The minimum application temperature of the bituminous binder shall not be less than two hundred-ninety (290º) degrees F. If the fabric is oversprayed the maximum application temperature shall not exceed three hundred twenty-five (325°) degrees F. to avoid damage to the fabric.

The bituminous binder shall be applied at the rate of 0.20 to 0.35 gallons per square yard or as established by the Engineer.

Application of the bituminous material shall be accomplished with an asphalt distributor. Areas not accessible to the distributor shall be hand sprayed. The distributor shall be started and stopped over paper or roofing felt to provide neat cutoff lines. The width of binder application shall be two (2) to six inches (6") wider than the fabric width. Care shall be exercised in the application of the binder to avoid spills or excessive application to cause flushing of the bituminous material.

C) Placement of Reinforcement Fabric - The fabric shall be placed after the bituminous binder has been applied and before the binder has cooled and lost tackiness. The fabric shall be unrolled and placed into the binder with the unfused (fuzzy) side down with a minimum of wrinkles. Every effort shall be made to lay the fabric as smooth as possible. The fabric shall be broomed to remove air bubbles and maximize fabric contact with the pavement surface. Wrinkles shall be cut and laid out flat.

If misalignment of the fabric occurs the fabric shall be cut, realigned and jointed as directed by the Engineer.

Overlap of fabric at joints shall be between two inches (2") and four inches (4"). Transverse joints shall be shingled in the direction of paving to prevent edge pickup by the paver. Additional binder shall be applied to joints at the rate specified by the Engineer by hand spraying or brushing.

The reinforcement fabric shall be embedded into the bituminous binder and bonded to the pavement. Self-propelled pneumatic-tired rollers may be used if deemed necessary by the Engineer.

D) Weather Limitations - Asphalt binder shall not be applied for installation of the fabric when the air temperature is less than fifty (50°) degrees F.

E) Tack Coat - Tack coat, if required for the pavement overlay, shall be applied in accordance with Section 939. The bituminous material type, grade, rate of application and temperature shall be approved by the Engineer. Cut-Back Asphalt or Emulsified Asphalt containing petroleum distillate additives shall not be used.

F) Pavement Overlay - Placement of the asphalt concrete pavement overlay should closely follow fabric laydown unless otherwise permitted by the Engineer. Any damage or disbonding of the fabric reinforcement membrane caused by traffic or wet weather conditions due to unnecessary delay or negligence of the Contractor shall be repaired at his own expense.

In the event excess binder bleeds through the fabric before the overlay is placed, the excess material shall be blotted by spreading sand on the affected area as directed by the Engineer.

The temperature of the paving mix at time of placement on the reinforcement fabric membrane shall not exceed three hundred twenty-five (325°) degrees F to prevent damage to the fabric.

The turning of pavers or other vehicles should be gradual and kept to a minimum to avoid damage to the fabric. Should equipment tires pick up the fabric or the paver cause movement of the membrane during paving operations asphalt paving mix may be broadcast ahead of trucks and the paver to prevent damage. Any damage to the reinforcement membrane due to equipment shall be repaired by the Contractor at his expense.

822.06 – METHOD OF MEASUREMENT

Pavement reinforcing fabric will be measured by the square yard complete in place.

The pavement reinforcing fabric shall be paid for at the contract unit price bid per square yard. Measurement shall be made by the square yard of pavement so reinforced. Such payment shall be full compensation for all materials, labor, equipment, tools, and incidentals necessary to complete the work.

822.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

PAVEMENT REINFORCING FABRIC S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 823 – CONCRETE SIDEWALKS AND DRIVEWAYS

823.01 – DESCRIPTION

This section covers concrete sidewalks and driveways constructed as herein specified and in conformity with the lines and grades as established by the Engineer and the details as shown on the plans.

823.02 – MATERIALS

All materials and requirements for concrete shall conform to the requirements of Section 305, "Concrete Curb and Gutter". Standard construction details shall also provide the requirements for expansion joints, forming, curing, and other incidental construction items related to the placing of concrete for sidewalks and driveways. Unless otherwise specified, High Early Strength Concrete shall be used for driveway construction to facilitate public access.

823.04 – CONSTRUCTION METHODS

A) General - Concrete sidewalks and driveways shall be constructed in accordance with the current Oklahoma City Engineering Department Construction Standards.

The Contractor shall furnish all materials, labor and equipment, and construct sidewalks and driveways, conforming to line, grade, location, and design as indicated on the plans and in these specifications, or as established by the Engineer.

B) Excavation - Excavation required for the construction of sidewalks and driveways shall be to the lines and grades as established by the Engineer, or as shown on the plans.

C) Fine Grading - The Contractor shall do all necessary filling, leveling, and fine grading required to bring the subgrade to the exact grades specified.

D) Forms - Construction methods and equipment for slip-form paving of sidewalks shall conform to the requirements of Section 305.

E) Finishing - Concrete sidewalks and driveways shall be finished to a true, even surface. They shall be troweled with a steel trowel and then brushed transversely to obtain a smooth uniform brush finish. Joint and sides shall be edged with suitable tools.

F) Joints - Expansion joints for sidewalks and driveways shall be formed using pre-molded expansion joint material of an approved type. Expansion joints shall be placed in the sidewalk at one hundred foot (100') intervals maximum distance or as otherwise specified by the Engineer. Expansion joints shall also be placed at all intersections or sidewalks with concrete driveways, poles, curbs, buildings, and other sidewalks. All expansion joints shall be three-fourths inch (3/4") in thickness, and shall be sealed.

The edges of all construction and expansion joints and the outer edges of all sidewalks shall be finished to approximately a one-half inch (1/2") radius with a suitable finishing tool. Contraction joints shall be saw cut in accordance with standard details.

G) Curing - Sidewalks and driveways shall be cured in accordance with the requirements of Section 305, "Concrete Curb and Gutter".

823.06 – METHOD OF MEASUREMENT

Measurement for sidewalks and/or driveways complete in place will be by the square yard.

Concrete sidewalks and driveways shall be paid for at the contract unit price bid, which price shall be full compensation for excavating and preparing the subgrade; furnishing and placing all materials, including expansion joint materials; and for all manipulation, labor, tools, equipment, and incidentals necessary to complete the work.

823.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SIDEWALK (WIDTH)	S.Y.
DRIVEWAY (WIDTH)	S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 824 – TEMPORARY SURFACING

824.01 – DESCRIPTION

This section covers the placing of temporary surfacing on areas to be used as temporary crossings and temporary routes of ingress and egress to residences and places of business adjacent to or near the

project.

824.02 – MATERIALS

Two types of temporary surfacing materials may be used as follows:

A) Asphalt - When called for, asphalt shall be type "A" mix placed a minimum of three inches (3”), and compacted on a prepared subgrade in accordance with the requirements of the Standard Specifications for asphalt paving.

B) Aggregate - When called for, aggregate shall be placed a minimum of four inches (4”), and compacted on a prepared subgrade and shall meet the requirements of one of the following gradations:

Type "A" - Type "A" material shall consist of hard durable particles of sand, gravel, mine chats, crushed rock or a combination of any of these materials.

Type "B" - Type "B" material shall consist of hard, durable particles of disintegrated granite with natural binder.

Type "C" - Type "C" material shall produce a bonded traffic bound surface course and shall consist of an intimate mixture of graded aggregate, coarse and fine.

Coarse aggregate (material retained on a No. 10 sieve) shall consist of sound, tough, durable particles or fragments of gravel, stone, disintegrated granite or combination thereof, crushed to size if necessary. Fine aggregate shall consist of sand, stone dust, or other inert finely divided mineral matter.

GRADATION REQUIREMENTS (Percent Passing)			
SIEVE SIZE	**TYPE "A"**	**TYPE "B"**	**TYPE "C"**
1 in.	100	100	100
¾ in.	95-100	95-100	...
½ in.	...	...	...
No. 4	5-75	0-85	40-75
No. 20	0-30	...	...
No. 40	...	...	20-40
No. 200	0-10	0-20	8-25
Plasticity Index	...	...	8-18
Liquid Limit	...	...	Not more than 35

824.04 – CONSTRUCTION METHODS

This work shall be constructed on a prepared subgrade in reasonable close conformity with the existing surfaces or established by the Engineer. Cross streets, side streets, approach streets, and temporary driveways to residences or places of business shall be shaped to a reasonable cross section to prevent ponding of water. Holes, waves and undulations which develop shall be corrected by blading and adding more material. The shaping of the surface material shall be continued until it is well compacted, free from ruts, waves, and undulations. Excess material not required for maintenance shall be removed from the construction site. The completed temporary surface shall be maintained in this condition until permanent repairs are constructed.

824.06 – METHOD OF MEASUREMENT

Payment for "Temporary Surfacing" shall be made at the unit price bid per ton for each material type. The

price established shall be full compensation for excavation, materials, labor, tools, equipment and incidentals necessary to complete this item of work.

824.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

TEMPORARY SURFACING (TYPE)	TON

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 825 – RIPRAP

825.01 – DESCRIPTION

This section covers the furnishing and placing of riprap protection of the type specified at the locations and in reasonably close conformity with the lines and dimensions shown on the plans or established by the Engineer. The types of riprap are as follows:

Type I	Plain Riprap
Type II	Plain Riprap with Filter Blanket
Type III	Special Plain Riprap
Type IV	Special Plain Riprap with Filter Blanket
Type V	Laid Up Riprap
Type VI	Grouted Riprap

825.02 – MATERIALS

Materials shall meet the requirements specified in the following Subsection of Part VIII - Materials:

Portland Cement Concrete	932
Fine Aggregate	932
Stone for Riprap	981
Filter Blanket	981

825.04 – CONSTRUCTION METHODS

A) General - The slopes, ditches, and areas to be protected shall be shaped and dressed to the lines and grades shown on the plans. Where Type V or Type VI construction is specified, the base shall be compacted in accordance with Section 302 before the riprap is placed.

B) Filter Blanket - Filter blanket, when specified, shall be placed on one (1) or two (2) layers as indicated on the plans.

Each layer shall be spread uniformly on the prepared base in a satisfactory manner to the neat lines indicated. Damage to the surface of the filter blanket during placing of the blanket shall be repaired before proceeding with the work. Compaction of the filter blanket will not be required, but it shall be finished to present a reasonably even surface free from mounds or windrows.

C) Types I, II, III and IV - The areas to be protected shall be dressed approximately to the lines and grades shown on the plans prior to placing riprap or the filter blanket, when a filter blanket is specified.

Plain riprap and special plain riprap, graded so that the smaller stone is uniformly distributed throughout the mass, may be dumped over the area designated until the required depth is attained. Hand or machine placing will be required as is necessary to deposit the stones to the general lines and to the thickness shown on the plans.

D) Type V - The foundation for riprap shall be excavated below probable scour or to the elevation shown on the plans, and no stone shall be laid or concrete placed until the footing is approved by the Engineer.

The stones or blocks shall be placed with their beds at the approximate angle to the slopes as indicated on the plans. They shall be laid in close contact and so as to break joints, and the individual stones shall be thoroughly keyed into the wall. Spaces between stones shall be filled with spalls securely rammed into place. The finished wall shall present an even, tight and reasonably plain surface of the contour required. Points of stones projecting beyond the surface of the wall shall be broken off.

E) Type VI - The foundation for riprap shall be excavated below probable scour or to the elevation shown on the plans, and no stone shall be laid or concrete placed until the footing is approved by the Engineer.

The stones or blocks shall be placed with their beds at the approximate angle to the slopes as indicated on the plans. They shall be laid in close contact and so as to break joints, and the individual stones shall be thoroughly keyed into the wall. Care shall be taken during placing to keep earth or sand from filling the spaces between the stones.

After the stones or blocks are in place, the spaces between them shall be completely filled with grout from bottom to top and the surface swept with a stiff broom. No riprap shall be grouted in freezing weather and in hot, dry weather the work shall be protected from the sun and kept moist for at least three (3) days after grouting.

Grout for grouted riprap shall consist of one (1) part of Portland Cement and three (3) parts of fine aggregate by volume thoroughly mixed with water to produce grout having the proper consistency. Retempering of grout will not be permitted.

825.06 – METHOD OF MEASUREMENT

Type I and Type II, Plain Riprap or Plain Riprap and Filter Blanket will be measured separately by the cubic yard determined by multiplying and specified thickness of each type of material by the actual area of the surfaces on which each material is acceptably placed, or by the ton.

Type III and Type IV, Special Plain Riprap or Special Plain Riprap and Filter Blanket will be measured separately by the cubic yard determined by multiplying the specified thickness of each type of material by the actual area of the surfaces on which each material is acceptably placed, or by the ton.

Type V, Laid Up Riprap will be measured by the square yard. This measurement covers the whole face area, regardless of thickness, and including additional thickness at base of walls.

Type VI, Grouted Riprap will be measured by the square yard. This measurement covers the whole face area, regardless of thickness, and including additional thickness at base of walls.

Accepted Riprap, measured as provided above, will be paid for at the contract unit price which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

825.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(TYPE) PLAIN RIPRAP	C.Y.
(TYPE) PLAIN RIPRAP	TON
(TYPE) FILTER BLANKET	C.Y.
(TYPE) FILTER BLANKET	TON
(TYPE) FILTER BLANKET	S.Y.
(TYPE) SPECIAL PLAIN RIPRAP	C.Y.
(TYPE) SPECIAL PLAIN RIPRAP	TON
(TYPE) LAID-UP RIPRAP	S.Y.
(TYPE) GROUTED RIPRAP	S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 826 – PIPE CONDUITS

826.01 – DESCRIPTION

This section covers the construction of pipe conduits of the type shown on the plans in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer. Included are pipe underdrains six inches (6”) in diameter or greater and all other pipe used in sanitary sewers, storm sewers, and pipe culverts.

826.02 – MATERIALS

Pipe conduit shall be of the kind specified on the plans and shall meet the requirements of Section 900. The class of reinforced aluminum pipe for various diameters and heights of fill above the top of pipes shall be shown on the standard drawings. When the class of reinforced concrete culvert pipe is not specified it shall be Class III.

When not specified on the plans the kind of approved pipe will be optional with the Contractor but the same kind of pipe shall be used throughout any one project, unless otherwise approved in writing by the Engineer.

Semicircular metal pipe will not be approved as optional for pipe underdrains when the pipe drain shown on the plans is eight inches (8”) in diameter or greater.

826.04 – CONSTRUCTION METHODS

The construction of all pipe conduit shall begin at the outlet or the low point in the line. When the construction involves the building of main or submain pipe conduit having one or more laterals or tributaries, the construction of tributary lines will not be started until the main or submain pipe conduit has been completed to the point where the tributary or laterals discharge into it.

During construction adequate provisions for drainage of the system shall be made by the Contractor.

The connection of storm or sanitary sewers or sewer appurtenances to other storm or sanitary sewers or to sewer appurtenances shall be made in accordance with the plans or under the direction of the Engineer. The work shall be done in a workmanlike manner in such a way as not to damage any of the structures involved. Sewer pipe shall not project beyond the inside wall line of other sewers or of sewer appurtenances.

The grade line shown on the plans or established by the Engineer is the elevation of the invert or flow line of the sewer. The centerline and grade line shall be accurately established in the trench at intervals of not more than twenty-five feet (25’).

Dead ends of all sewers, wyes, tees, etc., shall be closed with approved stoppers securely cemented in

place. Tight fitting stoppers or bulkheads shall be securely placed in or across the end of all sanitary sewer lines when construction is stopped at the end of each day's work or for any other cause. When work is stopped temporarily on storm sewers twenty-four inches (24”) in diameter and smaller, the end of the pipe shall be closed to prevent trash or debris from entering the pipe. Such stoppers should not be watertight.

A) Excavation - Excavation, backfill and related items shall conform to Section 212, "Trench Excavation and Backfill".

B) Laying Pipe - Pipe conduit shall not be laid unless the foundation is in a condition satisfactory to the Engineer. The laying of pipe in a wet trench shall be done only when and as approved by the Engineer. The spigot end of the pipe shall be laid in the direction of the flow. No buckling in or laying pipe downgrade will be permitted. Pipe shall not be dropped to the bottom of the trench, but shall be lowered and placed in its final position by hoisting equipment adequate to handle the pipe without damage to the pipe or trench. Damaged pipe shall be replaced by the Contractor at his expense. The inside of the barrel shall be cleaned when the pipes are lowered into the trench.

   The conduit laying shall begin at the downstream end of the conduit line. The lower segment of the conduit shall be in contact with the shaped bedding throughout its full length. Bell or groove ends of rigid conduits and outside circumferential laps of flexible conduits shall be placed facing upstream.

   Paving or partially lined conduit shall be laid so that the longitudinal centerline of the paved segment coincides with the flow line. Elliptical and elliptically reinforced conduits shall be placed with the major axis within five (5°) degrees of a vertical plane through the longitudinal axis of the conduit.

   On underdrain pipe the pipe shall be embedded firmly in the bedding material. The pipe shall be laid reasonably true to the established line and grade. Perforated pipe shall be laid with perforation down. After the pipe has been inspected and approved it shall be covered with the cover and backfill material as shown on standard drawing with care being taken in placing backfill material so as to prevent displacement or damage of pipe.

C) Joining Pipe Conduit - Rigid conduits may be of bell and spigot or tongue and groove design unless one type is specified. The method of joining conduit sections shall be such that the ends are fully entered and the inner surfaces are reasonably flush and even.

   Joints shall be made with oakum and mortar, cold applied mastic type, rubber gaskets, or plastic joint material in accordance with the appropriate specifications for the type of pipe being used. Joints shall be concentric, reasonably watertight and free from superfluous joint material on the inside of the pipe. Flexible conduit shall be joined by coupling bands.

D) Shop Elongating - When required on the plans the pipe shall be shop elongated in accordance with AASHTO M36 to form an approximate ellipse with the vertical diameter approximately five (5) percent greater than the nominal diameter of the corresponding round pipe.

826.06 – METHOD OF MEASUREMENT

Measurement for pipe conduit shall be per unit price bid per linear foot. All work required to conform to these specifications shall be considered incidental to the price per linear foot, when additional pay items are not specified.

Accepted Pipe Conduit, measured as provided above, will be paid for at the contract unit price which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

826.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(TYPE) PIPE CONDUIT (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 827 – GUARDRAIL

827.01 – DESCRIPTION

This work shall consist of the construction of guard rail and guide posts in accordance with these Specifications and in reasonably close conformity with the lines and grades shown on the Plans or Established by the Engineer. The types of guard rail are designated as follows:

Beam Guard Rail-Steel-W-Beam-Single
Beam Guard Rail-Steel-W-Beam-Double
Transition Section
Guard Rail Anchor Unit
Guard Rail Extruder Terminal
Cable Guard Barrier
Wrought Iron Chain Guard Barrier

Guide posts with reflective bands shall be wood as specified.

827.02 – MATERIALS

Materials shall meet the requirements specified in the following Sections of these Specifications:

Guardrail Posts	983
Guide Posts (Wood)	983
Spacer Blocks	983
Zinc Rich Paint	984
Metal Plate (Beam Type Galvanized Steel)	982
Metal Plate (Beam Type Aluminum)	982
Fittings (Steel or Aluminum)	982
Wire Cable	982
Portland Cement Concrete	932

827.04 – CONSTRUCTION METHODS

A) Setting Posts for Guard Rail, Guide Posts, or Barrier Posts

a. Set posts for guardrail in accordance with the Plans.

b. When posts are to be set in the ground, set them in holes that have been dug in thoroughly compacted soil.

c. Keep the bottom of the holes free of loose material so that the post will have a stable foundation.

d. Space the posts as shown on the Plans, setting them plumb and with the front faces in a straight line, or if on a curve, at a uniform distance from the edge of the pavement.

e. Set the top of the post to the elevation shown on the Plans or as approved by the Engineer.

f. After the posts are placed, backfill the holes with approved material, thoroughly compacted in layers not to exceed six inches (6”) in depth and in such manner as not to

shift the posts from the correct alignment.

NOTE: Posts for guardrail may also be machine driven. Promptly fill any depression in the surface resulting from driving the posts, and tamp with like material.

All other requirements shall be as shown on the current guard rail standard drawings.

B) **Rail Elements**. Erect rail elements in a manner resulting in a smooth, continuous installation. All bolts, except adjustment bolts, shall be drawn tight. Bolts shall be of sufficient length to extend beyond the nuts.

Where painting of railing components is specified, correct any damage to the shop coat of paint by applying an approved rust-inhibitive primer prior to other painting. If any surfaces will be inaccessible to paint after erection, field paint them before they're erected. Give the railing components the specified number of coats of paint, uniformly applying them by thorough brushing or by approved pressure spray as specified.

Protect the following with two coats of an approved zinc rich paint:

a. galvanized surfaces which have been abraded so that the base metal is exposed;

b. threaded portions of all fittings;

c. fasteners and cut ends of bolts.

Where double-faced guard rail is specified, install it in accordance with the Plans.

C) **Placing Metal Plate Rails and Fittings.** Where metal plate rails are specified or used, fasten them to the posts in the manner shown on the Plans. The plate shall be at the elevation shown on the Plans. All laps in the rail shall conform to the direction of traffic on the roadway. When the type of metal plate guard rail to be used is not specifically set out on the Plans, No more than one type will be permitted on any one Project.

D) **Placing Reflective Sheeting on Guide Posts.** After the posts are set, provide them with reflective sheeting when specified, fixed to the post with four 8d box nails as shown on the Plans.

E) **Guard Rail Anchor Units.** Construct guard rail anchor units as shown on the Plans. When rock harder than medium sandstone (outcropping on surface, massive boulders, and ledge rock under overburden) is encountered during construction of the concrete anchor, the following steps should be followed.

a. For surface outcropping, drill four properly spaced and patterned 2 inches (50 mm) diameter holes to receive the full depth anchor bolts as shown on the Plans. Half fill the rock holes with pourable epoxy grout, insert the bolts, and stabilize them to their final position; then fill the remainder of the hole. Air bubbles and voids shall be expelled from the holes to guarantee full bearing of the bolts.

b. For rock with a soil overburden up to 18 inches (450 mm) deep, following these steps:

i. Drill the four, properly-spaced holes to receive the anchor bolts.

ii. Drill four additional holes at 2 1/2 inch (64 mm) diameter, spaced at 90° and 12 inches from center of concrete anchor.

iii. Half fill the outer holes with pourable epoxy grout; then insert and stabilize plumb one number 9 reinforcing steel bar per hole, cut to the proper length.

iv. Fill the remaining hole and expel any bubbles. Length should enable insertion of full 12 inches into the rock and clear the top of the concrete anchor by 2 inches

v. Tie the 6x6-W1.5xW1.5 wire mesh to the bars after grout is dry.

vi. Spread pourable epoxy grout on the mating surface between the rock and concrete for positive bond.

vii. Construct the upper portion with the same details as shown on the Plans.

c. For encountered rock at depths greater than eighteen inches (18”), omit the holes for the four anchor bolts and construct the anchor as covered in Section 827.02 above.

F) **Placing Wrought Iron Chains** - The chain shall be fed through the two inch (2”) holes in the posts and drawn up until the sag between posts is as shown on the plans. The chain shall be permanently secured in this position by placing one-half inch (1/2”) bolt through the post at right angles to the chain and through a link in the chain. All bolts projecting more than one inch (1”) through the nut shall be cut off one-half inch (1/2”) from the nut.

G) **Placing Reflective Sheeting on Guide Posts** - After the posts are set, they shall be provided with reflective sheeting.

827.06 – METHOD OF MEASUREMENT

Cable Guard Barrier, Beam Type Guardrail (Single), Beam Type Guardrail (Double Faced) and Wrought Iron Chain Guard Barrier will be measured by the linear foot between end section. Guardrail Anchor Units will be measured separately as unit shown on the standard drawings. Fittings will not be measured separately but included as incidental to the type specified. Guide Posts will be measured by the number of posts, including reflective sheeting.

827.07 – BASIS OF PAYMENT

The accepted quantities of the various items, measured as provided above, will be paid for at the contract unit price for:

BEAM-TYPE GUARDRAIL (SINGLE)	L.F.
BEAM-TYPE GUARDRAIL (SINGLE)(SHOP CURVED)	L.F.
GUARDRAIL ANCHOR UNIT, TYPE "A" (SEE STD. GRAU-1-1)	EA.
GUARDRAIL ANCHOR UNIT, TYPE "B" (SEE STD. GRAU-1-1)	EA.
GUARDRAIL ANCHOR UNIT, TYPE "C" (SEE STD. GRAU-2-1)	EA.
GUARDRAIL ANCHOR UNIT, TYPE "D(BF)" (SEE STD. GRAU-1-1)	EA.
GUARDRAIL ANCHOR UNIT, TYPE "E" (SEE STD. GRAU-2-1)	EA.
GUARDRAIL ANCHOR UNIT, TYPE "F" (SEE STD. GRAU-2-1)	EA.
GUARDRAIL ANCHOR UNIT, TYPE "G" (SEE STD. GRAU-2-1)	EA.
GUARDRAIL ANCHOR UNIT, TYPE "GE" (SEE STD. GRAU-2-1)	EA.
NEW GUARDRAIL EXTRUDER TERMINAL	EA.
ATTENUATOR (UP TO 42" WIDE)	EA.
ATTENUATOR (WIDE) (42" AND WIDER)	EA.
CABLE GUARD BARRIER	L.F.
WROUGHT IRON CHAIN GUARD BARRIER	L.F.
GUIDE POSTS	EA.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

SECTION 828 – FENCES

828.01 – DESCRIPTION

This section covers the construction of fence and gates in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer.

The type of fence will be as shown on the plans. The types are designated as follows:

Fence	Type I
Standard Chain Link Fence	Type II
Fence	Type III
Glare Deflector Fence	Type IV

Fence gates shall be of the type and size as shown on the plans and shall be hung at locations shown on the plans or directed by the Engineer, and in accordance with the plans.

828.02 – MATERIALS

Materials shall meet the requirements of the following Section 900, Materials:

Fence Type I & II	982
Standard Chain Link Fence Type II	982
Glare Deflector Fence	982
Portland Cement Concrete	932

When not specified on the plans or in the proposal, the kind of posts, hardware and fittings meeting the requirements of Section 982 shall be optional with the Contractor but the kind selected shall be used throughout any one project unless otherwise approved in writing by the Engineer.

828.04 – CONSTRUCTION METHODS

A) General - The Contractor shall perform such clearing and grubbing as may be necessary to construct the fence to the required grade and alignment.

At locations where breaks in a run of fencing are required, or at intersections with existing fences, appropriate adjustment in post spacing shall be made to conform to the requirements for the type of closure indicated.

When the plans require that posts, braces or anchors be embedded in concrete, the Contractor shall install temporary guys, or braces as may be required to hold the posts in proper position until such time as the concrete has set sufficiently to hold the posts. Unless otherwise permitted, materials shall not be installed on posts or strain placed on guys and bracing set in concrete until five (5) days have lapsed from the time of placing of the concrete.

The tops of all posts shall be set approximately to the required grade and alignment. Cutting of the tops of the posts will be allowed only with the approval of the Engineer and under the conditions specified by him.

Wire or fencing of the size and type required shall be firmly attached to the posts and braces in the manner indicated. All wire shall be stretched taut and be installed to the required elevations.

At each location where an electric transmission, distribution or secondary line crosses any of the types of fences covered by the specifications, grounding of the fencing will be accomplished in accordance with the following:

A galvanized or copper coated steel ground rod eight feet (8') long having a minimum diameter of one-half inch (1/2") shall be installed directly below the point of crossing. The rod shall be driven vertically until the top is six inches (6") below the ground surface. A No. 6 solid copper conductor or equivalent shall be used to connect each fence element to the grounding rod. The connections shall be either brazed or fastened with approved non-corrosive clamps.

When a power-line runs parallel or nearly parallel to and above the fence, the fence shall be grounded at each end or gate post or at intervals not to exceed fifteen hundred feet (1500').

When required the Contractor shall provide the abutting property owners with the equivalent property protection given by the existing fences. The Contractor shall be responsible for the

maintenance of all types of fences and gates that he constructs during his construction operations.

B) Fence Type I

1) Alignment - The plan sheets shall show the general alignment, angles, corners and attachment types at culverts. In general, fence shall be constructed one foot (1') inside and parallel to the permanent right-of-way line and wire usually will be attached to the property side of the fence posts. On curves, wire fabric shall be placed on that side of the post which will maintain the wire where the location of the fence is to be constructed and shall be cleared of obstructions and ground leveled of minor irregularities so the fence can be free of excessive number of anchor posts and fans.

2) Setting Posts - Line posts shall be of the size indicated on the plans and shall be set a minimum of one foot (1') inside the permanent right-of-way or to a line shown on the plans or set by the Engineer, and in reasonably true line on the property owner's side to which wire generally is to be attached. They shall be embedded in the ground to the depth shown on the plans and shall be well tamped and firmly set. Spacing between line posts shall not exceed the dimensions shown on the plans. Additional posts shall be set at each abrupt change in grade.

   Extra length posts will be required at small depressions where it is not practicable for the fence to follow closely to the contour of the ground. At such small ground depressions the Contractor shall close the space below the bottom of the fence fabric with barbed wire, stretched taut between posts, either on horizontal lines or fanned at six inch (6") maximum spacing, as shown on the plans or as directed by the Engineer. The wires shall be stretched taut and securely fastened to the posts to prevent vertical movement of the wires.

   Concrete for encasing posts as indicated on the plans may be poured without forming if the excavation is of sufficient stability to receive the concrete without caving or sliding in. If specified by the Engineer, footings shall be formed.

3) Placing Fencing - Barbed wire shall be stretched uniformly tight by means of an approved mechanical tensioning device and in conformity to the location of the posts as designated on the plans.

   Splicing or barbed wire and wire fabric shall be made by a mechanical device of an approved type or a wire splice may be made in the following manner:

   The ends of the wires shall be carried two inches (2") past the splicing tools and wrapped around both wires backward from the tool for at least five (5) turns.

   Woven wire fabric shall be stretched uniformly tight by means of an approved mechanical tensioning device and in conformity to the location on the posts as designated on the plans. Parallel stays shall be straight and uniformly spaced as shown on the plans. Each woven fabric wire and barbed wire shall be stapled to wood posts or fastened with approved fittings to steel posts.

   Woven wire shall be cut and spliced at stretcher or wood posts as required to prevent buckling or undue stretching.

   Attachment assemblies shall be built according to the plans. When it is necessary to make attachments to culvert or bridge end-walls after the culvert is constructed, the hole shall be drilled with a drill of the same size as the expansion device and the holes shall be neat without chipping or breaking the concrete.

C) STANDARD CHAIN LINK FENCE TYPE II

Setting Posts and Placing Fencing - Post holes shall be dug to minimum size and spacing as shown on the plans. Posts shall be set plumb, centered in the hole and to the lines shown on the plans. Posts shall be placed in the concrete before initial set, thoroughly puddled and supported plumb

until concrete has set. Wire shall not be stretched until concrete in post holes is at least five (5) days old. Wire shall be stretched slightly above the tension recommended by the manufacturer for the season of the year in which construction takes place and allowed to slack away slightly when pullers are released. Pullers shall attach to wire full width and ties made in at least seven (7) places on each post before releasing. If desired, pulls may be made from two ways and jointed by inserting one picket. All post braces shall be set before placing any wire. Tension and barb wire shall be placed after plan size of fabric is placed. Wire shall be placed on the outside of the posts with respect to the road except on curves where the wire shall be placed on the outside of the post with respect to the center of the curve.

D) Fence Type III - Fence Type III shall be a barbed wire fence constructed in the same manner as Fence Type I except the fencing fabric shall consist of the same number of strands as the existing fence unless otherwise shown on the plans and shall be set one foot (1') inside the right-of-way line.

E) Glare Deflector Fence - All line posts shall be spaced equal distance in the fence line or a maximum of twelve and one-half feet (12 ½') centers. Posts shall be plumb and the top of the posts properly aligned. Posts shall be attached to the guardrail posts by the use of clamps and/or bolts as shown on the plans.

Horizontal braces shall be provided at all terminal posts. Braces shall be securely fastened to the terminal posts and adjoining line posts by brace ends and brace bands.

Diagonal braces shall be trussed from the brace end of the line post back to the terminal post and fastened to it by a brace band.

Glare deflector fence fabric shall be installed as shown on the plans and securely fastened to the line posts with nine (9) gauge fabric ties spaced at approximately fourteen inch (14") intervals, and to the top and bottom tension wire with fabric ties or hog rings at a maximum of twelve inch (12") intervals. The chain link glare deflector fence shall be tightened to provide a smooth, uniform appearance.

Stretcher bar bands shall be installed at a maximum of eleven inch (1") intervals.

Terminal posts shall be spaced at maximum one hundred foot (100') intervals or as shown on the plans.

828.06 – METHOD OF MEASUREMENT

Fence will be measured by the linear foot. Measurement will be along the ground line of the fence from outside to outside of end posts for each continuous run of fence.

828.07 – BASIS OF PAYMENT

The accepted quantities of fence, measured as provided above, will be paid for at the contract unit price per linear foot for fence and per each for gates of the types and sizes specified for:

FENCE - TYPE I	L.F.
GATES - TYPE I	EA.
FENCE - TYPE II	L.F.
GATES - TYPE II	EA.
FENCE - TYPE III	L.F.
GLARE DEFLECTOR FENCE - TYPE IV	EA.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

SECTION 840 – SODDING AND SPRIGGING

840.01 – DESCRIPTION

This section covers the furnishing and planting of viable bermuda grass sod or sprigs in accordance with these specifications and in reasonably close conformity with the areas and locations shown on the plans or as established by the Engineer.

840.02 – MATERIALS

Materials shall meet the requirements specified in the following Sections of Part VIII - Materials.

Solid Slab Sod	985
Row Sprigging	985
Broadcast Sprigging	985

Water shall be free from harmful quantities of toxic salts or other substances that might interfere with the establishment or future subsistence of turf or plants.

840.03 – EQUIPMENT

The Contractor shall furnish equipment in accordance with the following requirements:

A) Rolling Equipment - Unless otherwise approved by the Engineer, the machine for compacting sodding or sprigging shall be equipped with a single or tandem axle corrugated roller. It shall weight not less than one hundred twenty-five pounds (125#) or more than three hundred (300) pounds per foot of rolling width for each axle. It shall be operated approximately parallel to the contour of slopes.

B) Watering Equipment - Equipment shall apply water as specified without operating on the slopes.

C) Fertilizer and Lime Spreaders: Vertical Drop and Broadcast Type - The machine for applying dry fertilizer or lime shall be an approved agricultural type spreader. It shall be capable of distributing the specified material uniformly on the designated area at specified rates of application without damaging the fertilizer granules or lime.

D) Sprigging Equipment

1) Sprig Harvester - This machine shall have been designed and manufactured to harvest sprigs. It shall excavate sprigs from the soil, remove excess adhering soil and load the clean sprigs into a trailing vehicle having solid sides, all in one simultaneous operation.

2) Sprig Planter for Broadcast Sprigging - This machine shall have been designed and manufactured to broadcast and plant sprigs. It shall be equipped with an adjustable mechanism for accurately distributing sprigs at specified rates on the surfaces to be planted. It shall be equipped with straight disk spaced on two inch (2”) centers on tandem axles. The

rear disk wheels shall be placed so they trail between the front disks. They shall have an accurate and adjustable mechanism for adjusting the depth of sprig placement. The broadcasting and pressing operations shall be performed simultaneously.

3) Sprig Planter for Row Sprigging - The equipment for row planting of sprigs shall automatically open the furrows, place the sprigs in the furrow, then cover the sprigs and furrow with soil all in one continuous operation.

840.04 – CONSTRUCTION METHODS

840.04.01 – SOLID SLAB SODDING OPERATIONS

Preparation of areas to be sodded shall include filling, reshaping of eroded areas, cleaning ditches, refinishing slopes and medians to the established grading section. The area shall be cleared of all litter and debris. The location, placement and seasonal requirements for areas to be solid slab sodded will be as described in these specifications or as shown on the plans. Sod shall be placed at the earliest time possible after soil disturbance and final placement of the subgrade.

Topsoil shall be placed where excavation and backfill operations have left soil unsuitable for sod establishment.

The slabs of sod shall be placed soil side down. They shall be placed in rows, which on slopes shall run parallel to the roadway. Each slab shall fit tightly against the edge of adjoining slabs and shall be placed so that the vertical joints are not continuous across adjoining horizontal rows. Voids shall be filled with additional sod. All slabs shall be thoroughly pressed into firm contact with the soil underneath.

After the slabs have been placed, the sodded area shall be thoroughly watered. When sufficiently dry, additional voids shall be filled with good soil and watered again. The area shall then be thoroughly watered daily for a period of at least seven (7) days after placement. Remaining watering operations shall conform to Subsection 840.04 (F).

Fertilizer shall be applied in accordance with the appropriate sections of Section 840.

840.04.02 – ROW SPRIGGING OPERATIONS

A) Preparation of areas to be row sprigged shall consist of tilling the specified areas to a depth of at least four inches (4”) with an offset disk plow or a tandem disk plow.

B) Fertilizer shall be applied in accordance with Subsection 840.04.

C) The sprigs shall be planted with an automatic sprig planter conforming to Subsection 840.03 except that hand planting may be used in areas where the sprig planter cannot operate. The sprigs shall be planted in furrows parallel to the approximate contour lines of the slopes. The distance between furrows shall not exceed twenty inches (20”) on centers. The sprigs shall be placed approximately three inches (3”) deep at the rate of approximately thirty (30) bushels per acre with the ends of sprigs meeting or overlapping.

D) The sprig planter shall not be operated in excess of four miles per hour (4 mph).

E) Immediately following planting, the soil shall be compacted by rolling. The rolling of slopes shall be along approximate contour lines. All sprigged areas shall be rolled the same day they are planted.

F) The row sprigged areas shall be watered immediately after rolling. The remaining watering operation shall conform to Subsection 840.04.

840.04.03 – BROADCAST SPRIGGING OPERATIONS

A) Broadcast Sprigging Type A - Preparation of areas for broadcast sprigging, Type A, shall consist of tillage with either a tandem disk plow or an offset disk plow until the areas are suitable for sprig planting. The depth of tillage shall be approximately six inches (6”). If rains or other conditions

should pack the soil before being planted, the tillage shall be repeated. At least eighty (80) bushels of sprigs shall be planted per acre unless shown otherwise on the plans.

The sprigs shall be broadcast evenly and uniformly on the soil surface and immediately pressed into the soil. The planting depth mechanism shall be adjusted to cause the disk wheels to penetrate four inches (4") deep. Within two (2) hours after the sprigs have been planted the areas shall be disked to a depth of approximately three inches (3") with either a tandem or offset disk plow.

B) Broadcast Sprigging, Type B - At least twelve (12) bushels of sprigs shall be thoroughly incorporated into one hundred cubic yards (100 C.Y.) of stockpiled, Type B salvaged topsoil. A method approved by the Engineer shall be used to meter and distribute the sprigs into the stockpiled topsoil. During mixing operations both the soil and sprigs shall be kept moist. Preparation of areas for broadcast sprigging, Type B, shall consist of scarifying on the contour with approved equipment, the designated areas shown on the plans prior to placing the soil sprig mixture.

The soil sprig mixture shall be spread on the designated areas five inches (5") thick within four (4) hours of manipulation.

C) The following procedures shall be used for both methods of Broadcast Sprigging:

1) Fertilizer shall be applied in accordance with Subsection 840.04.

2) The planted areas shall be rolled and compacted with equipment conforming to Subsection 840.04. Rolling of slopes shall be along approximate contour lines and in a manner approved by the Engineer.

3) The sprigged areas shall be watered immediately after rolling. Remaining watering operations shall conform to Subsection 840.04(F).

840.04.04 – PLANTING SEASON AND WEATHER RESTRICTIONS

A) Time of sodding

1) Kentucky bluegrass sod may be planted during the periods of March 1 to June 15 and September 1 to November 15.

2) Buffalo grass sod may be established any time that the soil is workable with the exception of hot dry weather during July and August.

3) Bermuda grass sod strips or plugs and Bermuda grass sod retards shall be planted between April 1 and August 15. Divided Bermuda grass roots (rhizomes) shall be planted between April 15 and June 15.

B) Soil Moisture Requirements

1) Soil moisture shall exist throughout the zone from one inch (1") below the surface to at least five inches (5") below the surface at the time of planting. The required moisture content of the soil may be estimated and judged closely by the hand squeeze test. The soil should readily form a tight cast when squeezed in the hand. The cast should break into two (2) pieces without crumbling and without leaving excess water on the hand after casting.

2) Sodded or sprigged areas shall be watered for thirty (30) days after planting unless otherwise directed. The depth of watering with moving equipment shall be carried out on short sections until the soil is moist throughout the top one inch (1").

3) The application rate and fineness of the spray shall be adjusted according to wind velocity to provide uniform infiltration without appreciable erosion or excessive runoff.

Fertilizer Operations - Fertilizer shall not be placed on hard or glazed surfaces. Fertilizer shall be applied in accordance with Section 842.

Repair and Maintenance - The Contractor shall be responsible for repairs and maintenance of areas designated for sodding or sprigging until all work on the contract or designated portion thereof has been completed and approved for final acceptance.

4) Repair - This work shall include recovery, replacement and compaction of soil that has been removed by erosion; filling and reshaping eroded areas; cleaning ditches; and refinishing slopes and medians to the approximate typical grading section shown on the plans or as determined by the Engineer. Repair shall include resodding or sprigging, refertilizing, and watering damaged areas which shall be performed during the specified planting season.

5) Maintenance - This work shall consist of weed control by mowing, hand cutting, herbicides or other approved methods. Weed growth on sodded areas shall be removed as often as determined by the Engineer. If herbicides are used, they shall be used in accordance with label instructions and shall have prior approval from the Engineer.

840.06 – METHOD OF MEASUREMENT

Solid Slab Sodding, Row Sprigging and Broadcast Sprigging, Method A, and Broadcast Sprigging, Method B, will be measured by the square yard of sodded area.

Sanitary sewer construction, the maximum width of solid slab sod replacement paid for shall be fifteen feet (15') measured from the centerline of the sanitary sewer pipe placement. Additional sodding beyond this limit shall be placed at the contractor's expense.

840.07 – BASIS OF PAYMENT

Accepted Sodding, measured as provided above will be paid for at the contract unit price for:

SOLID SLAB SODDING	S.Y.
ROW SPRIGGING	S.Y.
BROADCAST SPRIGGING, METHOD A	S.Y.
BROADCAST SPRIGGING, METHOD B	S.Y.

The contract unit price shall be the total compensation for furnishing and placing all sod; for all rolling and tamping; watering and fertilizer; for disposal of all surplus materials; and for all materials, labor, equipment, tools and incidentals necessary to complete the work, all in accordance with the plans and these specifications.

SECTION 841 – SEEDING

841.01 – DESCRIPTION

This section covers the furnishing and planting of seeds in accordance with these specifications and in reasonably close conformity with those areas and locations shown on the plans or established by the Engineer.

841.02 – MATERIALS

Materials shall meet the requirements specified in the following:

Seed	Section 985
Fertilizer	Section 985

Water shall be free from harmful quantities of toxic salts or other substances that might interfere with the establishment and growth of turf.

841.03 – EQUIPMENT

The Contractor shall furnish equipment in satisfactory working condition and in sufficient quantity to perform the work as specified. The equipment shall be on the project site and approved by the Engineer before work on the corresponding item begins.

A) Hydraulic Seeder

1) This equipment shall be factory designed and built with sufficient pump capacity to apply specified quantities. The tank shall hold a minimum of one thousand (1,000) gallons and be equipped with a mechanical agitation system with operating capacity sufficient to suspend and homogeneously mix the seed and water. The distribution hoses shall be large enough to prevent clogging and equipped with spray nozzles that will provide even distribution on designated areas.

2) The equipment shall be mounted on a traveling unit which may be either self-propelled or pulled, capable of getting the tank and nozzles within sufficient proximity of the area to be seeded without the wheels operating on the areas to be seeded.

B) Grass Seed Drill - The drill shall be an approved native grass seed drill which shall be equipped with two (2) separate planter boxes and planting mechanisms which will plant large chaffy seed and fine clean seed simultaneously. The drill shall be equipped with a mechanism for accurately adjusting the rate of seed flow. The drill shall be equipped with double disk openers designed to open furrows on eight inch (8") or less centers with each disk having a depth regulating band one inch (1") from the disk edge.

Each furrow opener shall be equipped with heavy press wheels to firm the soil behind the opener and leave the seed covered to an average depth of one-half (1/2) to three-fourths (3/4) inch.

C) Corrugated Roller Seeder - The seeder shall be equipped with corrugated roller wheels mounted on tandem axles. The roller wheels shall be spaced on approximately two inch (2") centers and shall place the seed at a depth of one-fourth (1/4) to one-half (1/2) inch. The seeder shall be equipped with two (2) separate planter boxes and planting mechanisms which will plant clean, fine seed and large, chaffy seed simultaneously. The seeder shall also be equipped with a mechanism for accurately adjusting the rate of seed flow. The seeder shall weigh approximately one hundred twenty-five (125) to two hundred fifty (250) pounds per linear foot of rolling width.

Rolling, fertilizing, and watering equipment shall meet the requirements of Subsection 840.03.

841.04 – CONSTRUCTION METHODS

A) Seedbed Preparation

1) Preparation of areas to be seeded shall include filling and reshaping eroded areas, cleaning ditches, refinishing slopes and medians to the established typical grading section.

2) Seedbed preparation shall consist of eliminating all live plants by mowing and disking. Thick layers of previously applied mulching materials or residues of vegetation shall be completely incorporated into the soil by disking unless otherwise directed. Soil shall be tilled on the contour to a depth of four inches (4"). All clods larger than one inch (1") in diameter shall be crushed and then packed. The tillage shall consist of disking, harrowing and rolling. Where necessary, water shall then be applied.

3) When hydraulic seeding is specified, the seedbed surface shall be left rough or made sufficiently rough before seeding.

B) Planting Methods - All seed shall be planted uniformly at the specified rate. When several species are specified and cannot be combined due to different characteristics such as size, weight, hulled or unhulled, the seed shall be planted separately to obtain the specified seeding rate. Equipment shall not be operated on areas where rutting or slippage would mar the soil surface.

1) Seeding Method A - Hydraulic Seeder Method - The seed shall be placed in water in the spray tank of a hydraulic seeder conforming to Subsection 841.03(A). The seed shall then be distributed uniformly by power spraying through a suitable nozzle. Inoculants for legumes, if specified, may be placed in the spray tank with the seed in accordance with approved methods. The seed loaded into one thousand (1,000) gallons of water in the spray tank shall not exceed the quantity specified for two (2) acres. If less than one thousand (1,000) gallons of water is used, the amount of seed, other specified materials, and the area seeded per load shall each be reduced in proportion to the water.

2) Seeding Method B - Grass Seed Drill Method - The seed shall be planted with a grass seed drill conforming to Subsection 841.03(B). All drilling shall be carried out on the approximate contour lines.

3) Seeding Method C - Corrugated Roller Seeder Method - The seed shall be distributed with a corrugated roller seeder conforming to Subsection 841.03(C) that has been adjusted to accurately apply the specified quantities. Planting on slopes shall be along the approximate contour lines.

   Hand broadcasting shall not be used except in areas that are too small or inaccessible to accommodate the specified equipment.

C) Planting Season and Weather Restrictions - Permanent erosion control operations shall be in accordance with Subsection 840.04.04(A).

D) Soil Moisture and Watering Requirements

1) Soil moisture shall exist throughout the zone from one inch (1") to at least five inches (5") below the surface at the time of planting. The required moisture content of the soil may be estimated and judged closely by the hand squeeze test. The soil should readily form a tight cast when squeezed in the hand. The cast should break into two (2) pieces without crumbling and without leaving excess water on the hand after casting.

2) Watering of the areas seeded shall be performed if called for on the plans or as determined by the Engineer.

E) Fertilizer Application - Fertilizer application shall be in accordance with Section 842.

F) Repairs and Maintenance - The Contractor shall be responsible for repairs and maintenance of areas designated for seeding until all work on the contract or designated portion thereof has been completed and approved for final acceptance.

1) Repair - This work shall include the restoration of all eroded areas to the approximate typical grading section shown on the plans or as determined by the Engineer. Repair shall include seeding, fertilizing, and watering damaged areas, which shall be performed during the specified planting season.

2) Maintenance - This work shall consist of weed control by mowing, hand cutting, herbicides or other approved methods. Weed growth on sodded areas shall be removed as often as determined by the Engineer. If herbicides are used, they shall be used in accordance with label instructions and shall have prior approval from the Engineer.

841.06 – METHOD OF MEASUREMENT

A) Seeding - Seeding will be measured by the acre. Work and material used in repair of seeding will not be measured for payment.

B) Watering - Water used as a carrier for seed in hydraulic seeding operations is considered incidental to "seeding" and will not be measured for payment.

C) Fertilizer - Fertilizer will be measured and paid for in accordance with Section 842.

841.07 – BASIS OF PAYMENT

Accepted seeding measured as provided above will be paid for at the contract unit price bid for:

SEEDING AC

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

SECTION 842 – FERTILIZER

842.01 – DESCRIPTION

This section covers providing and distributing fertilizer over such areas as are designated on the plans and in accordance with these specifications.

842.02 – MATERIALS

All fertilizer used shall be delivered in bags or containers clearly labeled showing the analysis. The fertilizer is subject to the applicable requirements of the Oklahoma Department of Agriculture. A pelleted or granulated fertilizer shall be used with an analysis of 16-20-0 or 16-8-8 or having the analysis shown on the plans. The figures in the analysis represent the percent of nitrogen, phosphoric acid, and potash nutrients respectively as determined by the methods of the Association of Official Agricultural Chemists.

In the event it is necessary to substitute a fertilizer of a different analysis, it shall be a pelleted or granulated fertilizer with a lower concentration. Total amount of nutrients furnished and applied per acre shall equal or exceed that specified for each nutrient.

842.04 – CONSTRUCTION METHODS

When an item for fertilizer is included in the plans and proposal, pelleted or granulated fertilizer shall be applied uniformly over the area specified to be fertilized and in the manner directed for the particular item of work. Fertilizer shall be dry and in good physical condition. Fertilizer that is powdered or caked will be rejected. Distribution of fertilizer as a particular item of work shall meet the approval of the Engineer.

Unless otherwise indicated on the plans, fertilizer shall be applied uniformly at the average rate of three hundred (300) pounds per acre for all types of "Sodding" and four hundred (400) pounds per acre for all types of "Seeding".

842.06 – METHOD OF MEASUREMENT

Work and acceptable material for "fertilizer" shall be measured by the ton (2,000 pounds) as determined by approved scales or guaranteed weight of sacks shown by the manufacturer.

Work performed and materials furnished and measured as provided under Measurement will not be paid for directly but included in the price bid for "Sodding" or "Seeding".

SECTION 843 – TREE REPLACEMENT

843.01 – DESCRIPTION

This section covers replacement of trees one and one-half (1 1/2) to two and one-half (2 1/2) inches in diameter.

843.04 – CONSTRUCTION METHODS

Replaced trees shall be planted outside of public easements in accordance with good horticultural practices. The trees shall be replaced either in kind or by one of the following listed below:

London Plain Tree	Red Oak
Lace Bark Elm	Austrian Pine
Shademaster Honey Locust	Japanese Black Pine
Sweet Gum	Red Bud
Hackberry	Bradford Pear
Mulberry	Crabapple
Northern Oak	Russian Olive

The Engineer shall determine the type and location of the trees. The Contractor shall guarantee the trees for one (1) growing season.

843.06 – METHOD OF MEASUREMENT

Payment for "Tree Replacement" shall be made at the unit price bid per each tree. The price established shall be full compensation for removal and replacement of tree, including material, water, fertilizer, tools, equipment, labor and incidentals necessary to complete this item of work.

843.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

TREE REPLACEMENT (SIZE) EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 844 – HEDGE REPLACEMENT

844.01 – DESCRIPTION

This section covers replacement of hedge with the same kind and in a location determined by the Engineer.

844.04 – CONSTRUCTION METHODS

Hedges replaced shall be planted outside of public easements in accordance with good horticultural practices. The Contractor shall guarantee the hedge for one (1) growing season.

844.06 – METHOD OF MEASUREMENT

Payment for "Hedge Replacement" shall be made at the unit price bid per lineal foot. The price established shall be full compensation for the complete replacement of hedges, including material, water, fertilizer, tools, equipment, labor and incidentals necessary to complete this item of work.

844.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

HEDGE REPLACEMENT L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 845 – SHRUB REPLACEMENT

845.01 – DESCRIPTION

This section covers replacement of shrubs with the same kind and in a location determined by the Engineer.

845.04 – CONSTRUCTION METHODS

Shrubs replaced shall be planted outside of public easements in accordance with good horticultural practices. The Contractor shall guarantee the shrub for one (1) growing season.

845.06 – METHOD OF MEASUREMENT

Payment for "Shrub Replacement" shall be made at the unit price bid per each.

The price established shall be full compensation for the replacement of shrubs, including material, water, fertilizer, tools, equipment, labor and incidentals necessary to complete this item of work.

845.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SHRUB REPLACEMENT EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 850 – INCIDENTAL CONSTRUCTION STANDARD BID ITEMS

850.01 - DESCRIPTION

This section covers Standard Bid Items used in the contract documents for construction. Additional bid items may be called out in the Special Provisions, other sections of the Standard Specifications, or as directed by the Engineer for additional work covered and change orders.

SECTION	DESCRIPTION	UNIT
801	CONSTRUCTION STAKING	L.S.
802	CONSTRUCTION TRAFFIC CONTROL	L.S.
810	CLEARING AND GRUBBING	L.S.
811	STRUCTURE REMOVAL (TYPE)	L.S.
812	REMOVE PAVEMENT (TYPE) (THICKNESS)	S.Y.
812	REMOVE SIDEWALK (WIDTH)	S.Y.
812	REMOVE CURB AND GUTTER	L.F.
813	REMOVE DRIVEWAY	S.Y.
813	REMOVE AND REPLACE DRIVEWAY	S.Y.
814	PAVEMENT CUT AND REPAIR	S.Y.
815	REMOVE ALLEY PAVING (TYPE)	S.Y.
815	REMOVE AND REPLACE ALLEY PAVING (TYPE)	S.Y.
816	REPLACE SIDEWALK (WIDTH)	S.Y.
817	REMOVE AND REPLACE PARKING LOT PAVEMENT (TYPE)	S.Y.
818	BASE REPAIR (PAVEMENT TYPE)	S.Y.
819	ADJUST EXISTING STRUCTURE (TYPE)	EA.
820	SAWCUT PAVEMENT (TYPE)	L.F.
821	PLANE PAVEMENT (UPTO 11/2 INCH)	S.Y.
821	PLANE PAVEMENT (GREATER THAN 1 1/2 INCH)	S.Y.
822	PAVEMENT REINFORCING FABRIC	S.Y.
823	SIDEWALK (WIDTH)	S.Y.

SECTION	DESCRIPTION	UNIT
823	DRIVEWAY (WIDTH)	S.Y.
824	TEMPORARY SURFACING (TYPE)	TON
825	(TYPE) PLAIN RIPRAP	C.Y.
825	(TYPE) PLAIN RIPRAP	TON
825	(TYPE) FILTER BLANKET	C.Y.
825	(TYPE) FILTER BLANKET	TON
825	(TYPE) FILTER BLANKET	S.Y.
825	(TYPE) SPECIAL PLAIN RIPRAP	C.Y.
825	(TYPE) SPECIAL PLAIN RIPRAP	TON
825	(TYPE) LAID-UP RIPRAP	S.Y.
825	(TYPE) GROUTED RIPRAP	S.Y.
826	(TYPE) PIPE CONDUIT (SIZE)	L.F.
827	BEAM-TYPE GUARDRAIL (SINGLE)	L.F.
827	BEAM-TYPE GUARDRAIL (SINGLE)(SHOP CURVED)	L.F.
827	GUARDRAIL ANCHOR UNIT, TYPE "A" (SEE STD. GRAU-1-1)	EA.
827	GUARDRAIL ANCHOR UNIT, TYPE "B" (SEE STD. GRAU-1-1)	EA.
827	GUARDRAIL ANCHOR UNIT, TYPE "C" (SEE STD. GRAU-2-1)	EA.
827	GUARDRAIL ANCHOR UNIT, TYPE "D(BF)" (SEE STD. GRAU-1-1)	EA.
827	GUARDRAIL ANCHOR UNIT, TYPE "E" (SEE STD. GRAU-2-1)	EA.
827	GUARDRAIL ANCHOR UNIT, TYPE "F" (SEE STD. GRAU-2-1)	EA.
827	GUARDRAIL ANCHOR UNIT, TYPE "G" (SEE STD. GRAU-2-1)	EA.
827	GUARDRAIL ANCHOR UNIT, TYPE "GE" (SEE STD. GRAU-2-1)	EA.
827	NEW GUARDRAIL EXTRUDER TERMINAL	EA.
827	ATTENUATOR (UP TO 42" WIDE)	EA.
827	ATTENUATOR (WIDE) (42" AND WIDER)	EA.
827	CABLE GUARD BARRIER	L.F.
827	WROUGHT IRON CHAIN GUARD BARRIER	L.F.
827	GUIDE POSTS	EA.
828	FENCE - TYPE I	L.F.
828	GATES - TYPE I	EA.
828	FENCE - TYPE II	L.F.
828	GATES - TYPE II	EA.
828	FENCE - TYPE III	L.F.
828	GLARE DEFLECTOR FENCE - TYPE IV	EA.
840	SOLID SLAB SODDING	S.Y.
840	ROW SPRIGGING	S.Y.
840	BROADCAST SPRIGGING, METHOD A	S.Y.
840	BROADCAST SPRIGGING, METHOD B	S.Y.
841	SEEDING	AC
843	TREE REPLACEMENT (SIZE)	EA.
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SECTION 921 – LIME

921.01 – GENERAL

Lime will be applied either using pelletized lime or as a slurry. Lime dust will not be tolerated.

921.02 – HYDRATED LIME

Definition. Hydrated lime for stabilization shall consist essentially of a calcium hydroxide (with a lesser amount of calcium oxide, magnesium oxide, and magnesium hydroxide) made from a dry powder obtained by treating quick-lime with enough water to satisfy its chemical affinity for water under the conditions of its hydration.

Chemical Composition. When tested under the appropriate sections of ASTM C 25, the lime shall conform to the following requirements: Available calcium hydroxide. Available lime index (as is basis) expressed as Ca(OH)2 - Not less than 90 percent.

Fineness. When tested under the appropriate sections of ASTM C 110, the lime shall conform to the following requirements:

SIEVE SIZE PERCENT PASSING	
No. 20	99 - 100
No. 200	80 - 100

921.03 – QUICK LIME

Definition. Quick lime for stabilization purposes shall consist of a calcined material, the major part of which is calcium oxide or calcium oxide in natural association with a lesser amount of magnesium oxide capable of slaking with water.

Chemical Composition. When tested under the appropriate sections of ASTM C 25, the lime shall conform to the following requirements: Available calcium hydroxide expressed as calcium oxide. Available lime index (as is basis) expressed as CaO - not less than 90 percent.

Fineness. When tested under the appropriate sections of ASTM C 110, the lime shall conform to the following requirements:

PROPERTY LIMITS
Slaking Temperature Rise, °C, minimum 40
Total active Slaking Time, minutes, maximum 20

When tested in accordance with method OHD L-28 the lime shall conform to the following requirements:

SIEVE SIZE PERCENT PASSING	
5/8 inch	95-100
No. 200	0-15

921.04 – BY-PRODUCT LIME

By-product lime will be tested under the appropriate sections of ASTM C 25 to determine the available lime index (by rapid sugar method) expressed as available calcium hydroxide Ca(OH)2 . Calculations will be based on the dry mass of the material. Sufficient by-product lime shall be required to provide an equivalent amount of available lime based on 90 percent availability per ton (metric ton) (dry mass) of

hydrated lime.

921.05 – AGRICULTURAL LIMESTONE

Agricultural limestone shall be a high calcic or dolomitic limestone having a neutralization value of at least 80 percent of calcium carbonate. The neutralization value and sieve analysis shall be in accordance with ASTM C 602. The material shall be free from harmful quantities of toxic salts and other objectionable matter.

The fineness shall conform to the following requirements:

SIEVE SIZE PERCENT PASSING	
No. 4	100
No. 8	90-100
No. 60	30-100

SECTION 922 – FLY ASH

922.01 – DESCRIPTION.

This section covers fly ash to be used to modify or stabilize soils and fly ash to be used as an admixture for concrete.

922.02 – GENERAL

Fly ash shall meet the requirements of ASTM C 618, Class C or Class F. The product of only one plant shall be used on the project, unless otherwise approved by the Engineer.

The Contractor shall provide suitable means of storing and protecting the fly ash against contamination and dampness. Fly ash which has become partially set, contains lumps of caked fly ash, or has been contaminated will be rejected.

All methods of sampling and testing shall be in accordance with the above requirements except as modified by the Department' s acceptance policy published as: "Procedure for Sampling, Testing and Acceptance of Fly Ash." Copies of the procedure are available at the office of the Materials Engineer.

SECTION 923 – AGGREGATE, MISCELLANEOUS USES

923.01 – DESCRIPTION

This Section covers the requirements for aggregate intended for various uses not specifically covered in other sections of these Specifications.

A) Materials Covered - These Specifications cover the aggregate for use in the construction of aggregate base courses, backfill and surfacing.

B) General Requirements - Aggregate material shall consist of an intimate mixture of graded aggregate, coarse and fine, and shall be practically free from vegetable or other deleterious substances. Coarse aggregate (material retained on a No. 10 sieve) shall consist of sound, tough, durable particles or fragments of gravel, stone, mine chats, disintegrated granite, or a combination thereof. Fine aggregate shall be sand, stone dust or other inert finely divided mineral matter.

C) At least 40 percent of that portion of the completed mixture retained on the No. 4 sieve shall be composed of uniformly graded crushed particles (pieces of aggregate with one or more fractured faces resulting from the artificial crushing).

D) Physical Properties - The coarse aggregate retained on the 3/8 inch sieve of the finished mixture shall have a percent of wear, Los Angeles Abrasion Test, of not more than 50. No

source of material used in the blend shall have a percent of wear of more than 50.

E) Gradation - The graded aggregate when uniformly blended and sampled from trucks or windrows shall conform to the following requirements depending on the type being used. Materials which contain oversize particles of rock, gravel, lumps of clay or conglomerated material shall not be loaded into vehicles for delivery to the road. Such oversize particles of aggregate must be screened, crushed or otherwise processed to meet the Specifications before delivery to the road. The samples taken from trucks or windrows after the graded aggregate has been uniformly blended, shall conform to the gradation limits for the type being constructed, as follows:

TABLE 923.01 – GRADATION OF MISCELLANEOUS AGGREGATE

Sieve Size	Percent Passing	
Square	Type A	Type B
3 in.		100
1 ½ in.	100	40-100
¾ in.	40-100	30-75
3/8 in.	30-75	25-60
No. 4	25-60	20-50
No. 10	20-43	15-35
No. 40	8-26	7-22
No. 200	4-12	3-10

Note: The material passing the No. 200 sieve shall not be greater than 2/3 of the amount of material passing the No. 40 sieve.

F) Characteristics of material passing the No. 40 sieve - for all types, the material passing the No. 40 sieve shall conform to the following:

- The plasticity index shall not exceed 6
- The liquid limit shall not exceed 25

The blending of separate aggregates will be permitted to produce an aggregate mixture meeting the above requirements providing no individual aggregate has a plasticity index in excess of 8.

G) Sampling and Testing - Tests shall be conducted in accordance with the latest revision of the following AASHTO Methods except as noted:

- Los Angeles Abrasion T 96
- Sieve Analysis T 27
- Sampling T 2
- Determining Plastic Limit & Plasticity Index T 90
- Fractured Faces OHD L-18
- Method of Preparation of Samples T 87
- Determining Liquid Limit T 89
- Standard Density T 180 Method D

SECTION 931 – PLANT MIX BITUMINOUS BASES AND SURFACES

This Section covers the materials requirements, mix designs, proportioning, mix tolerances, and sampling and testing methods for plant- mixed bituminous bases and surfaces.

931.01 – APPROVAL OF MATERIALS.

Prior to use, aggregate sources and percentage of blends must be approved on a project basis by the Materials Engineer. The aggregate shall be stockpiled in accordance with Subsection 109.17.5 and may be accepted in stockpile at the plant site. The plant mixed materials may be accepted after blending and mixing at the plant. Asphalt must be obtained from an approved source and may be conditionally accepted in accordance with Subsection 931.06.

931.02 – MINERAL AGGREGATE.

The mineral aggregate shall be composed of coarse aggregate, fine aggregate, and mineral filler as required to meet these Specifications. If natural gravel is to be crushed for use in any of the mixes, a washing operation may be required to provide complete separation of all fines which may be stuck to the gravel.

NOTE: In no case will the blending of different material in the same storage or feeder be permitted. The aggregates shall meet the requirements set forth in Table 1.

TABLE 931.02 – PHYSICAL PROPERTIES OF AGGREGATES

Aggregates to be used in: Test	Asphalt Concrete	Open Graded Friction Course	Open Graded Bituminous Base	Hot Mix Cold Lay
L. A. Abrasion [a], % wear, max	40	30 b	40	40
Sand Equivalent [b], %,min				
Wearing Course	45	NA	NA	45
Base or Binder	40	NA	NA	40
Mechanically Fractured Faces [b], [c], %, min	75w/2	75w/2 [a]	75w/2	75w/2
Aggregate Durability Index [a], min	40	40	40	40
Insoluble Residue [d, e],%, min				
3000 Million ESAL' s or More	40	40	NA	NA
Less Than 3000 Million ESAL' s	30	30	NA	NA
Flat or Elongated Pieces [b, c, f], %, max	15	15	15	15
Natural Sand and Gravel [b], %, max				
1000 ADT or more	15 [h]	0	0	NA
Less Than 1000 ADT	25 [h]	0	0	NA
Clay Balls and Friable Particles g,%, max	1.0	0	0	1.0
Soft Particles a ,%, max	5	5	5	5
Sticks or Roots a ,%, max	0.5	0	0	0.5

[a] Applies to each source except as noted.
[b] Applies to the combined aggregate except as noted.
[c] Applies to the aggregate retained on the No. 4 sieve.
[d] Applies to the combined coarse aggregate.
[e] Applies to the coarse aggregate used in the surface course. Does not apply to shoulders and temporary detours.
[f] A flat or elongated piece is one in which the length is greater than five times the average thickness.
[g] Applies to the combined aggregate. Provided the maximum for the combined aggregate is not exceeded, a maximum 1.5 percent will be allowed for any one source.
[h] Limited to 10 percent for Type E.

The use of a crusher run or similarly graded aggregate shall not be the sole source of crushed coarse aggregate in asphalt concrete, types A, B, and C.

Coarse Aggregate. The coarse aggregate shall be that part of the aggregate retained on the No. 10 sieve and shall consist of clean, tough, durable particles. It shall be practically free from soft and disintegrated pieces, shale, clay, organic or other injurious matter occurring either free or as a coating on the aggregate. Natural gravel shall not be used as a source of insoluble material unless it has been crushed so that at least 75 percent of the material retained on the No. 4 sieve has two or more

mechanically fractured faces. The natural gravel used as a source of insoluble materials shall have not more than 30 percent passing the No. 4 sieve after crushing except when used in asphalt concrete, type D.

Fine Aggregate. Fine aggregate shall be that part of the aggregate passing the No. 10 sieve and shall consist of hard, durable grains of natural sand, crushed stone, stone dust, crushed gravel, mine chat or jig-sand or any combination of these materials. Crushed materials shall be produced from material conforming to the requirements of coarse aggregate. When used in the wearing course, the material in the natural sand passing the No. 200 sieve shall be less than 50 percent of that contained in the combined aggregate including mineral filler.

Mineral Filler. Mineral filler, when required in addition to that naturally contained in the aggregate, shall conform to AASHTO M 17.

931.03 – ASPHALT MATERIALS.

General. Asphalt cement shall met the requirements of AASHTO MP1 for the grade specified. All other bituminous materials shall meet the requirements shown in Tables 2 through 3C for the type and grade of asphalt material specified.

TABLE 931.03.01 – ASPHALT MATERIALS REQUIREMENTS FOR CUT - BACK ASPHALT (MEDIUM CURING TYPE)

Cut-back asphalt shall be produced by fluxing an asphalt base with suitable petroleum distillates, shall show no separation or curdling prior to use, and shall not foam when heated to application temperature.

GRADE	MC- 30		MC- 70		MC- 250		MC- 800		MC- 3000	
TEST	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Kinematic Viscosity, 140° F	30	60	70	140	250	500	800	1600	3000	6000
Flash Point (Tag, open- cup), °	100	…	100	…	150	…	150	…	150	…
Water, %	…	0.2	…	0.2	…	0.2	…	0.2	…	0.2
Distillation Test: Distillate % by Vol. of total distillate to 680° F										
to 440° F	…	25	0	20	0	10	…	…	…	…
to 500° F	40	70	20	60	15	55	0	35	0	15
to 600° F	75	93	65	90	60	87	45	80	15	75
Residue from distillation to 680° F volume percentage of sample by difference	50	…	55	…	67	…	75	…	80	…
Tests on residue from distillation:										
Absolute Viscosity, 140° F	40	120	40	120	40	120	40	120	40	120
Ductility [a], 77° F	100	…	100	…	100	…	100	…	100	…
Solubility in Trichloroethylene, %	99.0	…	99.0	…	99.0	…	99.0	…	99.0	…
Spot test with Standard Naphtha Solvent		Neg		Neg		Neg		Neg		Neg

[a] If the ductility is less than 100, the material will be accepted if its ductility at 60° F is 100 or greater.

TABLE 931.03.02 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR EMULSIFIED ASPHALT RAPID SETTING, MEDIUM SETTING

The emulsified asphalt shall be homogeneous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing.

GRADE	RAPID- SETTING				MEDIUM- SETTING					
TYPE	RS- 1		RS- 2		MS- 1		MS- 2		MS- 2h	
TEST	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max

TABLE 931.03.02 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR EMULSIFIED ASPHALT RAPID SETTING, MEDIUM SETTING

The emulsified asphalt shall be homogeneous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing.

Tests on emulsion:										
Viscosity, Saybolt Furol, 77° F	20	100	…	…	20	100	100	…	100	…
Viscosity, Saybolt Furol, 122° F	…	…	150	400	…	…	…	…	…	…
Storage stability test, 24- h, %	…	1	…	1	…	1	…	1	…	1
Demulsibility [a] , 35 ml, 0.02 N CaCl 2 , %	60	…	60	…	…	…	…	…	…	…
Coating ability and water resistance:										
Coating	…	…	…	…		good		good		good
Coating retention	…	…	…	…		Fair		Fair		Fair
Sieve test, %	…	0.10	…	0.10	…	0.10	…	0.10	…	0.10
Residue by distillation,	55	…	63	…	55	…	65	…	65	…
Tests on residue from distillation test:										
Viscosity, 140° F	40	120	40	120	40	120	40	120	160	480 [b]
Penetration, 77° F	100	200	100	200	100	200	100	200	40	90
Ductility, 77° F	40	…	40	…	40	…	40	…	40	…
Solubility in Trichloroethylene, %	97.5	…	97.5	…	97.5	…	97.5	…	97.5	…

Typical applications [c] :
RS- 1: Surface treatment, penetration macadam, sand seal coat, tack coat, mulch.
RS- 2: Surface treatment, penetration macadam, coarse aggregate seal coat (single and multiple).
MS- 1: Cold plant mix, road mix, sand seal coat, crack treatment, tack coat.
MS- 2: Cold plant mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat, sand seal coat.
MS- 2h: Cold plant mix, hot mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat.

TABLE 931.03.03 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR EMULSIFIED ASPHALT HIGH FLOAT, SLOW SETTING

TYPE	HIGH FLOAT								SLOW SETTING			
GRADE	HFMS- 1		HFMS- 2		HFMS- 2h		HFMS- 2s		SS- 1		SS- 1h	
TEST	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Tests on emulsion:												
Viscosity, Saybolt Furol, 77° F,	20	100	100	…	100	…	50	…	20	100	20	100
Viscosity, Saybolt Furol, 122° F	…	…	…	…	…	…	…	…	…	…	…	…
Storage stability test, 24- h, %	…	1	…	1	…	1	…	1	…	1	…	1
Coating ability and water resistance:												
Coating	Good		Good		Good		Good		Good		Good	
Coating retention	Fair		Fair		Fair		Fair		Fair		Fair	
Cement mixing test, %	…	…	…	…	…	…	…	…	…	2	…	2
Sieve test, %	…	0.1	…	0.1	…	0.1	…	0.1	…	0.1	…	0.1

TABLE 931.03.03 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR EMULSIFIED ASPHALT HIGH FLOAT, SLOW SETTING

TYPE	HIGH FLOAT								SLOW SETTING			
GRADE	HFMS- 1		HFMS- 2		HFMS- 2h		HFMS- 2s		SS- 1		SS- 1h	
TEST	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Residue by distillation, %	55	…	65	…	65	…	65	…	57	…	57	…
Tests on residue from distillation test:												
Viscosity, 140° F	40	120	40	120	160	480[b]	20	60	40	120	160	480[b]
Penetration, 77° F	100	200	100	200	40	90	200	…	100	200	40	90
Ductility, 25° C,	40	…	40	…	40	…	40	…	40	…	40	…
Solubility in Trichloroethylene, %	97.5	…	97.5	…	97.5	…	97.5	…	97.5	…	97.5	…
Float test, 140° F	1200	…	1200	…	1200	…	1200	…	…	…	…	…

Typical applications c :

HFMS- 1: Cold plant mix, road mix, sand seal coat, crack treatment, tack coat.

HFMS- 2: Cold plant mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat, and seal.

HFMS- 2h: Cold plant mix, hot plant mix, coarse aggregate seal (single and multiple), crack treatment, road mix, tack coat.

HFMS- 2s: Dense- graded cold plant mix and road mix, stockpile mix, crack treatment, patching mix.

SS-1& SS-1h: Cold plant mix, road mix, slurry seal coat, tack coat, fog seal, dust layer, mulch.

[a] The demulsibility test shall be made within 30 days from date of shipment.

[b] Variability will be limited to ± 60 Pa· s from the target value established by the manufacturer.

[c] These typical applications are for use only as a guide for selecting and using emulsion for pavement construction and maintenance.

TABLE 931.03.04 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

The emulsified asphalt shall be homogeneous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing

TYPE	RAPID- SETTING				MEDIUM - SETTING			
GRADE	CRS - 1		CRS - 2		CMS-1		CMS- 2	
TEST	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Tests on emulsions:								
Viscosity, Saybolt Furol, 77° F	…	…	…	…	…	…	…	…
Viscosity, Saybolt Furol, 122° F	20	100	150	400	50	500	50	450
Storage stability test [a], 24- h,	…	1	…	1	…	1	…	1
Demulsibility [a], 35ml 0.8%								
Sodium dioctyl sulfosucinate %	40	…	40	…	…	…	…	…
Classification test	Passes		Passes					
Coating ability and water resistance:								
Coating	…	…	…	…	Good		Good	
Coating retention	…	…	…	…	Fair		Fair	
Particle charge test	Pos		Pos		Pos		Pos	
Sieve test, %	…	0.1	…	0.1	…	0.1	…	0.1
Cement mixing test,	…	…	…	…	…	…	…	…
Distillation:								

TABLE 931.03.04 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

The emulsified asphalt shall be homogeneous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing

TYPE	RAPID- SETTING				MEDIUM - SETTING			
GRADE	CRS - 1		CRS - 2		CMS-1		CMS- 2	
TEST	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Oil distillate, by vol of emulsion, %	…	0.1	…	0.1	…	8	…	12
Residue, %	60	…	65	…	65	…	65	…
Tests on residue from distillation test:								
Viscosity, 140° F	40	120	40	120	[c]	…	40	120
Penetration, 77° F	100	250	100	250	300	…	100	250
Ductility, 77° F	40	…	40	…	40	…	40	…
Solubility in Trichloroethylene, %	97.5	…	97.5	…	97.5	…	97.5	…

Typical applications[c]:

CRS - 1: Surface treatment, penetration macadam, sand seal coat, tack coat, mulch.

CRS - 2: Surface treatment, penetration macadam, coarse aggregate seal coat (single and multiple).

CMS- 1: Cold plant mix, road mix, hot mix- cold lay.

CMS- 2: Cold plant mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat, sand seal coat.

CSS- 1 & CSS- 1h: Cold plant mix, road mix, slurry seal coat, tack coat, fog seal, dust layer, mulch.

[a] The 24 hour storage stability test results do not necessarily predict satisfactory 5 - day settlement test results.

[b] If the particle charge test result is inconclusive, material having a maximum pH value of 6.7 will be acceptable.

[c] The Saybolt Furol viscosity of the residue shall be 200- 600 seconds when tested at180° F (82° C).

[d] Variability will be limited to ± 60 Pa· s from the target value established by the manufacturer.

[e] These typical applications are for use only as a guide for selecting and using the emulsion for pavement construction and maintenance.

TABLE 931.03.05 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

The emulsified asphalt shall be homogeneous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing.

TYPE	SLOW - SETTING			
GRADE	CSS- 1		CSS- 1h	
TEST	MIN	MAX	MIN	MAX
Tests on emulsions				
Viscosity, Saybolt Furol, 77° F	20	100	20	100
Viscosity, Saybolt Furol, 122° F	…	…	…	…
Storage stability test [a], 24- h,	…	1	…	1
Sodium dioctyl sulfosucinate %	…	…	…	…
Classification test				
Coating ability and water resistance:				

TABLE 931.03.05 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

The emulsified asphalt shall be homogeneous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing.

TYPE	SLOW- SETTING			
GRADE	CSS- 1		CSS- 1h	
TEST	MIN	MAX	MIN	MAX
Coating	Good		Good	
Coating retention	Fair		Fair	
Particle charge test	Pos[b]		Pos[b]	
Sieve test, %	…	0.1	…	0.1
Cement mixing test,	…	2	…	2
Distillation:				
Oil distillate, by volume of emulsion, %	…	…	…	…
Residue, %	57	…	57	…
Tests on residue from distillation test:				
Viscosity, 140° F	40	120	160	480[d]
Penetration, 77° F	100	250	40	90
Ductility, 77° F	40	…	40	…
Solubility in Trichloroethylene, %	97.5	…	97.5	…

Typical applications[c]:

CRS- 1: Surface treatment, penetration macadam, sand seal coat, tack coat, mulch.

CRS- 2: Surface treatment, penetration macadam, coarse aggregate seal coat (single and multiple).

CMS- 1: Cold plant mix, road mix, hot mix- cold lay.

CMS- 2: Cold plant mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat, sand seal coat.

CSS- 1 & CSS- 1h: Cold plant mix, road mix, slurry seal coat, tack coat, fog seal, dust layer, mulch.

[a] The 24 hour storage stability test results do not necessarily predict satisfactory 5 - day settlement test results.

[b] If the particle charge test result is inconclusive, material having a maximum pH value of 6.7 will be acceptable.

[c] The Saybolt Furol viscosity of the residue shall be 200- 600 seconds when tested at180° F (82° C).

[d] Variability will be limited to ± 60 Pa· s from the target value established by the manufacturer.

[e] These typical applications are for use only as a guide for selecting and using the emulsion for pavement construction and maintenance.

TABLE 931.03.06 - REQUIREMENTS AND TYPICAL APPLICATIONS FOR POLYMER MODIFIED CATIONIC EMULSIFIED ASPHALT

TABLE 931.03.05 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

The emulsified asphalt shall be homogeneous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing.

TYPE	SLOW- SETTING			
GRADE	CSS- 1		CSS- 1h	
TEST	MIN	MAX	MIN	MAX
The emulsified asphalt shall be homogeneous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing.				
TYPE	RAPID-SETTING		SLOW-SETTING	
GRADE	PMCRS-2s [a]		PMCSS-1h	
TEST	MIN	MAX	MIN	MAX
Tests on emulsions				
Viscosity, Saybolt Furol, 77° F	…	…	20	100
Viscosity, Saybolt Furol, 122° F	125	400	…	…
Storage stability test [b], 24- h, %	…	…	…	1
Storage stability test [c], 5 day, %	…	5	…	…
Classification test	Passes			
Particle charge test	Positive		Positive	
Sieve test, %	…	0.1	…	0.1
Demulsibility	60	…	…	…
Distillation:				
Oil distillate, by volume of emulsion, %	…	2	…	0.5
Residue, %	65	…	62	…
Tests on residue from distillation test:				
Viscosity, 140° F	110	…	8000	…
Penetration, 77° F	100	200	40	90
Ductility, 77° F	…	…	70	…
Ductility, 40° F	30	…	…	…
Softening point, ring and ball ° F	112	…	135	…
Elastic Recovery, 50° F	58	…	…	…
Tensile Stress @ 800% elongation, 40° F, 50 cm/min, kPa	196	…	…	…
Solubility in Trichloroethylene, %	…	…	97	…
Ash Content, %	…	1	…	…

Typical applications [f] :

PMCRS-2s: Bituminous binder in bituminous surface treatments

PMCSS-1h: Bituminous binder in micro-surfacing

FOOTNOTES:

[a] A Type B certification shall be furnished for each lot for polymer modified asphalt

[b] The 24 hour storage stability test results do not necessarily predict satisfactory 5 day settlement test results.

[c] Upon examination of the test cylinder after standing undisturbed for 5 days, there shall be no milky colored substance anywhere within the test cylinder but a homogenous brown color throughout.

[d] The standard distillation procedure will be modified as follows:

TABLE 931.03.05 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

The emulsified asphalt shall be homogeneous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing.

TYPE	SLOW- SETTING			
GRADE	CSS- 1		CSS- 1h	
TEST	MIN	MAX	MIN	MAX

Temperature of 350°F±5°F (177°C ± 3°C) will be maintained on lower thermometer for the last 20 minutes of test.

Test duration of 60 ± 10 minutes from the first application of heat. e The distillation residue of the modified emulsion shall contain a minimum of 3% polymer solids by mass of asphalt, as determined by an analytical method approved by the Department.

[f] These typical applications are for use only as a guide for selecting and using the emulsion for pavement construction and maintenance.

TABLE 931.03.07 – TEMPERATURE RANGES FOR USE OF ASPHALT MATERIALS

Type or Grade of Asphalt	Asphalt Temperature		
	Mixture At Discharge Max. °F	For Mixing °F	For Spraying °F
PG76	350	275-350	285-350
PG70	350	275-350	285-350
PG64	350	275-350	285-350
PG58	350	275-350	285-350
PG52	325	275-350	285-350
MC-30		50-120	50-120
MC-70		80-150	80-150
MC-250	200	100-200	100-200
MC-800	210	160-210	185-260
MC-3000	250	200-250	225-275
ALL EMULSIONS		70-185	70-185

Handling. The handling, loading, hauling, transfer pumping or similar operations connected with the movement of bituminous materials shall be in compliance with the requirements of the Oklahoma Department of Transportation, Materials Division. Copies of these requirements may be obtained at the office of the Materials Engineer. If at any time materials furnished for use under these Specifications fail to produce satisfactory results, further shipments will be rejected. The material will not be accepted for further work until the producer satisfies the Engineer that the material has been so corrected as to produce satisfactory results.

Application Temperature. The temperature to which asphalt materials shall be heated at the time of use shall be as shown in Table 4, unless otherwise specified.

Additional requirements for Asphalt Cement. PG 64-22 OK, PG 70-28 OK, PG 76-28 OK shall meet the requirements for PG 64-22, PG 70-28, and PG 76-28 as shown in AASHTO MP1. Additionally, they must meet the requirements as shown below.

- Elastic recovery, ASTM D6048, 25°C, run on RTFO residue.
  - 65% Minimum for PG 70-28 OK
  - 75% Minimum for PG 76-28 OK
- Separation, AST D5976, except test as original binder for G* value according to AASHTO
- TP5. (Separation is defined as 10% or greater difference in G* between top and bottom samples.)
- AASHTO TP5 - Test Method for Determining the Rheological Properties of Asphalt Binder
- Using a Dynamic Shear Rheometer (DSR)
- Original DSR G*/sin (d) limits 1.00 - 2.50.
- RTFO DSR G*/sin(d) limits 2.20 - 5.50
- PAV DSR (G*)*(sin(d)) -Run at 25°C for PG 64-22OK, PG 70-28 OK and PG 76-28 OK
- Spot test with standard Naphtha Solvent, AASHTO T102, Negative, PG 64-22 OK
- Flash Point, AASHTO T48, increase from 230°C to 288°C
- Solubility in Trichloroethylene, AASHTO T44 and AASHTO MP1 (99% Soluble Required)

Asphalt Binder Suppliers shall furnish recommended mixing and compaction temperatures for their product to the hot-mix producer. They shall also supply handling requirements.

931.04 – COMPOSITION OF MIXTURES.

Asphalt Mix Design and Initial Job-Mix Formula. The asphalt mix design and initial job-mix formula are the responsibility of the Contractor and shall be submitted to the Materials Engineer for review. The review of the proposed mix design will be to determine that the mix meets the design criteria. The Contractor shall furnish one mix design for each specific asphalt concrete mixture listed on the plans or in the Contract. The mix design shall be prepared in an approved laboratory of the Contractor' s choice. A request for laboratory approval may be made either by a Contractor or a Laboratory. Approval will be according to the Materials Division Policy for Asphalt Mix Design Laboratories.

The initial job-mix formula shall meet the requirements of Tables 5A or 5B and Tables 6A and 6B for the type mix specified on the Plans or in the Proposal. Prepare a trial mixture in accordance with Subsection 403. If the trial mixture, prepared at the initial job-mix formula proportions, fails to meet the requirements of Tables 6A and 6B, propose changes to the job-mix formula. If these changes do not result in a mixture meeting the requirements of Tables 931.04.01 or 931.04.02 and Tables 6A and 6B, the Engineer will require a new mix design. If the changes do result in a mixture meeting these Specifications, the job-mix formula will be adjusted accordingly. The job-mix formula shall establish a single percentage of aggregate passing each required sieve, a single percentage of asphalt to be contained in the mixture, and a single temperature of the mixture at point of discharge from the plant. The job-mix formula with the allowable tolerances shown in Table 7 shall establish the Specification limits for each mixture. These limits may be outside the broad range in Tables 5A or 5B except for the following conditions:

Absolute maximum sieve size. Example, 1/2 inch (12.5 mm) sieve for type C.

Open graded friction surface. The job-mix formula with allowable tolerances shall be within the broad range given in Table 5A.

No tolerances are shown. The broad ranges in Table 5A are the Specification limits.

Plant Produced Mixtures. The plant produced mixture shall be a uniform mixture of the combined aggregate and asphalt and shall conform to the requirements of Tables 6A and 6B and the Specification limits established by the job-mix formula with allowable tolerances. After the plant is in operation, the Contractor may propose adjustments to the job-mix formula within the limits shown in Tables 5A or 5B. If test results indicate these adjustments will result in a mixture meeting the requirements of Tables 6A and 6B, the job-mix formula will be adjusted accordingly. Should a change in sources of materials be made, a new job-mix formula shall be established before the new material is used. When unsatisfactory results or other conditions make it necessary, the Engineer will require a new job-mix formula. The job-mix formula for asphalt is the target value. Every effort shall be made by the Contractor to incorporate that amount of asphalt into the mixture regardless of the allowable

tolerances. For temporary construction, such as crossovers and detours, the requirements given in Table 5A for minimum percent asphalt and Tables 6A and 6B for retained strength and V.M.A. will be waived.

Recycled Bituminous Pavements. Unless otherwise noted on the Plans, bituminous mixtures containing up to 25 percent reclaimed asphalt concrete pavement will be accepted provided that the mixture meets all the requirements of these Specifications. For roadways with 0.3 million ESALS or more, bituminous mixtures containing reclaimed asphalt concrete pavement will not be accepted in the wearing course. The reclaimed asphalt concrete pavement shall be crushed, screened or otherwise sized such that at least 95 percent passes the 2 inch (50 mm) sieve. The insoluble residue content for reclaimed asphalt concrete pavement will be considered to be zero unless it is from a known source and documentation of insoluble residue content is available. The total amount of natural sand and gravel permitted in the combined aggregate will be reduced by the amount of natural sand and gravel contained in the reclaimed asphalt concrete pavement.

TABLE 931.04.01 – MIXTURES (HOT MIX - HOT LAY)

ASPHALT CONCRETE MIXTURE TYPE:	A	B	C	D	E	OPEN GRADED BITUM. BASE	OPEN GRADED FRICTION SURFACE [a]
Sieve Size	**Percent Passing**						
1 ½ inch	100					100	
1 inch	90-100					95-100	
¾ inch		100					
½ inch	70-90	90-100	100		100	25-60	100
3/8 inch		70-90	90-100	100	80-95		90-100
No. 4	40-65	45-70	60-80	80-100	45-60	0-10	25-45
No. 10	25-45	25-50	35-60	50-90	20-35	0-5	0-10
No. 40	10-26[b]	12-30b	15-35b	20-50	9-19		
No. 80	6-18	7-20	8-22	10-30	6-14		
No. 200	…[c]	…[c]	…[c]	5-15	…[c]	0-3	0-5
Asphalt Cement [d], % of mix mass	3.8-6.5	4.7-7.5	5.1-7.5	5.5-7.5	4.8-7.5	…[e]	…[f]
Viscosity Grade Asphalt Cement	…[g]	…[g]	…[g]	…[g]	…[g]	…[g]	…[g]

TABLE 931.04.02 - TABLE OF MIXTURES (HOT MIX - COLD LAY)

TYPE:	HC1	HC2	HC3	HC4
Sieve Size	**Percent Passing [h,i,j]**			
1 ½ inch	100			
1 inch	90-100			
¾ inch	…	100		
½ inch	70-90	90-100	100	
3/8 inch	…	70-90	90-100	100
No. 4	40-65	45-70	60-80	80-100
No. 10	25-45	25-50	35-60	50-90
No. 40	10-26	12-30	15-35	20-50

No. 80	6-18	7-20	8-22	10-30
No. 200	3-6	4-7	4-8	5-15
Asphalt Type [k]	MC-800	MC-800	MC-800 or PG 52-22	MC-800 or CMS-1

FOOTNOTES FOR TABLES 931.04.01 AND 931.04.02

[a] A minimum of 55 percent of the aggregate shall be retained between the 3/8 inch (9.5 mm) and the No. 4 (4.75 mm). An approved anti-stripping agent shall be used at the rate of 5 gallon per 1000 gallons (5 liter per 1,000 lSiter) of asphalt cement.

[b] The upper limit for the No. 40 (425 µm) sieve shall be controlled by the gradation of the No. 10 (2.00 mm) sieve as follows:

Type A		**Type B**		**Type C**	
No. 10	No. 40 Max	No. 10	No. 40 Max	No. 10	No. 40 Max
25-32	19	25-43	24	35-49	27
33	20	44	25	50	28
34	21	45	26	51	29
35	22	46	27	52	30
36	23	47	28	53	31
37	24	48	29	54	32
38	25	49-50	30	55	33
39-45	26	…	…	56	34
…	…	…	…	57-60	35

[c] The ratio of the percent passing the No. 200 sieve to the percent asphalt cement shall be a minimum of 0.6 to a maximum of the 1.2. This ratio will establish the master range for the job-mix formula on the No. 200 sieve.

[d] The lower limit may be adjusted if the effective specific gravity of the combined aggregates is greater than 2.65. This adjustment will be allowed if a theoretical lab molded specimen at the JMF asphalt content meets the VMA requirement at 4 percent air voids.

[e] The amount of binder shall be 2.5 ± 0.3 percent by mass of the mix. The amount of asphalt binder may be adjusted if the effective specific gravity of the combined aggregate is greater than 2.833 or less than 2.495.

[f] The job-mix formula for percent AC in the open graded friction course is calculated by the following equation: % AC = (16.5) / (Effective Specific Gravity + 0.165).

[g] Three grades of asphalt cement will be used as shown below unless otherwise specified on the plans. Use PG 64-22 OK in roadways with <3M ESALs and with all mixes more than 5 inches (125 mm) below the surface of the pavements in roadways with >3M ESALs and with all mixes used for shoulders and temporary detours. Use PG 70-28 OK with all mixes in the top 5 inches (125 mm) of pavements in roadways with >3M ESALs. Use PG 76-28 OK with all mixes in the top 5 inches (125mm) of pavements in readway >30M ESALs or in roadways with slow, standing, or turning traffic such as urban intersections with >3M ESALs.

[h] If emulsion or MC grade asphalt is used, the aggregate shall be surface dry and heated to a temperature above 160°F.

[i] AC Type Mixtures. The aggregate shall be thoroughly dried and delivered to the mixer at a temperature above 200°F (93.3°C) and not higher than the temperature of the asphalt binder. Water, not exceeding 3 percent and primer not exceeding 1.2 percent of the aggregate by mass, shall be added as necessary to assure the required workability of the mixture. The quantity of water and primer

added to the aggregate shall be accurately controlled by a meter or other suitable measuring device. Except as otherwise requested by the Engineer, the workability of the mixture shall be suitable for stockpiling and use at ambient temperatures.

[j] The temperature of the aggregate shall not be heated in excess of the temperature of the liquid asphalt at time of mixing.

[k] MC-3000 may be substituted for MC-800 when specified or approved by the Engineer.

TABLE 931.04.03 – PROPERTIES OF LABORATORY MOLDED SPECIMENS		
Asphalt Mixture Property	**Hot Mix-Concrete Hot**	**Mix-Cold Lay**
Density, % of max. theo.sp.gr.		
3 million ESALs or more	94-96	93-97
0.3 million to 3.0 million ESALs	95-97	93
0.3 million ESALs or less	96-98	93
Hveem Stability, min,		
0.3 million ESALs or more [a]	40	35
Less than 0.3 million ESALs	35	35
% Retained Strength, min.	75	NA

TABLE 931.04.04 – PROPERTIES OF LABORATORY MOLDED SPECIMENS							
	ASPHALT CONCRETE						
	Type A	**Type AH**	**Type B**	**Type BH**	**Type C**	**Type D**	**Type E**
V.M.A. min % [b]	13	13	15	15	16	17	16

[a] Includes all city streets regardless of ESALs.

[b]V.M.A. (Voids in the Mineral Aggregate) is based on the effective specific gravity of the aggregates. V.M.A. shall be applicable when establishing the initial job-mix formula, when evaluating a pro-posed adjustment to the job-mix formula, and when transferring the mix design to another project.

NOTE: V.M.A. is an important mixture property and shall be calculated and reported for all asphalt concrete mixtures.

Acceptance of Combined Cold Feed Aggregate Gradation. Combined aggregate samples obtained by an approved sampling device may be tested for gradation in accordance with Subsection 931.06 (AASHTO T 27 & T 11) in lieu of testing extracted aggregate for gradation, provided the asphalt mixture does not contain reclaimed bituminous materials and the aggregate does not degrade appreciably during the drying and mixing process. The use of combined aggregate samples taken prior to asphalt coating for gradation acceptance of the mixture will be at the Engineer' s discretion. When approved or directed by the Engineer, acceptance of bituminous plant mix gradation results based on cold feed combined aggregate samples under this Contract will be contingent on the following conditions.

When the aggregate gradation test on extracted aggregates per AASHTO T 30 compares favorably with the results of cold feed aggregate gradation results.

When the Independent Assurance Samples test results of extracted gradation analysis compare favorably with Job Control Acceptance Samples.

When the results do not compare favorably, acceptance will be based on results of gradation tests performed in accordance with AASHTO T 30 on extracted aggregate.

Acceptance of Bitumen Content. Determination of the bitumen content of plant produced mixtures shall be determined by OHD L-26 method of test.

931.05 – TOLERANCES.

The tolerances shown in Table 7 shall be applied to the job-mix formula (JMF) as described in Subsection 931.04. The job average for gradation shall meet the stated tolerances. An individual sample will be allowed 1-1/2 times the tolerance shown for gradation, providing adjustments are made and the subsequent sample is within the stated tolerance.

TABLE 931.05 - RANGE OF TOLERANCES				
	Asphalt Concrete	Hot Mix Cold Lay	Open Graded Friction Course	Open Graded Bituminous Base
Sieve Size	Percent Passing			
No. 4 & larger	±7	±7	±7	--
No. 10	±4	±5	±4	--
No. 40	±4	±4	--	--
No. 80	±4	±4	--	--
No. 200	±2	±2	±2	--
Asphalt Cement	±0.4 a	±0.5 a	±0.3 b	±0.3 b
Temp. of mix as discharged from mixer °C	±10	±10	±10	±10

a The tolerances shown for asphalt content are for individual samples. The average asphalt content by OHD L-26 shall be within ±0.2 percent of the job-mix formula.

b The percent asphalt may be determined by the tank strap method of measurement or the printed batch weights from an approved automatic printer system or the counter on a drum-mix plant.

931.06 – SAMPLING AND TESTING.

Methods. Sampling and testing shall be done in accordance with AASHTO methods, except as noted below:

TABLE 931.06.01 – SAMPLING AND TESTING AGGREGATES:	
Sampling	T 2
Sieve Analysis	T 27
Material Passing No. 200 Sieve	T 11
Los Angeles Abrasion	T 96
Mud, Clay Balls, Sand Clusters, Sticks and Root Retained on No. 4	OHD L-9
Equivalent	T 176
Aggregate Durability Index	T 210
Insoluble Residue	OHD L-25
Soft Particles	OHD L-38

TABLE 931.06.02 – SAMPLING AND TESTING BITUMINOUS MIXTURES:	
Mechanical Analysis of Extracted Aggregate	T 30
Sampling [a]	T 168
Bitumen Content	OHD L-26
Recovery of Asphalt from Solution by Abson Method	T 170
Maximum Specific Gravity of Bituminous Paving Mixtures	T 209
Bulk Impregnated Specific Gravity of Aggregates [b]	OHD L-7
Compacting Materials for Stabilometer Value	OHD L-8
Specific Gravity and Wt.per ft 3 (m 3) Compressed Bituminous Mixture	OHD L-14
Test for Stabilometer Value (Hveem)	OHD L-16
Retained Strength	OHD L-36
a The sample size of compacted bituminous pavement shall be in accordance with T 166	

TABLE 931.06.02 – SAMPLING AND TESTING BITUMINOUS MIXTURES:
b OHD L-7 shall only be used when the results obtained from AASHTO T 209 are suspect.

TABLE 931.06.03 – TESTING ASPHALT MATERIALS:	
Absolute Viscosity	T 202
Kinematic Viscosity	T 201
Saybolt Furol Viscosity	T 72
Penetration	T 49
Flash Point	T 48
Solubility in Trichloroethylene	T 44
Thin Film Oven Test	T 179
Ductility	T 51
Spot Test	T 102
Water	T 55
Rolling Thin Film Oven Test	T 240
Distillation	T 78
Flash Point	T 79

TABLE 931.06.04 – TESTING EMULSIFIED ASPHALT	
pH of Aqueous Solutions with the Glass Electrode	T 200
Coating & Retention Testing for Mixing Grade Emulsions	T 59 Modified
Specific Gravity by Pycnometer	T 228
Specific Gravity by Hydrometer	ASTM D3142
Elastic Recovery	OHD L-42
Ash in Bituminous Material	T 111
Creep Stiffness by Bending Beam Rheometer	TP1
Rhelogical Properties by Dynamic Shear Rheometer	TP5
Grading or Verifying Asphalt Binder	PP6
Accelerated Aging of Asphalt Binder by Pressure Aging Vessel	PP1
Fractured Faces Sand	OHD L-18

Method and Procedure for Sampling Bituminous Materials. Sampling of bituminous materials shall be in accordance with AASHTO T 40, except that the method at the project site or mixing plant shall be in accordance with OHD L-5. The methods of sampling, testing and acceptance as specified may be modified for the bituminous materials under the Department' s acceptance policy. Copies of the procedure are available at the office of the Materials Engineer. Sampling will be done at the point of manufacture whenever the quantity shipped will warrant such procedure, and samples may also be taken at the point of destination. Bituminous materials shall not be used until conditionally approved at the source by the Materials Division.

SECTION 932 – PORTLAND CEMENT CONCRETE

This Specification covers all materials, classification, mix designs, proportioning, and testing of portland cement concrete. All concrete shall be air entrained unless otherwise shown on the Plans. The equipment and tools necessary for the mixing of concrete shall meet the requirements of Section 403, with Sections 304 and 404 as specified for each use.

932.01 – MIX DESIGN AND PROPORTIONING.

932.01.01 - CLASSES OF CONCRETE.

The classes of concrete are shown in the following table:

CLASSES OF CONCRETE					
Class of Concrete	**Maximum Cement Content[a]**	**Minimum 28-day Air Content**	**Water/Cement Ratio[b]**	**Slump [c]**	**Minimum 28-day Compressive Strength**
	lb/y [3]	Percent	lb/lb	inches	psi
AA	611	6.5±1.5	0.44	2±1	4000
A	564	6±1.5	0.48	2±1	3000
AP	470	6±1.5	0.48	2±1	3000
C	395	6±1.5	0.62	3±1	2400
P	611	5±1.5	0.44	3±1	As specified

[a] Cement Substitution. Fly ash meeting the requirements of Section 922 may be substituted for up to 15% (20% from April through October) of the required cement. Ground granulated blast furnace slag meeting the requirements of AASHTO M 302 Grade 100 or Grade 120 may be substituted for up to 25% of the required cement. A combination of up to 25% ground granulated blast furnace slag and up to 15% fly ash may be substituted for up to 40% of the required cement. From April through October, a combination of up to 25% ground granulated blast furnace slag and up to 20% fly ash may be substituted for up to 45% of the required cement. Substitution shall be by weight: 1.0 pound (1 kg) for each 1.0 pound (1 kg) of cement. The concrete mix design shall be appropriately adjusted. These substitutions will not be allowed for high early strength concrete, Class P concrete or concrete containing Type IP, Type I (PM), or Type I (SM) cement. If the specified minimum cement content is satisfied, additional fly ash or ground granulated blast furnace slag, or silica fume complying with ASTM C 1240, may be added to the mix when approved as part of the mix design.

[b] Water Cement Ratio. Using the weight in pounds of each material, calculate the water-cement ratio (W/C) by the following equation: W/C = Water/ (Cement + Fly Ash + Blast Furnace Slag + Silica Fume) The water actually used is determined by the water measured into the batch plus the free water on wet aggregate minus the water absorbed by dry aggregate plus water in any admixture solutions and shall not exceed the limit specified.

[c] Slump. The slump shall be as shown, or as specified in the contract documents, or as approved by the Engineer, and the consistency required shall be that which will provide satisfactory workability for the type work being done. Slump tests will be made during the progress of the work as a measure of uniformity of the consistency of the concrete. If using a high-range water reducing admixture, limit the slump to a maximum of 9 inches (230 mm).

[d] Compressive Strength. Compressive strength is based on the average of three test cylinders. The compressive strength requirements of Class P concrete will be specified in the contract documents. When the class of concrete is not expressly indicated on the Plans, the following requirements shall govern:

- Class AA. Use Class AA concrete in superstructure items, such as bridge floors, approach slabs, reinforced concrete piles, drilled shaft foundations, parapet walls, concrete rail and handrails.
- Class A. Use Class A concrete for pavements and in substructures items, such as pier caps, columns, abutments, retaining walls, box culverts, and all reinforced concrete not requiring Class AA concrete.
- Class AP. Use Class AP concrete in shoulders, merge areas and gore areas for PCC pavements, unless otherwise directed by plan notes.
- Class C. Use Class C concrete for soil erosion control structures.

✍ Class P. Use Class P concrete for precast prestressed concrete members, such as PC beams, double tees, prestressed concrete piling, and stay-in-place precast concrete deck panels, and cast-in-place post-tensioned structures.

932.01.02 – PROPORTIONING

Base the mix design on absolute volume for the class of concrete specified and the consistency suitable for satisfactory placement of the concrete. Design and produce concrete mixtures that conform to the Class of Concrete table in this section and base the mix design on absolute volume. Proportion the coarse and fine aggregate in accordance with ACI 211.1. Use the least amount of sand and mixing water which will ensure concrete of the required workability for placement conditions. Meet the minimum strength within 72 hours of placement for high early strength concrete. Submit the mix design at least 14 days before production to the Engineer. Include at least the following information with each mix design:

A) Project identification

B) Name and address of contractor and producer

C) Mix design designation

D) Intended use of the mix design

E) Expected travel time from batch to placement

F) If the concrete will be pumped or not

G) Aggregate sources, gradation, moisture content, saturated surface dry batch mass, LA abrasion (AASHTO T 96-92), and freeze thaw durability (AASHTO T 103-91).

H) Fineness modulus of fine aggregate

I) Cement type and source

J) Type of cement replacement, if used, and source

K) Type of admixtures and sources

L) Material proportions

M) Air content

N) Slump

O) Water / cement ratio

P) Strengths at 7 and 28 days

Q) Strengths at 72 hours for high early strength concrete.

NOTE: Do not place any concrete until the mix design is approved.

Submit new mix designs if:

A) The mix design is rejected by the Engineer

B) The source of any material changes

C) The mix design produces unacceptable workability or production test results.

932.01.03 – TESTS AND SAMPLES.

Conduct fresh concrete sampling using AASHTO T141. If pumped, sample concrete after discharge from the pump. Determine the slump using AASHTO T119, and the air content using AASHTO T121, AASHTO T152 or AASHTO T196 as appropriate. Make and cure test specimens in accordance with AASHTO T23, except, after initial curing, specimens for acceptance testing will be cured in a medium maintained at 40°F (4°C) to 85°F (29°C) until tested. Test specimens for acceptance according to AASHTO T22 for cylinders.

932.02 – PORTLAND CEMENT

Portland cement shall conform to the requirements of AASHTO M 85 or AASHTO M 240. Type I, Type I(SM), Type I(PM), and Type IP shall be used in concrete for general concrete construction. When white portland cement is required, it shall meet the requirements of Type I. Type II shall be used in concrete exposed to moderate sulphate action or moderate heat of hydration, when specified on the Plans or in the Proposal.

Type III may be used when high early strength concrete is required. Unless otherwise approved by the Engineer, the product of only one mill of any one brand and type of portland cement shall be used on any structure or adjacent structures. Provide suitable means of storing and protecting the cement against dampness.

NOTE: Cement which for any reason has become partially set or which contains lumps of caked cement will be rejected. Cement salvaged from discarded or used bags shall not be used. All methods of sampling and testing shall be in accordance with the requirements of AASHTO M 85 or AASHTO M 240, except as modified by the Department' s acceptance policy: "Procedure for Sampling, Testing and Acceptance of Portland Cement." Copies of the procedure are available at the office of the Materials Engineer.

932.03 – ADMIXTURES

Use admixtures included in the approved mix design only, unless otherwise specified in the contract documents. This subsection does not specify requirements covering fly ash, ground granulated blast furnace slag, or silica fume. In addition, admixtures shall not be used to replace cement, and admixtures containing chlorides such as Cl^- in excess of ten thousand ppm shall not be used in prestressed or reinforced concrete.

A) Accurately measure admixtures into each batch by methods approved by the Engineer.

B) Dispense admixtures in liquid form. Dispensers for liquid admixtures shall have sufficient capacity to measure at one time the full quantity required for each batch. Unless liquid admixtures are added to premeasured water for the batch, their discharge into the batch shall be arranged to flow uniformly into the stream of water. Do not allow the dosage to vary more than 5 percent from the dosage established by the mix design for the mix requirements. Make sure the measuring equipment allows for easy confirmation of the accuracy of measurement of the admixture dosage.

C) Store admixtures in a manner to prevent freezing and agitate them to prevent separation or sedimentation of solids. Do not use air agitation.

D) If more than one liquid admixture is used, be certain that they are compatible, and dispense each one by separate equipment.

NOTE: Any type of admixture shall be uniform in properties throughout its use in the work; if the furnished admixture is not uniform in properties, discontinue using it. Use only those admixtures which have been approved by the Materials Engineer. A list of approved commercial admixtures is maintained by the Materials Division.

NOTE: Admixtures not on the approved list may be accepted if the manufacturer presents a type A certification defined in Section 109.17 that the admixture meets all the requirements of AASHTO M 154 or AASHTO M 194 as appropriate. Furnish the Engineer a type C certification from the manufacturer with each lot or shipment to the effect that the admixture supplied for use in the work is identical in all essential respects, including concentration, to the admixture tested and approved under these Specifications.

A) Air Entraining Admixtures. Air entraining admixtures shall conform to AASHTO M 154. An exception to the above requirement may be granted in the case of admixtures manufactured by neutralizing vinsol resin with caustic soda provided the manufacturer furnishes certification that the product is neutralized vinsol resin and contains no other additive. Air entraining admixture shall be ADDED DURING BATCHING ONLY.

B) Chemical Admixtures. Chemical admixtures shall conform to AASHTO M 194 for the particular type specified.

C) High Range Water Reducer (HRWR) Concrete Mixture. The use of a Type F and G HRWR in concrete mixes will require written approval of the Engineer and meet the additional requirements of this Subsection for each specific project. If a high range water reducing chemical admixture is to be used, the concrete mixture shall meet the requirements of Subsection 932.01 or 509.01 prior to the addition of the admixture. When proposing the use of high range water reducer, provide a work plan with the mix design. Include the following in the work plan:

1) Purpose. Describe the purpose for using a high range water reducing admixture.

2) Sequence. Specify the batching sequence detailing when, where, and how HRWR is to be added to the mix.

3) Mixing Data. Specify the mixer capacity and the mixing time and revolutions before and after the addition of the HRWR.

4) Redose. Specify any condition that may require a redose include the redose dosage, permissible slump range for the redose, and the mixing time after redosing. Check air content after each redose.

5) Slump Loss. Provide an estimate of slump immediately before and after the addition of the HRWR, slump during placement and finishing, and the total length of time the HRWR is effective. Base the estimate upon trial batches or data from previous work using a similar mix design and consider the time required for delivery, placement, finishing, and temperature.

6) Air Content. For each slump estimate required above, provide a corresponding estimate of air content.

D) Corrosion-Inhibiting Admixtures. When an approved corrosion-inhibiting admixture is required by the contract documents, the admixture shall meet the following requirements. The admixture shall comply with the following characteristics when tested using the procedures described in AASHTO M194.

Physical Requirements for Corrosion-Inhibiting Admixture

Characteristic Value	
Calcium Nitrite Content	30%±2% (by weight)
Time of Setting	allowable deviation from control, (h:min)
Initial, not more than	1:00 earlier nor 3:30 later
Final, not more than	1:00 earlier nor 3:30 later
Compressive Strength	minimum percent of the control, any time: 90
Flexural Strength	minimum percent of the control, any time: 90
Length Change	maximum shrinkage, percent of the control: 135
Relative Durability Factor	minimum: 80

The average corrosion current of the corrosion inhibitor protected specimens shall be less than two microamps when tested according to ASTM G109 “Standard Test Method for Determining the Effects of Chemical Admixtures on the Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments.” The test shall be run for three complete cycles after the control specimens have failed according to Section 8, Period of Testing. Protection potentials (Ep) shall be more positive than 280 mV versus SCE when tested according to ASTM G61 “Standard Test Method for Conducting Cyclic Potentiodynamic Polarization Measurements for Localized Corrosion Susceptibility of Iron, Nickel, or CobaltBased Alloys.” The test medium shall be modified to contain a calcium hydroxide

solution with a pH similar to concrete of 12.5, and sodium chloride content equivalent to approximately 5 lb/yd 3 (3kg/m 3) of concrete.

After five years of testing, the corrosion inhibitor protected test specimens shall have a corrosion current in microamps of less than 10% of the control when tested according to ASTM G109. The test specimens shall have a minimum 1 inch (25mm) of concrete cover over the reinforcement and a maximum water to cement ratio of 0.40.

Unless otherwise specified, the concrete shall contain 4.0 gallons of corrosion inhibiting admixture per cubic yard (19.8 l/m 3). Account for possible set acceleration effects from the use of calcium nitrite based admixture. Set retarding admixtures may be required.

932.04 – WATER

All water used in mixing or curing Portland cement concrete or cement treated base shall be clean and practically free from oil, salt, acid, alkali, organic matter, or other substances injurious to the finished product. Water from city water supply may be accepted without being tested. Water from doubtful sources shall not be used until tested and approved. When required by the Engineer, the quality of the mixing water shall be determined in accordance with AASHTO T 26. When tests are made comparing the water with water of known satisfactory quality, any indication of unsoundness, marked change in time of set, or reduction in mortar strength shall be sufficient cause for rejection of the water under test.

932.05 – FINE AGGREGATE

A) Materials Covered. These Specifications cover the quality and size of fine aggregates for portland cement concrete pavements or bases, highway bridges, and incidental structures. Mortar sand shall meet the requirements of AASHTO M 45.

B) General Requirements. Fine aggregate shall consist of natural sand, or, subject to approval, combinations of manufactured sand and natural sand, having hard, strong, durable particles, and it shall conform to these Specifications. Mix and store fine aggregate from different sources in separate stockpiles; in addition, do not use them alternately in the same class of construction or mix without permission from the Engineer or as provided herein for manufactured sand. Stockpile fine aggregate in accordance with Subsection 109.17.05. When manufactured sand is approved for use in combination with natural sand, at least 50 percent of the total fine aggregate by mass shall be natural sand. Store and batch the two materials separately. Each of the materials shall conform to the requirements of these Specifications, except that the mortar strength test shall be made on the blend of materials proposed for use.

C) Deleterious Substances. The amount of deleterious substances shall not exceed the following limits:

ITEM	LIMITS:
Clay lumps and friable particles	%, maximum 3.0
Coal and Lignite	%, maximum 0.25

D) Organic Impurities. All fine aggregate shall be free from injurious amounts of organic impurities. Aggregates subjected to the colorimetric test for organic impurities and producing a color darker than the standard shall be rejected unless they pass the mortar strength test as specified below. Should the aggregate show a darker color than that of samples originally approved for the work, its use shall be withheld until tests satisfactory to the Engineer have been made to determine whether the increased color is indicative of an injurious amount of deleterious substances.

NOTE: A fine aggregate failing in the test may be used provided that, when tested for the effect of organic impurities on strength of mortar, the relative strength at 7 and 28 days calculated in accordance with Section 10 of AASHTO T 71 is not less than 95 percent.

E) Gradation. Fine aggregate shall be well graded from coarse to fine, and when tested by means of

laboratory sieves, it shall conform to the following requirements:

SIEVE SIZE	PERCENT PASSING
3/8 inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	5-30
No. 100	0-10
No. 200	0-3

The gradation requirements given above represent the extreme limits which shall determine suitability for use from all sources of supply. The gradation from any one source shall be reasonably uniform and not subject to the extreme percentages of gradation specified above. For the purpose of determining the degree of uniformity, determine a fineness modulus (See Note). Determination shall be made from a representative sample obtained by the Engineer from the Contractor' s proposed source. Reject fine aggregate from any one source having a variation in fineness modulus greater than 0.20 either way from the fineness modulus of the representative sample.

NOTE: The fineness modulus of an aggregate is determined by adding the total percentages of material in the sample that are coarser than each of the following sieves (cumulative percentages retained), and dividing the sum by 100; No. 100 (150 µm), No. 50 (300 µm), No. 30 (600 µm), No. 16 (1.18 mm), No. 8 (2.36 mm), No. 4 (4.75 mm), 3/8 inch (9.5 mm), 3/4 inch (19.0 mm), 1 1/2 inch (37.5 mm), and larger increasing at the ratio of 2 to 1.

F) Methods of Sampling and Testing. Sampling and testing of fine aggregate shall be in accordance with the following methods of the American Association of State Highway and Transportation Officials:

Sampling	T 2
Friable particles	T 112
Coal and lignite	T 113
Amount of passing a No. 200 sieve	T 11
Organic impurities	T 21
Mortar-making properties	T 71
Sieve analysis	T 27

932.06 – COARSE AGGREGATE

A) Materials Covered. These Specifications cover the quality and size of coarse aggregate for use in portland cement concrete pavements or bases, highway bridges, and incidental structures.

B) General Requirements. Stockpile coarse aggregate in accordance with Subsection 109.17.05. Coarse aggregate shall be a gravel or crushed stone which shall conform to the requirements of AASHTO M 80, Class A, except as modified by these Specifications. Coarse aggregate shall produce Class A concrete with a durability factor of 50 or more. The durability factor will be determined after 350 cycles of alternate freezing and thawing in accordance with AASHTO T 161, Procedure A. The Los Angeles Abrasion percent wear shall be limited to a maximum of 40 percent after 500 revolutions when tested in accordance with AASHTO T 96. The sodium sulfate soundness require-ment shall not apply. Use only coarse aggregate shall consisting of clean, tough, durable particles, practically free from clay, shale, coatings of any character, disintegrated or soft pieces, conglomerates, mud balls, sticks, salt, alkali, or vegetable matter. Crushed stone or crushed gravel from different sources may be combined in the mix when stored and batched separately in recommended proportions, upon written permission of the Engineer. At least 70 percent of all

aggregate retained on the No. 4 (4.75 mm) sieve in the combined mix shall be crushed stone or mechanically crushed gravel having two or more fractured faces and shall contain not more than 15 percent of flat and elongated pieces. (A flat and elongated piece is one in which the length is greater than five times the average thickness).

C) Gradation. The coarse aggregate shall be well graded within the limits of the following table:

Processed Aggregate Size Number

	357	57	67	7	8
SIEVE SIZE	**PERCENT PASSING**				
2 1/2 inch	100				
2 inch	95-100				
1 1/2 inch		100			
1 inch	35-70	95-100	100		
3/4 inch			90-100	100	
1/2 inch	10-30	25-60		90-100	100
3/8 inch			20-55	40-70	85-100
No. 4	0-5	0-10	0-10	0-15	10-30
No. 8		0-5	0-5	0-5	0-10
No. 16					0-5
No. 200	0-1.5	0-2.0	0-2.0	0-2.0	0-2.0

- ✍ Furnish coarse aggregate for Class A concrete in the No. 57 size only except as noted below.
- ✍ Furnish coarse aggregate for massive Class A concrete in the No. 357 size. Coarse aggregate for Class C concrete may be either No. 57 or No. 357.
- ✍ Furnish coarse aggregate for thin section concrete in the No. 7 size.
- ✍ Coarse aggregate for Class AA or P concrete shall be furnished in the No. 67 size. No. 7 or No. 8 coarse aggregate may be used in Class P concrete if either the specified 28-day compressive strength is in excess of 6000 psi (41.4 MPa) or permeability limits are specified.

932.07 – CURING AGENTS

Concrete curing agents shall consist of burlap, cotton mats, earth, white or red pigmented membrane curing compound, waterproof paper, polyethylene film, linseed oil emulsion, or water for ponding. Keep the curing agents reasonably free from ingredients which may damage or be detrimental to the surface of the concrete.

A) Burlap. Burlap cloth shall conform to AASHTO M 182, Class 3 or better. Burlap shall be new burlap or burlap which has been used for no purpose other than the curing of concrete. New burlap, not previously used for curing concrete, shall be reasonably free from starch, filler, or other substances added during the process of manufacturing, or shall be washed by repeated rinsing in clear water until reasonably free from such substances. Worn burlap or burlap with holes will not be permitted. Burlap shall be at least 2 feet (600 mm) longer than the width of the pavement slab.

B) Cotton Mats. Cotton mats shall be either new, or they shall not have been used for any other purpose than curing concrete. Do not use mats with holes.

C) Earth. Earth used in curing concrete pavement shall be reasonably free of roots, sticks, stones, or other ingredients which may be detrimental to the surface of the concrete, and shall be of such nature as to retain moisture.

D) Liquid Membrane Curing Compounds. Liquid membrane curing compounds shall conform to AASHTO M 148 with these exceptions:

1) The type 2, white pigmented compound hiding power shall have an apparent daylight

reflectance of not less than 65 percent compared to magnesium oxide as determined by ASTM E 97.

2) The type 1-D compound shall be colored by a red fugitive dye so that inspection may indicate complete coverage. The color must be maintained at least 4 hours, after which it should gradually disappear.

3) When tested in accordance with OHD L-17, the curing compound shall provide a water retention of at least 90 percent.

E) Sheet Materials. Sheet Materials shall conform to AASHTO M 171. Sheet material not specifically defined in AASHTO M 171 may be approved providing all other requirements of AASHTO M 171 are met. The sheeting material shall be fabricated into sheets of such width as to provide a complete cover for the entire concrete surface. All joints in the sheets shall be securely cemented together in such a manner as to provide a waterproof joint. Do not use sections of membrane which have lost their moisture- retaining qualities.

F) Linseed Oil Emulsion. Linseed oil emulsion shall comply with the following table of composition:

TABLE 937.05 – LINSEED OIL EMULSION

Composition	Weight Percent
Oil Phase (50% min. by volume)	
Boiled Linseed Oil	97.0 ± 0.1
Saturated Tallow Alcohol	3.0 ± 0.1
Total	100
Water Phase (50% max. by volume)	
Water	99.6 ± 0.01
Sodium Hydroxide	0.37 ± 0.01
Dipicolinic Acid	0.03 ± 0.001
Total	100

The emulsion shall be stable at the time of application.

Fugitive Dye. Linseed oil emulsion shall be colored by a red fugitive dye so that inspection may indicate complete coverage. The color must be maintained at least four (4) hours, after which it should gradually disappear within a couple of weeks.

Moisture Retention. When tested in accordance with OHD L-17, the curing compound shall provide a water retention of at least 90 percent when applied at the rate of 1 gallon per 175 square feet(4.3 m 2 /l).

Containers. All linseed oil emulsion furnished under this Specification shall be in plastic containers. Each container shall be marked or labeled with the manufacturer's name, contents "Linseed Oil Emulsion", lot number, and date of manufacture.

G) Water for Ponding and Material for Dikes. Water for ponding shall be reasonably free from salt, acid, alkali, oil, or any substance that would injure or discolor the surface. Water suitable for use in-mixing portland cement concrete will be satisfactory to use for ponding. Material for dikes shall be loam, sand, clay, or any combination of the above, free from rocks, sticks, or any objects that would prevent formation of a watertight dike.

932.08 – JOINT FILLERS AND SEALERS

This Subsection establishes the requirements for joint fillers and sealers for portland cement concrete.

A) Preformed Expansion Joint Filler (Bituminous Type). This joint filler shall conform to the requirements of AASHTO M 33. Do not use this type filler in joints for which the Plan detail requires a sealer. Submit a type A certification from the manufacturer for each lot or shipment of materials.

B) Preformed Expansion Joint Fillers. (Nonextruding and Resilient Types). 1. Nonbituminous Joint

Filler. The nonbituminous joint filler shall conform to AASHTO M 153. 2. Bituminous Joint Filler. The bituminous joint filler shall conform to the requirements of AASHTO M 213, except that the maximum permissible load to compress the test specimen to 50 percent of its thickness before testing shall be 1500 psi (10.34 MPa). Compliance with the asphalt content requirement is waived providing the material meets all other physical requirements as specified. Submit a type A certification from the manufacturer for each lot or shipment of materials.

C) Preformed Elastomeric Compression Joint Sealer.

1) Description. These Specifications cover preformed elastomeric compression joint sealers for use in portland cement concrete pavements and concrete bridge floors.

2) Materials.

a) Preformed Joint Seals. The joint seals shall be manufactured from an elastomeric material that is resistant to heat, oil, jet fuel and ozone. The material shall be compatible with concrete and shall conform to the physical requirements of AASHTO M 220. All tests will be made on samples taken from the preformed joint sealer.

b) Shape and Dimensions. The molded joint seals shall be of cross sectional dimensions, lengths and tolerances shown on the Plans. The sealer shall be one piece for the full length of the transverse joint and in practical lengths for longitudinal joints. Elongation of the joint material of more than 2 percent during placement will require the preformed elastomeric compression joint sealer to be removed and replaced.

c) Samples. Two 2 foot (600 mm) long pieces of each size of sealer to be used shall be submitted to the Materials Division for tests as warranted.

d) Inspection. Representative sections of each lot shall be subject to surface and dimensional inspection by the Engineer to determine visual compliance with applicable requirements of this Specification which do not require physical tests.

e) Lubrication Adhesive. Any lubricant adhesive used shall be compatible with the sealer and the concrete and relatively unaffected by the normal moisture in the concrete. The lubricant adhesive shall be a compound consisting of the same base polymer as the sealer, blended with a suitable volatile solvent. It shall maintain a suitable consistency at the temperature at which the seal is installed.

f) Certification. A type A certification shall be submitted by the manufacturer for each lot or shipment of materials. Any cracking visible after recovery testing is basis for rejection.

D) Polymer Type, Two Component Cold Applied Machine Extruded and Pourable Joint Sealer.

1) Description. These Specifications cover two-component, polymer- type, rubberlike, cold applied joint sealing compounds for use in portland cement concrete pavements and bridge floors. When recommended by the manufacturer, use a primer in accordance with the manufacturer' s recommendation. The shape of the joint and joint sealer shall be as shown on the Plans.

2) Materials. Materials meeting Federal Specifications SS-S-200 may be used. Use the bond breaker recommended by the materials manufacturer as shown on the ODOT standard drawings.

a) Acceptance. Furnish a type A certification with each shipment or lot.

b) Packaging. Package the joint sealer in sealed containers identified by the name of the manufacturer, the manufacturer' s lot number, and the date of manufacture, and bearing instructions for mixing and application. Containers including the curing agent shall be marked A, and the container including the polymer shall be marked B. If a

primer is required by the manufacturer, it must be so stated on containers A and B. Give proper instructions for use of the primer on its container.

c) Tests. Tests shall be made in accordance with OHD L-21.

3) Machine Extruded Joint Sealer.

a) General. The joint sealer shall be a modified polysulfide or polyurethane polymer consisting of 2 components to be machine mixed and machine extruded directly into the joints. The polysulfide components shall be mixed at a 1:1 ratio by volume and the polyurethane components shall be mixed in accordance with the manufacturer's recommendations. Upon being opened, component B shall not exhibit more than a slight degree of skinning.

b) Properties of Laboratory Mixed Material.

Determination Requirements	
Penetration, 77°F, 0.1 mm (25°C)	50 to 120
Penetration, 158°F (70°C)	1.5 x Pen. at 25°C
Cold Flow, 3 minutes, mm, minimum	19.1
Cold Flow, 40 minutes, mm, maximum	12.7
Resilience, 77°F (25°C), %, minimum	70
	60 [a]
Resilience of oven aged sample, 7 days, %, minimum	70
	60 [a]
Resilience, 158°F (70°C), %, minimum	60
	50 [a]
Bond to concrete b , 100% extension, dry, -20°F	No failure
Bond to concrete b , 100% extension, wet, -20°F	No failure
Nonvolatile content, %, minimum	88

[a] Applies if penetration at 77°F is 90 to 120(0.1mm) (25°C is 90 to 120)
[b] Cure Sample for 24 hours at 77°F (25°C); then oven age for 7 days at 158°F±2°F (70 ± 1°C).

4) Pourable Joint Sealer.

a) General. The joint sealer shall be a polymeric material consisting of two components to be uniformly mixed and poured directly into the joints. The mass of component A in the mixture shall be not less than 10 percent of the mass used of component B. Upon being opened, neither component shall exhibit more than a slight degree of skinning.

b) Properties of Laboratory Mixed Material

Determination Requirements	
Viscosity, 5 minutes after mixing, Pa·s	2.00 to 3.50
Application time (Pot life or time to reach 20.00 Pa·s), 77°F , hr, minimum	1
Penetration, 77°F , 24 hours aging, maximum	150
Penetration [a] , 77°F (25°C)	50 to 120
Penetration [a] , 158°F (70°C)	1.5 x Pen @ 25°C
Resilience [a] , 77°F (25°C), %, minimum	70
	60 [b]
Resilience [a] , 158°F (70°C), %, minimum	60
	50 [b]
Resilience [a] , oven aged sample, 7 days, %, minimum	70
	60 [b]

Bond to Concrete [c] , 100% extension, dry, -20°F (-29°C)	No failure
Bond to Concrete [c] , 100% extension, wet, -20°F (-29°C)	No failure
Nonvolatile content, %, minimum	88

[a] After 96 hours aging at 77°F (25°C)
[b] This requirement applies if penetration at 77°F (25°C) after 96 hours at 77°F is 90 to 120(0.1mm) (25°C is 90 to 120).
[c] Cure sample for 24 hours at 77°F (25°C), then oven age at 158°F±2°F (70°C ± 1°C) for 7 days before testing.

E) Hot Poured Joint Sealer.

1) Description. Joint sealers furnished shall be of the hot poured type which readily bonds to concrete surfaces.

2) Materials.

a) Sealer. Joint sealers used under these Specifications shall meet the requirements of Federal Specification SS-S-1401. The sealant material shall be heated for application to the temperature within the range recommended by the manufacturer unless otherwise established by the Engineer.

(i) Safe Heating Temperature. The safe heating temperature shall be set forth by the manufacturer and furnished with samples for approval. The safe heating temperature shall also be shown on all containers and packages in each shipment received at the job site.

(ii) Acceptance. Hot poured joint sealer furnished under these Specifications will be accepted for use upon receipt of a type C certification in accordance with Section 109.17. Sealer materials damaged by excessive or prolonged heating will be rejected.

b) Backer Rod. When shown on the Plans, the use of a backer rod of the size and dimensions shown shall be required. The backer rod shall be compatible with the joint sealant. The backer rod shall be an approved product listed for use by the Materials Division.

F) Low Modulus Silicone Joint Sealant.

1) Description. These Specifications cover low modulus silicone joint sealant and expanded poly-ethylene backer rod for use in sealing portland cement concrete pavement joints. The silicone sealant shall be furnished in a one part silicone formulation. Acetic acid cure sealants are not acceptable.

2) Materials.

a) Silicone Sealant. The silicone sealant shall meet the color, toxicity, stability, and durability requirements of the current Federal Specification TT-S-001543 for Class A sealants and the following test requirements:

Test	Limit	Test Method
Flow, inches , maximum	0.3	MIL S 8802
Extrusion Rate, g/minute	75-250	MIL S 8802
Tack Free Time, 77°F, 45-55% relative humidity, minutes	20-75	MIL S 8802
Specific Gravity	1.01 - 1.515	ASTM D 792 Method A [a]
Durometer, Shore A, 0°F (-17.8°C)	10-27	ASTM D 2240 [a]
Tensile Stress, 100% Elongation, psi (kPa), maximum	75 (517)	ASTM D 412 Die C [a]
Elongation, %, minimum	500	ASTM D 412 Die C [a]

[a] Cured 7 days at 77°F±4°F (25 ± 2°C) and 50 ± 5 percent relative humidity. Concrete primer may be used if specified by the sealant manufacturer.

(i) Acceptance. The sealant shall be accepted on the basis of manufacturer' s certification and approval by the Materials Engineer in accordance with Subsection 109. A type A certification shall be furnished for the above listed test requirements. A type D certification shall be required for compliance with current Federal Specification TT-S-001543 in accordance with Subsection 2.1 of these Specifications. Samples of the joint sealant shall be submitted by the manufacturer to the Materials Division for tests and approval prior to use.

(ii) Storage and Shelf Life. Storage and use of the joint sealant shall be in accordance with the manufacturer' s recommended practices.

b) Backer Rod. The backer rod shall be of the size and dimensions shown on the Plans. The backer rod shall be compatible with the joint sealant and no bond or reaction shall occur between the rod and sealant. The backer rod shall be an approved product listed for use by the Materials Division.

G) Low Modulus Silicone Joint Sealant (Self-Leveling).

1) Description. These Specifications cover self-leveling, low modulus silicone joint sealants and polyethylene backer rod for use in sealing portland cement concrete pavement joints and/or portland cement concrete to asphalt concrete pavement joints. The self-leveling silicone sealant shall be furnished in a one part silicone formulation. Acetic acid cure sealants are not accept-able.

2) Materials.

a) Silicone Sealant. The silicone sealant shall meet the color, toxicity, stability, and durability requirements of the current Federal Specification TT-S-001543 for Class A sealants and the following test requirements:

(i) 2.1.1.Acceptance. The sealant shall be accepted on the basis of the manufacturer' s certification and approval by the Materials Engineer in accordance with Subsection 109. Furnish a type A certification for the above listed test requirements. Furnish a type D certification to comply with current Federal Specification TT-S-001543 in accordance with Subsection 2 of these Specifications. Submit samples of the joint sealant to the Materials Division for tests and approval prior to use.

(ii) Storage and Shelf Life. Storage and use of the joint sealant shall be in accordance with the manufacturer' s recommended practices.

b) Backer Rod. The backer rod shall be of the size and dimensions shown on the Plans. The backer rod shall be compatible with the joint sealant, and no bond or reaction shall occur between the rod and the sealant. The backer rod shall be an approved product listed for use by the Materials Division.

Test	Limit	Test Method
Appearance	Smooth, non-grainy, homogeneous mixture	MIL S 8802
Extrusion Rate, g/minute, minimum	200	MIL S 8802
Tack Free Time, 77°F (25°C), 45-55% relative humidity, hr	5	MIL S 8802
Specific Gravity	1.26-1.34	ASTM D 792, Method A
Elongation, %, minimum	500	ASTM D 3583-85 Section 13, Modified [a]

Modulus @ 50%, psi, maximum	10	ASTM D 3583-85 Section 13, Modified [a]
Modulus @ 100%, psi, maximum	15	ASTM D 3583-85 Section 14, Modified [a]
Modulus @ 150%, psi, maximum	20	ASTM D 3583-85 Section 14, Modified [a]

[a] Clean two 1x1x3 inch concrete test blocks, hold under running tap water, and scrub with a brush for approximately 30 seconds. Allow blocks to dry for 24 hours at room temperature. Assemble blocks with 1x3 inch surface facing with 1/2 x 1/2 x 1 inch Teflon spacers. Hold in place with a clamp. Without touching the surface with your fingers, insert backer rod closed cell 1/2 inch diameter x 1 inch. Inject sealant to fill the cavity with no air entrapment. Allow the sealant to flow to a smooth surface, and do not strike off. Allow it to cure at 77°F and 45-55% relative humidity. After 21 days, remove the clamp and Teflon spacers and pull the test specimens at 2 inches per minute.

H) Rapid Cure Joint Sealant and Elastomeric Mortar.

1) Description. These Specifications cover rapid cure joint sealant and elastomeric mortar for use in expansion joints in bridge decks.

2) Materials.

a) Joint Sealant. Joint sealer shall be a self-leveling, rapid cure silicone joint sealant that cures to a low-modulus rubber upon exposure to atmospheric moisture. Rapid cure is defined as the development of sufficient integrity within the silicone in 8 hours or less to accommodate highway traffic and movements associated with bridges. Deliver each lot or batch of sealing compound to the job site in the manufacturer' s original sealed container. Each container shall be marked with the manufacturer' s name, and batch or lot number, and shall be accompanied by the manufacturer' s certification. Petroleum products shall not be deleterious to the sealant. Joint sealant shall meet the following requirements:

Test	Limit	Test Method
AS SUPPLIED:		
Extrusion Rate, g/minute, minimum	200	MIL S 8802
Specific Gravity	1.25 - 1.35	ASTM D 1475
AS INSTALLED - AT 77°F (25°C) AND 46-54% RH:		
Accelerated Weathering, No cracks, blisters	5,000 hours or bond loss	ASTM C 793-75
Skin-over time, minutes, maximum	20	OHD L-3
Non-volatile content, %, minimum	93	OHD L-4
Joint Elongation, %, minimum	600	ASTM D 3583-85
Joint Modulus at 100%, psi	3-12	ASTM D 3583-85 [a]

[a] Section 14, Modified: Clean six 1x1x3 inch concrete blocks; hold under running tap water and scrub with a brush for approximately 30 seconds. Allow blocks to dry for 24 hours at room temperature. Assemble blocks with 1x3 inch surfaces facing with 932.08, 1/2 x1/2 x 1 inch Teflon spacers; hold in place with a clamp. Insert backer rod, closed cell, 1/2 inch diameter by 2 inches; do not touch surface with fingers. Inject sealant to fill the cavity, with no air entrapment. Allow the sealant to flow to a smooth surface, do not strike off. Allow to cure at 77°F and 46-54% relative humidity. Cure for 160 hours, remove clamp and Teflon spacers, and pull the test specimens at 2 inches per minute.

b) Elastomeric Mortar. The binder material shall be a two-component, rapid curing liquid polymer that cures to a dense, semi-flexible polymer resistant to chemicals, weather, abrasion and impact. The binder material shall be compatible with the sealant, as

determined by the sealant manufacturer. The binder shall be cured in the “neat” to form the primer between the elastomeric mortar and the existing surfaces and shall be mixed with aggregate to form the polymer based mortar. Aggregate for the elastomeric mortar shall be compatible with the liquid polymer (binder material), as determined by the manufacturer. Properties for the binder material shall conform to the following requirements:

COMBINED LIQUID COMPONENTS (The mixing ratio shall be 1:1 by volume)		
Test	Limit	**Test Method**
Viscosity, Pa·s, 75°F±2°F (23.9°C ± 1.1°C) (Brookfield Model LVT) (Spindle No. 2, 30 RPM)	0.9 - 2.0	ASTM D 2393
Gel Time, minutes	25 - 60	AASHTO M-200
Elongation, %	40 - 55	ASTM D 638 [a]
Tensile Strength, psi (MPa), minimum	900 (6.21)	ASTM D 638 [a]
Shore D Hardness, 77°F (25°C), 7 day cure	45 - 75	ASTM D 2240
[a] Test Method Type 1, Molded Specimens, 1/4 inch (6.4 mm) thickness; speed of testing shall be 0.2±0.05 inch (5.1 ± 1.3 mm).		

Properties for the elastic mortar shall conform to the following:		
Test	**Limit**	**Test Method**
Absorption, %, maximum	1	ASTM D 570
Compressive Strength, 24 hr, psi (MPa), Method B, minimum	2500 (17.24)	ASTM C 579
Bond Shear Strength, psi (MPa), minimum	750 (5.17)	ASTM C 882
Abrasion Resistance Wear Index, Taber H-22, maximum	1.5 ASTM C 501	
Compressive Stress, psi (MPa), minimum	350 (2.41)	OHD L-6
Resilience, %, minimum	70	OHD L-6
Thermal Compatibility	Pass	ASTM C 884

c) General Use Procedure. Mixing and application time shall be as recommended by the manufacturer. No modification of the elastomeric mortar should be attempted without first consulting the manufacturer.

d) Acceptance and Sampling. The sealant and elastomeric mortar shall be accepted on the basis of the manufacturer’ s certification in accordance with Subsection 109 and acceptable performance on the project. A type A certification shall be furnished for the joint sealant, except a type B certification shall be furnished for the Accelerated Weathering test. A type B certification will be furnished for elastomeric mortar, except a type A certification will be furnished for the binder material. Samples of the rapid cure joint sealant, and the binder material and aggregate for the elastomeric mortar, shall be submitted by the manufacturers to the Materials Division for testing and evaluation.

e) Backer Rod. Backer rod shall be in accordance with Section 932.08 of the Standard Specifications.

f) Primer. Primer shall be applied as detailed in the plans prior to installation of the sealant or as specified by the sealant manufacturer.

g) Alternate Joint Products. When alternate expansion joint systems are specified on the plans, the Contractor may use the alternate joint system in place of the nosing and sealant specified above. Sealants and nosing material may be considered as an equal alternate to the above specified materials provided that they successfully complete a 3-year trial installation and evaluation in the State of Oklahoma as determined by the Bridge Engineer.

932.09 – METAL PARTING STRIPS.

These Specifications cover metal parting strips for use in forming longitudinal joints in concrete pavement or concrete base course. Metal parting strips shall be shaped from metal of the sheet thickness shown on the Plans and shall be free from bends and kinks. They shall conform to the dimensions and be punched for pins and tie bars as shown on the Plans. Punching for pins may not be farther apart than 3 feet (915 mm) center to center. Sections of metal parting strips shall be not less than 10 feet (3.0 m) in length and so designed that adjoining sections may be securely fastened together by lapping and pinning, by means of a slip joint or other approved method.

932.10 – HIGH DENSITY CONCRETE FOR BRIDGE DECK REPAIR AND OVERLAY

This Subsection covers the material requirements for high density concrete used for bridge deck repairs and/or overlays.

A) Aggregate.

1) Fine Aggregate. The fine aggregate shall meet all requirements of Subsection 932.05 except for gradation.

2) Coarse Aggregate. The coarse aggregate shall be a crushed stone containing no chert or shale and having a minimum durability of 50 as determined by AASHTO T 210. The coarse aggregate shall meet all other requirements of Subsection 932.06 and shall have an absorption of not more than 3 percent by mass.

3) Gradation. The combined aggregate shall meet the following gradation requirements:

SIEVE SIZE	PERCENT PASSING
3/4 inch	100
1/2 inch	75 - 90
3/8 inch	62 - 80
No. 4	38 - 54
No. 16	16 - 32
No. 30	‘10 - 20
No. 50	‘4 - 12
No. 100	‘2 - 8
No. 200	‘0 - 4

B) Concrete. The concrete shall meet the following requirements:

Basic Absolute Volumes per Unit Volume of Concrete.

Combined Aggregate	0.6194
Air Content	0.0650
Water	0.1601
Cement	0.1555
	1.0000

A water-reducing admixture meeting the requirements of Subsection 932.03 shall be used. The slump, measured in accordance with AASHTO T 119, shall be 3/4 inch ± 1/4 inch (20 ± 5 mm). The air content of the freshly mixed concrete shall be 6.5 ± 1.0 percent when tested in accordance with AASHTO T 152 or T 196.

C) Grout. Grout for bonding new concrete to existing concrete shall consist of equal parts by mass of portland cement and sand, mixed with sufficient water to form a stiff slurry. The consistency of this slurry shall be such that it can be applied with a stiff brush or broom to the old concrete in a thin, even coating that will not run or puddle in low spots. For sealing vertical joints around repair or between adjacent lanes of overlay and at curbs, this grout shall be thinned to paint consistency.

932.11 – LATEX MODIFIED CONCRETE FOR BRIDGE DECK OVERLAYS

Description. This Subsection covers the material requirements for latex modified concrete for bridge deck overlays.

A) Aggregate.

1) Fine Aggregate. The fine aggregate shall meet all requirements of Subsection 932.05 except for gradation.

2) Coarse Aggregate. The coarse aggregate shall be a crushed stone containing no chert or shale and having a minimum durability factor of 50 as determined by AASHTO T 210 and have an absorption of not more than 3 percent. The coarse aggregate shall meet all other requirements of Subsection 932.06.

3) Gradation. The combined aggregate shall meet the following gradation requirements:

SIEVE SIZE	PERCENT PASSING
3/4 inch	100
1/2 inch	68 - 83
3/8 inch	56 - 70
No. 4	36 - 46
No. 16	‘12 - 24
No. 30	‘7 - 17
No. 50	‘4 - 12
No. 100	‘2 - 8
No. 200	‘0 - 4

B) Latex Emulsion Admixture. Formulated latex admixture shall be nontoxic, film forming, polymeric emulsion in water to which all stabilizers have been added at the point of manufacture and shall be homogenous and uniform in composition. Physical properties of the latex modifier shall conform to the following requirements:

Polymer Type Stabilizers	Styrene Butadiene
Latex	Nonionic Surfactant
Portland Cement Composition	Polydimethyl Siloxane
Percent Solids	46.0 - 49.0
Mass per Unit Volume, lbs/gallon, 77°F (kg/l, 25°C)	8.4 (1.007)
Color	White

A type D certification of materials will be required and shall be furnished to the Materials Engineer before acceptance of the product. Latex admixture to be stored shall be kept in suitable enclosures which will protect it from freezing and from prolonged exposure to temperatures in excess of 29°C. Containers of latex admixture may be stored at the bridge site for a period not to exceed 10 days. Such stored containers shall be covered completely with suitable insulating blanket material to avoid excessive temperatures

C) Latex Modified Concrete. The latex modified concrete for use in overlay shall be a workable mixture having the following properties or limits:

Material or Property	Concrete
Cement (Parts by Mass)	1

Fine Aggregate (Parts by Mass)	2.5
Coarse Aggregate (Parts by Mass)	2.0
Latex Emulsion Admixture, gallon/bag cement	3.5
Air Content, %	3-6
Slump [a,b] , inches	4-6

[a] Following sampling of the discharged, normally mixed material, the commencement of the slump test shall be delayed from 4 to 4-1/2 minutes.

[b] Water may be added to obtain slump within the prescribed limits, but the water-cement ratio produced should be between 0.35-0.40 by mass. All of the non solids in the latex admixture should be considered as a part of the water.

932.12 – PENETRATING WATER REPELLENT FOR TREATMENT OF CONCRETE SURFACES

Description. This Subsection covers the material requirements for penetrating water repellents for use on concrete surfaces.

A) General. The penetrating water repellent treatment solution shall be an organo silicon compound dissolved in a suitable solvent carrier that, when applied, will produce a hydrophobic surface covalently bonded to the concrete. The organo silicon compound shall be one of the following:

- ALKYL-ALKOXYSILANE
- OLIGOMEROUS ALKYL-ALKOXYSILOXANE

The solvent shall leave less than one percent residue by mass upon evaporation. The penetrating water-repellant treatment solution shall not permanently stain, discolor, or darken the concrete. Application of the solution shall not alter the surface texture or form a coating on concrete surfaces and shall be compatible with the use of special surface finish texture coatings specified in Section 412.04. Treated concrete shall be surface dry within 30 minutes after application. The penetrating water repellent treatment solution shall be tinted with a fugitive dye to enable the solution to be visible on the treated concrete surface for at least four hours after the application. The fugitive dye shall not be conspicuous more than seven days after application when exposed to direct sunlight.

Certification. A type D certification shall be submitted for each lot or shipment of materials prior to use. The manufacturer' s recommended rate of coverage for the treatment solution as approved for use under these Specifications shall be included with the type D certification.

SECTION 933 - PORTLAND CEMENT MORTAR

933.01 - GENERAL

Portland Cement Mortar shall consist of Portland Cement, fine aggregate and water.

933.02 – MATERIALS

All materials for mortar shall conform to requirements of the following specifications:

PORTLAND CEMENT	Section 932
WATER	Section 932
SAND	Section 932

933.03 - EQUIPMENT

All equipment, tools and machinery used in mixing and handling mortar shall be approved by the Engineer.

933.04 - COMPOSITION

The proportions of Portland Cement, fine aggregate and water shall be such as to produce a plastic

mortar. The workability shall be consistent with the type of work for which it is used in order to secure the best results.

The classes of mortar as specified for the several types of work shall be proportioned in accordance with the following tabulation:

Class of Mortar	Portions of Cement	Parts by Volume Fine Aggregates
A	1	1
B	1	1.5
C	1	2
D	1	2.5
E	1	4

Proportioning of batches shall be by volume unless otherwise shown on the plans or specified in the special provisions. One (1) sack of cement weighing ninety-four (94) pounds shall be considered one (1) cubic foot. Correction for bulking of the fine aggregate shall be made as directed by the Engineer.

933.05 - ADMIXTURE

A) Lime which has been thoroughly air slacked may be added, up to ten (10) percent of the cement content of the mix, to increase the workability of the mortar upon approval of or at the direction of the Engineer. Lime shall conform to ASTM Specifications, Designation C-144-55.

B) Commercial Admixtures to increase the workability of mortar or concrete will not be used unless specifically approved in writing by the Engineer.

C) Lime Putty may be prepared from hydrated lime or quicklime. Hydrated lime shall be mixed with water to form a putty and stored with reasonable care to prevent evaporation for at least twenty-four (24) hours before use. Quicklime shall be slaked with enough water to make a cream, passed through a #10 sieve and then stored with reasonable care to prevent evaporation for at least seven (7) days before use.

SECTION 941 - REINFORCING STEEL

941.01 - BAR STEEL REINFORCEMENT - BILLET STEEL

This section covers plain and deformed billet steel bars for concrete reinforcement and dowels used in the work. The billet steel bars shall meet the specification requirements of AASHTO M-31, Grade 40.

A sample shall consist of two (2) bars, not less than twenty-four (24) inches in length, from each lot of bars in the shipment. The chemical analysis report shall be furnished with each lot. The term "lot" used in this paragraph means all bars of one size bearing one manufacturer's roll mark.

941.02 - AXLE STEEL

This section covers deformed and plain axle steel bars for concrete reinforcement and dowels which may be used in lieu of those as specified in Subsection 941.01.

Axle steel bars shall meet the specification requirements of AASHTO M-53, Grade 40.

Sampling shall conform to Subsection 941.01 above except that the carbon range for each lot will be required in lieu of a full chemical analysis.

941.03 - WELDED STEEL WIRE FABRIC

This section covers cold drawn steel wire to be used as such, or in fabricated form, for the reinforcement of concrete.

The fabric shall comply with the requirements of AASHTO M-55 or AASHTO M-221. The size and

spacing of wires in the fabric shall be as shown on the plans. Welds shall be of sufficient strength that they will not be broken during handling or placing.

Reinforcing fabric shall be furnished in flat sheets or rolls. Any material that may have become bent or distorted must be straightened and otherwise put in proper condition before using. When placed in the work, the fabric shall be free from excessive rust, scale, or coating of any character which will impair its bond with the concrete.

Two (2) samples, each twenty-four (24) inches in length, cut from the fabric shall be submitted for each different bar size in the fabric. Samples shall be submitted for each ten (10) tons or less of material.

941.04 - PRETENSIONING STEEL WIRE STRAND

Steel for pretensioning shall conform to the specifications for Uncoated Seven Wire Stress Relieved Strand for Prestressed Concrete, AASHTO M-203.

941.05 - BARS FOR POST TENSIONING

Bars shall be High Strength Alloy Steel Bars meeting the requirements of AASHTO M-215.

941.06 - POSTTENSIONING STEEL WIRE

Steel cable for posttensioning shall conform to the specifications for Uncoated Stress Relieved Wire for Prestressed Concrete, AASHTO M-204, Type BA or WA, as specified. Type A Certification shall be furnished for each coil or wire.

941.07 - ANCHORAGES FOR POSTTENSIONED TENDONS

A) Bars - Wedge type anchorages shall be used for bars. The wedge device shall develop the minimum ultimate stress specified for the nominal bar area. Wedge anchorages shall bear against anchorage plates fabricated of hot rolled steel having physical characteristics not less than as specified for No. 1040 of the American Iron and Steel Institute (AISI) Specifications. Type A Certification shall be furnished for each heat of anchorage plates.

B) Parallel Wire Assemblies - Wedge type anchorages of the sandwich plate or conical type shall generally be used. The anchorage device shall be capable of developing the ultimate strength of the total number of wires anchored. Conical type anchorages shall be embedded within the ends of the concrete members unless otherwise specified. Anchorages shall generally bear against embedded grids of reinforcing steel of approved type.

SECTION 942 - STRUCTURAL STEEL

942.01 - DESCRIPTION

This section covers the requirements for structural steel, bolts, nuts and washers, shear connector studs and filler material for welds.

942.02 - STRUCTURAL STEEL

Steel shall be furnished according to the following specifications:

A) General Requirements - The general requirements for delivery of rolled steel plates, shapes, sheet piling, and bars for structural steel shall conform to AASHTO M-160. Test specimens of structural, rivet or eyebar steel shall show a fracture having a silky or fine granular structure throughout with a bluish gray or dove color and shall be entirely free from granular, black and brilliant specks.

B) Specific Requirements - Structural steel shall conform to the requirements of the current AASHTO specification as follows:

Structural Steel (A-36)	M-183
Structural Rivet Steel (A-502)	M-228

High Strength Low Alloy Structural Steel (A-242)	M-161
High Strength Structural Steel (A-440)	M-187
High Strength Low-Alloy Structural Manganese Vanadium Steel (A-441)	M-188
High Strength Low-Alloy Columbium-Vanadium Steels (A-572)	M-223
High Strength Low-Alloy Structural Steel (A-588)	M-222
High Yield Strength, Alloy Steel Plate (A-514)	M-244

Unless specified otherwise steel used in structures shall conform to the Current Specification for Structural Steel, AASHTO M-183 and rivets shall conform to the requirements of the current Specification for Structural Rivet Steel, AASHTO M-228.

Unless shown otherwise on the plans structural steels for main load carrying members subject to tensile stresses listed herein shall meet the longitudinal charpy V-notch tests for the appropriate climatic service zone specified in the special requirements for the structural steel being used. Members such as shoes, diaphragms, stiffeners (including bearing stiffeners), lateral bracing, diagonals, armor joints and finger joints shall not be considered main load carrying members.

Steel for secondary nonstress carrying members in unpainted structures shall conform to AASHTO M-222 or M-161, except that M-161 steel members shall be used only for riveted or bolted construction unless the weldability of the steel is established in accordance with AWS D1.1. Mil test reports shall be furnished for each heat of material.

942.03 - BOLTS, NUTS AND WASHERS

Except as provided in the next paragraph below bolts, nuts and circular washers if required, shall conform to requirements of AASHTO M-164.

Other fasteners which meet the chemical composition requirements of AASHTO M-164 and which meet the mechanical property requirements of the same specification in full size tests and which have body diameter and bearing areas under the head and nut, or their equivalent, not less than those provided by a bolt and nut of the same nominal dimensions may be used. Such alternate fasteners may differ in other dimensions from those of the specified bolts and nuts.

The slope of surfaces of bolted parts in contact with the bolt head and nut shall not exceed 1:20 with respect to a plane normal to the bolt axis. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material. Holes may be punched, subpunched and reamed or drilled, as required by the applicable code or specification and shall be a nominal diameter not more than one-sixteenth (1/16) inch in excess of the nominal bolt diameter.

When assembled all joint surfaces, including those adjacent to the bolt heads, nuts or washers, shall be free of scale, except tight mil scale, and shall also be free of burrs, dirt and other foreign material that would prevent solid seating of the parts.

Contact surfaces within friction type joints shall be free of oil, paint, lacquer or galvanizing, except for inorganic ink primer.

When shown on the plans or in the proposal that the structural steel is to be left bare and unpainted, the chemical composition of bolts, nuts and washers shall be modified to provided atmospheric corrosion resistance similar to the structural steel being used.

942.04 - WELDING

All welding shall meet the appropriate section of the current specifications of AWS Structural Welding Code as modified by AASHTO.

942.05 - WELDED STUD SHEAR CONNECTORS

The materials, installation and inspection of end welded stud shear connectors where welded to steel beams, girders, or plates to connect the members to concrete in composite steel concrete construction

shall be in accordance with the AWS Structural Welding Code as modified by the AASHTO "Standard Specification for Welding of Structural Steel Highway Bridges" or as follows:

A) General Requirements - Before placing orders for studs the Contractor shall submit to the Engineer for approval the following information on the studs to be purchased:

1) The name of the manufacturer.
2) A detailed description of the stud and arc shield to be furnished.
3) A certification from the manufacturer that the stud base is qualified.
4) A copy of the qualification test report as certified by the testing laboratory.

For quality control purposes the Contractor shall furnish certification from the manufacturer that the studs as delivered are in accordance with the specification. Certified copies of in plant quality control test reports shall be furnished to the Engineer.

Construction Requirements - The first two studs welded on each beam or girder, after being allowed to cool, shall be bent forty-five (45) degrees by striking the stud with a hammer. If failure occurs in the weld of either stud, the procedure shall be corrected and two (2) successive studs successfully welded and tested before any more studs are welded to the beam or girder. The Engineer shall be promptly informed of any changes in the welding procedure at any time during construction. When the temperature of the base metal is below thirty-two (32) degrees F, one (1) stud in each one hundred (100) studs welded shall be bent forty-five (45) degrees in addition to the first two bent as specified above.

SECTION 943 - ELASTOMERIC MATERIALS

943.01 - DESCRIPTION

This section covers the materials, fabrication, and placement of elastomeric materials except as may otherwise be covered in other particular specifications or on the plans.

943.02 - MATERIALS

A) Elastomeric Bearings - When so specified on the plans concrete beams, steel beams, and other major structural members shall be seated on elastomeric bearings. These bearings may be either "plain" (consisting of elastomer only) or "laminated" (consisting of layers of elastomer interspersed with non-elastic laminates) as shown on the plans. Elastomeric bearings shall be specified on the plans by hardness (durometer), size and configuration and in the case of laminated bearings, by the thickness of individual layers of elastomer and the size and position of special connection members, if any, required to be vulcanized with the bearing.

1) General - Unless shown otherwise on the plans the elastomer for bearings shall be one hundred (100) percent virgin neoprene stock. Natural rubber, vulcanized rubber (natural or synthetic), or other synthetic rubber like materials will not be acceptable. Non-elastic laminates shall be one-sixteenth (1/16) inch thick (-0, +1/16") rolled mild steel plates or sheets conforming to ASTM Designation A-570. Metal for special connections shall conform to ASTM Designation A-36 unless shown otherwise on the plans.

2) Physical Properties of Elastomer - The elastomer shall meet the requirements shown in Table 943.02.01. Tests of the material shall be made in accordance with the test methods stipulated. Insofar as possible all tests shall be made on the finished product. A deviation of ten (10) percent from the values shown in Table 943.02.01 will be allowed where tests are performed on samples taken from the finished product. Special molded and/or prepared specimens where required shall conform to the preparation requirements of the particular test involved.

3) Formulation, Prequalification, and Certification - All bearings furnished by the Contractor shall be produced by a bearing manufacturer who has previously submitted the required prequalification test samples and certifications and whose elastomer formulation has been

initially approved for use by the Engineer. Each elastomer formulation produced by a manufacturer must be approved by the Engineer prior to its first use on City projects. For a bearing manufacturer to prequalify and obtain initial approval of a particular formulation he shall submit to the Engineer well in advance of anticipated use of his product certified test results indicating actual test values obtained when the physical properties of the elastomer to be furnished were tested for compliance with the specifications involved. In the case of laminated bearings, one finished laminated bearing typical of the size and type to be subsequently furnished on City projects shall be submitted for prequalification testing. In addition, a non-laminated bearing of the approximate size of one layer of elastomer in the laminated bearing shall be furnished. The bearing manufacturer shall certify that all of the samples submitted are of the same basic elastomer formulation and of the equivalent cure of that to be used subsequently in the finished products to be furnished on City projects.

The Engineer may require that the complete testing procedure for prequalification purposes be performed again by the producer during later production should the Engineer feel such action appropriate.

Table 943.02.01 Elastomeric Material Properties

Hardness (Durometer)	50	60	70	80	90
Original Physical Properties					
Hardness ASTM D-2240	50 ±5	60 ±5	70 ±5	80 ±5	90 ±5
Tensile Strength, min psi [1]	2500	2500	2500	2500	2500
Elongation at Break, min %	450	400	300	150	100
Accelerated tests to determine term aging characteristics, Oven aged at 70 hrs at 212º F, ASTM D573					
Hardness, points change max	0 to +15	0 to +15	0 to +15	0 to +15	0 to +15
Tensile Strength % change	-15	-15	-15	-15	-15
Elongation at Break, % change max	-40	-40	-40	-40	-40
Ozone: 100PPHM in Air by Volume, ASTM D395, Method B					
20% strain at 100º+2ºF 2	No Cracks	No Cracks	No Cracks	No Cracks	No Cracks
Compression Set 22 hrs, % max	25	25	25	25	25
Low Temperature Resistance ASTM D746, Procedure B					
Brittleness, at –26ºC	No Failure	No Failure	No Failure	No Failure	No Failure

ADHESION: For limited bearings, bond between the elastomer and laminates will be qualitatively evaluated by the procedure outlined in the THD Manual of Testing Procedures, Test Method TEX-601-J.

1ASTM D-412, 2ASTM D-1149

* Samples to be solvent wiped before test to remove traces of surface impurities.

4) Manufacturing Requirements - All components of a laminated bearing shall be molded together into an integral unit. All edges of the non-elastic laminations shall be covered by a minimum of one-eighth (1/8) inch of elastomer except that exposure of the laminates will be permitted at approved laminate restraining devices and around holes that will be entirely closed in the finished structure. Unless shown otherwise on the plans all laminates shall be parallel with the bottom surface of the bearing, subject to the tolerances that follow.

   Plain bearings may be molded individually, cut from previously molded strips or slabs or extruded and cut to length. The finish of cut surfaces shall be at least as smooth as ASA #250 finish. The batch or lot number shall be marked on one side of each bearing in such a manner as to remain legible until the structure is completed. A batch is defined as the quantity of compound produced from each separate mixture of ingredients. A lot is defined as the quantity of compound resulting from the mixture of two (2) or more batches.

5) Appearance and Dimensions - Flash tolerance, finish, and appearance shall meet the

requirements of the latest edition of the "Rubber Handbook" as published by the Rubber Manufacturers Association, Inc., RMA F3-T.063 for molded bearings and RMA F2 for extruded bearings. For both plain and laminated bearings the permissible variation from the dimensions and configuration required by the plans and these specifications shall be as follows:

a) Overall Vertical Dimensions
   (i) Average Total Thickness 1 1/4 Inch or Less -0, +1/8 Inch
b) Average Total Thickness 1 1/4 Inch -0, +1/4 Inch
   (i) Overall Horizontal Dimensions +1/4 Inch
   (ii) Thickness of Individual Layers of Elastomer +1/8 Inch
c) Laminated Bearings Only
   (i) Variation from a Plane Parallel to the
      1. Theoretical Surface, 1/8 Inch
      2. Top, 1/4 Inch
      3. Sides, 1/8 Inch
d) Individual Non-Elastic Laminated (As determined by measurements at edges of the bearing)
e) Position of Exposed Connection Members 1/8 Inch
f) Edge Cover of Embedded Laminates or Connection Members -0, +1/8 Inch
g) Size of Holes, Slots, or Inserts -0, +1/8 Inch
h) Position of Holes, Slots, or Inserts 1/8 Inch
i) Thickness of Non-Elastic Laminates -0, +1/16 Inch

6) Routine Inspection, Sampling and Testing - After prequalification approval, one plain bearing and/or one laminated bearing will be taken by the Engineer from each project or from each batch or lot of elastomer compound in case the same batch is used for more than one project. These bearings will not be returned for use in the project. For laminated bearings only, each bearing shall be subjected by the manufacturer to an average compression of one thousand (1000) pounds per square inch of bearing area. The performance of each bearing will be considered satisfactory provided there is no visible evidence of bond failure or other damage to the bearing because of this loading.

7) Waterstops - Waterstops shall be furnished and installed in accordance with the details shown on the plans. Except where otherwise indicated on the plans waterstops may be manufactured from either natural (plain) or synthetic rubber or from polyvinyl chloride (PVC) as specified below:

a) Materials

   (i) Natural (plain) rubber waterstops shall be manufactured from a stock composed of a high grade compound made exclusively from new plantation rubber, reinforcing carbon black, zinc oxide, accelerators, antioxidants, and softeners. This compound shall contain not less than seventy-two (72) percent by volume of new plantation rubber.

   (ii) Synthetic rubber waterstops shall be manufactured from a compound made exclusively from neoprene or GRS, reinforcing carbon black, zinc oxide, polymerization agents, and softeners. This compound shall contain not less than seventy (70) percent by volume of neoprene or GRS.

   (iii) Physical properties of natural or synthetic rubbers for waterstops shall be as shown in Table 943.02.02.

   (iv) Unless specified otherwise on the plans the material for polyvinyl chloride (PVC) shall conform to the Corps of Engineers Specifications No. CRD-C-572-60.

Table 943.02.02 Physical Properties of Rubber for Waterstops		
	Natural (Plain) Rubber	Synthetic (Neoprene GRS) Rubber
Original Physical Properties:		
*Hardness ASTM Designation D-2240 (Durometer)	60 ± 5	55±5
Tensile Strength*, min psi ASTM Designation D-412	3500	2500
Elongation at Break, minimum point	550	425
Accelerated Tests To Determine Aging Characteristics**:		
**Either - after 7 days in air at 158°(±2°) F. (ASTM Designation D-573)		
Or - after 48 hours in oxygen (ASTM Designation D-572) at 158°(±2°) F. and 300 psi pressure Tensile Strength, % change max.		
	35	35
Elongation, % change, Maximum	35	--

8) Manufacturer's Certification - The manufacturer shall furnish certified test results indicating compliance with these specifications for each batch or lot of waterstop furnished under the contract. In case of doubt of the quality furnished, the burden of proof shall be on the manufacturer and the decision of the Engineer shall be final.

9) Manufacturing Requirements

a) Rubber Waterstops - Waterstops shall be manufactured with an integral cross section which shall be uniform within plus or minus one-eighth (1/8) inch in width, and the web thickness or bulb diameter within plus one-sixteenth (1/16) inch and minus one thirty-second (1/32) inch. No splices will be permitted in straight strips. Strips and special connection pieces shall be well cured in a manner such that any cross sections shall be dense, homogeneous, and free from all porosity. All junctions in the special connection pieces shall be full molded. During the vulcanization period the joint shall be securely held by suitable clamps. Field splices shall be either vulcanized, mechanical, using stainless steel parts, or made with a rubber splicing union of the same stock as the waterstop, at the option of the Contractor. All finished splices shall have a tensile strength of not less than fifty (50) percent of the unspliced material.

b) PVC Waterstops - Requirements shall be as in paragraph 3(a) above for rubber waterstops except that splicing of PVC shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations. A thermostatically controlled electric source of heat shall be used to make all splices. The heat shall be sufficient to melt but not to char the plastic.

c) Elastomeric Pads - When so specified on the plans, rail posts, rail members, metal shoes, or minor structural members shall be insulated, leveled, shimmed, or otherwise protected by elastomeric pads, sheets, or washers. Such bearings may be any elastomeric material, plain, fibered, or laminated, having a hardness (durometer) between seventy (70) and one hundred (100) as certified by the manufacturer to the Engineer. Acceptance testing will not be required.

d) Other Elastomeric Products - Other elastomeric products shall be in accordance with the requirements on the plans.

943.03 - CONSTRUCTION METHODS

A) Elastomeric Bearings - Unless shown otherwise on the plans, concrete bearing seats shall be float finished to the required elevation. Variation from a level plane shall not exceed one-sixteenth (1/16) inch within the limits of the bearing. After erection of the steel superstructure the horizontal

distortion of the bearings shall be measured, corrected for temperature and adjusted if necessary, so that the horizontal displacement between top and bottom of bearing at seventy (70) degrees F does not exceed fifteen (15) percent of the elastomer thickness. Welding in the vicinity of the bearings shall be done with care to avoid injury to the elastomer.

B) Waterstops - Field splices shall be either vulcanized, mechanical, using stainless steel parts, or made with a rubber splicing union of the same stock as the waterstop, at the option of the Contractor. All finished splices shall have a tensile strength of not less than fifty (50) percent of the unspliced material.

943.04 - METHOD OF MEASUREMENT

Unless specified otherwise on the plans elastomeric bearings used with prestressed concrete units, and other miscellaneous elastomeric materials will not be measured for payment but will be considered subsidiary to the various pertinent bid items in the contract.

Unless specified otherwise on the plans elastomeric bearings used in conjunction with steel superstructures will be measured by each elastomeric bearing of the type shown on the plans.

943.05 - BASIS OF PAYMENT

Payment for elastomeric bearings, measured as specified above will be at the unit price bid for each "Elastomeric Bearing" of the type specified.

ELASTOMERIC BEARING (TYPE) EA.

This price shall be full compensation for all materials, tools, equipment, labor, and for all incidentals, including anchor bolts and top plates, necessary to complete the work.

SECTION 944 - DRAINAGE CONDUITS

944.01 - DESCRIPTION

This section covers the conduit material to be used specifically for storm sewer and culvert construction. Conduits are considered to be either rigid or flexible and are categorized within the following subsections. This section supersedes any other material requirement within these specifications which conflicts with the intent of the material to be used specifically for drainage purposes.

944.02 - MATERIALS

A) Rigid Conduits - Materials covered in this Subsection: perforated pipe, reinforced concrete circular, elliptical, and arch pipe; precast reinforced concrete box sections, meeting the following requirements of the noted AASHTO Specification or the Equivalent ASTM Specification:

1) Concrete Culverts

   a) Reinforced Concrete Culvert, Pipe shall conform to AASHTO M 170 or M 170M (Metric).
   b) Reinforced Concrete Arch Culvert, shall conform to AASHTO M 206 or M 206M (Metric).
   c) Reinforced Concrete Elliptical Culvert, Pipe shall conform to AASHTO M 207 or M 207M (Metric).
   d) Reinforced Concrete D-Load Culvert, Pipe shall conform to AASHTO M 242 or M 242M (Metric).

2) Precast Box Sections for Culverts

   a) Precast Reinforced Concrete Box Sections for Culverts, shall conform to AASHTO M 259 or M 259M (Metric).
   b) Precast Reinforced Concrete Box Sections for Culverts, With Less Than 2 Feet of

Cover Subject to Highway Loadings shall conform to AASHTO M 259 or M 259M (Metric).

B) Flexible Conduits - Materials covered in this Subsection: steel conduits, coated and clad steel conduits, aluminum conduits, and clad aluminum conduits, meeting the following requirements of the noted AASHTO Specification or the Equivalent ASTM Specification:

1) Steel Conduits-Culverts

a) Metallic (Zinc or Aluminum) Coated, Corrugated Steel Culverts and Underdrains shall conform to AASHTO M 36.

b) Sheets for Culverts - Zinc coated (Galvanized) steel sheets for culverts and underdrains shall conform to AASHTO M 218. Steel sheet, aluminum-coated (type 2) by the hot-dip process for sewer and drainage pipe shall conform to AASHTO M 274. Aluminum-zinc alloy coated sheet steel for corrugated steel pipe shall conform to AASHTO M 289.

c) Externally Coated or Clad Culverts

d) Precoated Galvanized Steel Culverts and Underdrains shall conform to AASHTO M 245 or M 245M (Metric) or steel sheet, metallic-coated and polymer precoated for corrugated steel pipe conforming to AASHTO M 246 or M 246M (Metric).

2) Aluminum Conduits-Culverts

a) Corrugated Aluminum Alloy Culverts and Underdrains shall conform to AASHTO M 196. If bituminous coating is specified it shall be type A coating unless type B or type C coating is specified, meeting the requirements of AASHTO M 190.

b) Clad Aluminum Alloy Sheets for Culverts and Underdrains shall conform to AASHTO M 197.

3) Steel Conduits-Underdrain

a) Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrain shall conform to AASHTO M 36.

b) Sheets for Underdrain shall conform to AASHTO M 36 (see Subsection (B) 1.1.1)

c) Types - Underdrain shall be furnished in type III pipe with Class I perforations unless otherwise specified on the Plans. Minimum thickness shall be 0.052 inch for 6 inch diameter and .064 inch for all other diameters.

d) Externally Coated or Clad Underdrains - When called for on the Plans, underdrain shall be furnished clad, meeting the requirements of AASHTO M 245 or M 245M (Metric).

4) Aluminum Conduits-Underdrains

a) Corrugated Aluminum Alloy Culverts and Underdrain shall conform to AASHTO M 196. If bituminous coating is specified, it shall be type A coating unless type B, type C or type D is specified, meeting the requirements of AASHTO M 190.

b) Clad Aluminum Alloy Sheets for Culverts and Underdrains shall conform to AASHTO M 197.

c) Types - Aluminum underdrains shall be furnished in type III pipe with Class I perforations unless otherwise specified on the Plans. Thickness shall be .060 inch for all sizes.

SECTION 945 - REINFORCED CONCRETE PIPE

945.01 - DESCRIPTION

This section covers specifications for reinforced concrete pipe.

945.01.01 - GENERAL

Concrete pipe is acceptable only in diameters of eighteen (18) inches and greater. All concrete pipe shall be reinforced concrete sewer or culvert pipe and shall be machine made pipe and shall be steam cured in accordance with ASTM Specifications. Concrete pipe forty-eight (48) inches and smaller shall be tested by the three (3) edge bearing method and conform to ASTM Designation C-76-82 and subsequent revisions thereto. Concrete pipe fifty-four (54) inches and larger shall be tested in accordance with ASTM Specifications C-42 or as directed by the Engineer. Pipe manufacturing equipment and pipe quality shall be approved by the Engineer, and meet these specifications.

Reinforced concrete standard-strength and extra-strength culvert pipe shall conform to ASTM Specifications Designation C-76-60 and any subsequent revisions thereof, together with requirements of the special provisions and these specifications and specific requirements and modifications thereof hereinafter designated.

945.01.02 - CLASS

Pipe manufactured according to these specifications shall be of two (2) classes known respectively as "Standard Strength Reinforced Concrete Culvert Pipe" and "Extra Strength Reinforced Concrete Culvert Pipe".

945.04 - JOINT REINFORCEMENT

Section 16, ASTM Designation C-76-82 Specifications shall be modified as follows: Joints shall conform to Section 3.3 of AWWA C-302-57

945.05 - COMPRESSION TEST CYLINDERS OF CONCRETE FOR CONCRETE PIPE

Section 26, ASTM C-75-55 Specifications shall be expanded as follows: When strength of concrete pipe is determined from six (6) inch by twelve (12) inch test cylinders in accordance with "Test for Compressive Strength of Molded Concrete Cylinders" (ASTM C-39-49), there shall be furnished by the Contractor not less than four (4) cylinders for testing for each fifty (50) joints of pipe.

Section 27, ASTM Designation C-76-82 Specifications shall be expanded as follows: Specifications under Section 304 with respect to number of cylinders to be tested, ordering of tests by the Engineer, manner of collecting test cylinders and requirements regarding seven (7) day and twenty-eight (28) day tests shall apply to this section.

The Engineer may order at any time additional test specimens be prepared and tested should there be a change in the concrete design mix, aggregates or from any cause which might affect the strength or absorptive qualities of the concrete pipe. Two (2) cylinders shall be tested for compressive strength at age of seven (7) days and two (2) cylinders at age of twenty-eight (280 days. One (1) of the cylinders in each age group shall be tested for absorption before being tested for compressive strength. Before being tested for compression the cylinder used for the absorption test shall be thoroughly dried.

Test cylinders shall be molded in a manner similar to that of placing the concrete in the pipe forms, insofar as possible, with particular reference to tamping, packing, and vibrating. For pipe manufactured by the field cast method test molds shall be welded or solidly attached to the pipe forms so that vibration of the specimen will be the same as that of the pipe form.

In the event the cylinders tested for compressive strength at the age of seven (7) days do not show strength of eight (80) percent of the required twenty-eight (28) day strength for pipe made using high early cement and seventy-five (75) percent of the required twenty-eight (28) day strength for pipe made using standard Portland Cement, the pipe represented by these tests will be held in storage until the results of the twenty-eight (28) day cylinder tests are known.

SECTION 946 - METAL PIPE

946.01 - GENERAL

Metal pipe meeting the requirements these specifications may be used as approved by the City Engineer.

946.02 - CORRUGATED STEEL PIPE

Corrugated steel pipe (CSP) manufactured in accordance with the latest AASHTO M-36 specification and designed according to AASHTO design requirements shall be an acceptable pipe material for culverts, storm drains, and sanitary sewers. The following types of CSP shall be acceptable based on appropriate hydraulic and durability considerations;

Culverts and Storm Drains

A) Galvanized per AASHTO M-218.
B) Bituminous coated per AASHTO M-190.
C) Aluminized per AASHTO M-274.
D) Polymeric coated per AASHTO M-245.

Pipe ends shall have a minimum of two reformed annular corrugations to accommodate connecting bands. Connecting bands shall be of the hugger type and shall be designed to accommodate "O" ring gaskets when required. Connecting bands shall meet the performance criteria set forth in Section 23 of AASHTO Standard Specifications for Highway Bridges. Dimpled bands will not be allowed except by special permission of the Engineer.

Flared metal end sections shall be considered as an acceptable method of end treatment.

946.03 - METAL END SECTIONS

This section covers the specifications for metal end sections to be attached to the inlet and outlet ends of pipe and Pipe-Arch culverts.

The materials used in the fabrication of end sections shall conform to the applicable requirements of AASHTO Specification M-36.

End sections shall be fabricated in accordance with the details and dimensions shown on the plans, except that minor variations may be accepted to permit the use of the manufacturer's standard methods of fabrication.

946.04 - SLOTTED DRAIN PIPE

Slotted drain shall be considered an acceptable material to collect surface drainage in such application as curb inlets, median or berm drains and pavement or parking lot drainage.

Slotted drain shall be of the diameter and gauge detailed on the plans and shall be made from pipe fabricated in accordance with the applicable provisions of Section 14, Welded Seams of AASHTO Designation M-36. Pipes shall be joined together by means of a Hugger-type coupling band that will provide soil tightness and when installed shall provide a maximum gap between ends of grating of not more than one (1") inch.

The grating shall have a one and three-fourths (1 3/4) inch wide opening and shall be comprised of two (2) vertically spaced bearing members, substantially normal to the axis of the pipe section. It shall extend longitudinally the length of the slot and shall be hot dip galvanized in accordance with ASTM A-123. The bearing members shall be joined by solid web spacers not more than six (6) inches center to center longitudinally. The spacers shall be substantially normal to the vertical bearing members and substantially at the neutral axis of the pipe section wall. They shall extend the full depth of the grating section except for a three-sixteenths (3/16) inch recess to accommodate an expanded wire mesh if called for in the plans. They shall be of sufficient thickness and shall be welded to the vertical bearing member in such a manner as to maintain structural continuity across the throat of the open slot.

SECTION 947 - CASTINGS FOR STORM SEWER MANHOLES AND INLETS

947.01 - GENERAL REQUIREMENTS

This section covers requirements for manhole frames and covers, sewer inlet frames and gratings for manholes and inlets if required. All castings shall conform strictly to the standard design or designs designated, or to special designs when required. Casting shall be of cast iron or cast steel as designated. Castings shall be free from pouring faults, sponginess, cracks, blow holes and other defects in locations affecting the strength and value of the casting for the service intended and shall be filleted at angles and the rises shall be sharp and true. All castings shall be free from warp and shall be true to the shape and dimension required. Surfaces shall be machined where indicated or where otherwise necessary to secure flat true surfaces. All covers, gratings, etc., fitting into frames shall fit properly and set uniformly and solidly.

Where weight is specified or shown on the plans castings shall conform to such requirements.

947.01 - QUALITY

A) Steel Castings - Steel castings shall conform to the requirements of the "Standard Specifications for Steel Castings" (Serial Designation A-27-55) of the ASTM and subsequent revisions thereof. Steel castings shall be Class "B", Grade U-60-60, unless otherwise specified.

B) Gray Iron Castings - Iron castings shall conform to the "Standard Specifications for Gray Iron Castings" (ASTM Designation A-48-48) and subsequent revisions thereof. Iron castings shall be equal to or better than Class No. 30.

947.03 - BOLTS, RIVETS, ETC.

Accessories such as bolts, rivets, spacers, small I-beams, channels, plates, etc., used for the assembling or supporting gratings in multiple grating sewer inlet installations shall be first quality standard commercial materials free of defects which affect their value for the service intended. Steel shapes, plates, and bars covered under this section shall comply with requirements of Tentative Specifications for Steel Bridges and Buildings, ASTM Designation A-36 or A-709.

Rivet steel shall conform to Tentative Specifications for Structural Rivet Steel, ASTM Designation A-502-76, grade 1.

Certified copies of mill tests of bolts, rivets, and metal used in structural shapes, herein specified, shall be furnished by the manufacturer if requested by the Engineer. Any defects appearing upon delivery or installation of material covered in this section in such degree as to affect the strength or quality of the work shall be cause for rejection and such material shall be replaced by the Contractor as ordered by the Engineer.

SECTION 948 – PAINT FOR STRUCTURAL STEEL

948.01 – GENERAL REQUIREMENTS.

This Section covers the various types of paint used to protect structural steel.

948.01.01 - CERTIFICATION

For each shipment of paint, furnish a Type C certification in accordance with Section 109, for each lot of each paint. For a paint system to be considered for inclusion on the list of approved products, the paint manufacturer shall submit a Type A certification showing satisfactory test results from an approved testing laboratory.

The certification shall include

A) The Manufacturer' S Name,
B) System Performance
C) Test Results And

D) Dates

The Certification will also show the following for each paint:

A) Test Results And Dates,
B) Brand Name,
C) Lot Number, And
D) Date Of Manufacture.

New certification shall be required if any of the following conditions occur:

A) the manufacturing process or paint formulation is changed,
B) testing indicates nonconformance to the Specifications, or
C) the certification is older than 5 years.

A 1-gallon (4 liter) sample of each component in a paint system may be required by the Engineer for testing purposes. In case of variance, the Department' s test results will govern. Failure to meet Specification requirements will be grounds for removal from the list of approved products. The Department reserves the right to suspend approval of products if paint system performance is unsatisfactory (i.e., the paint has poor durability or appearance).

948.01.02 – SYSTEM PERFORMANCE.

Paint shall be evaluated according to Performance Class. The performance of the coating system shall be measured using test panels. These test panels shall be coated with all required paint coats. Each coat shall be applied as specified.

A) ***Performance Class 1.*** Performance Class 1 coating systems shall be tested as follows: Three test panels shall be made for each of the specified tests; the test panels shall be prepared as described in AASHTO M300; and, where applicable, blistering shall be rated by ASTM D714.

1) ***Fresh Water Resistance.*** Fresh water resistance testing shall conform to the requirements of ASTM D870. Panels shall be scribed in accordance with AASHTO M300 for Salt Fog Resistance and then immersed in fresh tap water at 75±5°F (24 ± 3° C). After 30 days of immersion, the panels shall not show any rusting, nor shall the coating show any blistering, softening, or discoloration.

2) ***Salt Water Resistance.*** Salt water resistance testing shall conform to the requirements of ASTM D870. Panels shall be scribed in accordance with AASHTO M300 for Salt Fog Resistance and then immersed in a solution of water and 5% sodium chloride at 75±5°F (24 ± 3° C). After 30 days of immersion, the panels shall not show any rusting, nor shall the coating show any blistering, softening, or discoloration. Panels shall be rated at 7, 14, and 30 days. The saline solution shall be replaced with fresh saline solution after the 7 and 14 day examinations.

3) ***Salt Fog Resistance.*** Panels shall be tested as described in AASHTO M300 for Salt Fog Resistance except that the exposure will be 2,500 continuous hours.

4) ***Weathering Resistance and Specular Gloss.*** Weathering resistance testing shall conform to the requirements of ASTM D4587, Method D, utilizing UVA 340 bulbs. Testing of the panels shall start at the beginning of a wet cycle. After 3,000 hours continuous exposure, the coating shall not show any blistering or loss of adhesion, nor shall the panels show any rusting. The 60° specular gloss measurements shall be performed on the sprayed panels utilized for the weathering resistance test. The initial specular gloss measurements (one from each panel) shall be averaged together. The final specular gloss measurements shall also be averaged together.

5) ***Elcometer Adhesion Test.*** Elcometer adhesion testing shall conform to the requirements of ASTM D4541. The panels shall be tested using an adhesion tester 1000 psi (6.9 MPa) in accordance with the following: the coating surface and aluminum dolly shall be lightly sanded and a quick-set adhesive applied; the adhesive is cured overnight; the coating and

adhesive around the dolly is scribed before testing; and a minimum of three trials is made and reported. For a paint to be acceptable, each trial must have adhesion of 400 psi (2.76 MPa) or more and show no evidence of fracture at the primer-blast interface.

B) **Performance Class 2.** Performance Class 2 coating systems shall be tested as follows: Three test panels shall be made for each of the specified tests; the test panels shall be prepared as described in AASHTO M300. Where applicable, blistering shall be rated by ASTM D714 and rusting in accordance with ASTM D610.

1) ***Salt Fog Resistanc***e. Panels shall be tested as described in AASHTO M300 for Salt Fog Resistance except that the exposure will be 1,000 continuous hours.

2) ***Prohesion.*** Panels shall be tested for 2,000 hours in accordance with ASTM G 85, Appendix A5. The electrolyte solution for the cyclic fog/dry test shall consist of a Timmins solution: 0.40 wt% (NH 4) 2 SO 4 with 0.05 wt%NaCl. The temperature shall be maintained at 100°F (38°C) during the fog/dry cycles. Any test panels having rust spots, blisters, or undercutting at the scribe will be considered a failure.

3) ***Fluorescent UV.*** Test for 2,000 hours in accordance with ASTM G53 (8 hours UV at 160°F (71°C) followed by four hours condensation at 120°F(49°C)). Any test panels with rust spots, blisters, or undercutting at the scribe will be considered a failure. Additionally, the paint system shall have at least three years of satisfactory performance (less than 1% of the painted surface shows visible rust, rust breakthrough, paint blistering, peeling, or scaling) in a bridge environment. Case histories from at least five bridge projects shall be included in the Type A certification data.

C) **Containers and Labeling.** All paint furnished under these Specifications shall be supplied in strong, tight, approved containers. Each container shall be labeled with the manufacturer' s name, paint type, Volatile Organic Compounds (VOC) content, date of manufacture, lot number, mixing instructions, and equipment cleanup instructions. Labels shall be sufficiently weather resistant to withstand one year of outdoor storage exposure without deterioration or fading. If not affixed to the paint containers, Material Safety Data Sheets and Product Data Sheets shall be supplied with each paint shipment. Copies of both sheets shall be posted on the project site and submitted to the Resident Engineer prior to painting.

D) **Toxic Substance Restriction.** Lead paint, or similar coatings containing lead or lead compounds, in which the lead content (calculated as lead metal) is in excess of 0.19% by mass of the total nonvola-tile content of the paint or the mass of the dried paint film shall not be used on Department projects. Paints containing asbestos or containing leachable hazardous elements in the dry paint film exceeding the limits shown below when tested using the Toxicity Characteristic Leaching Procedure (TCLP), 40 CFR 261, "Identification and Listing of Hazardous Waste ," shall not be used on Department projects. The TCLP test shall be included in the Type A certification.

Arsenic, ppm	5.0
Barium, ppm	100.0
Cadmium, ppm	1.0
Chromium, ppm	5.0
Lead, ppm	5.0
Mercury, ppm	0.2
Selenium, ppm	1.0
Silver, ppm	5.0

A) **VOC Limitation.** The maximum permissible Volatile Organic Compound (VOC) level in any paint used for Department projects shall be 2.9 lb/gal (350 g/l) as thinned for application. VOC is defined as any organic compound which has a vapor pressure of .0019 psi (13 Pa) absolute or greater at standard condition. Lower VOC limits may be specified in the plans depending on project location. When shop painting is done, be aware that VOC regulations could be stricter than required by the Department. The Contractor shall comply with the most severe VOC regulations applicable.

B) **Color.** Unless otherwise specified on the plans, the color of the coatings shall be as follows: the topcoat shall be light gray, Federal Standard No. 595A-16440, except for weathering steel, in which case the topcoat shall be dark brown, Federal Standard No. 595A-10075. The primer and intermediate-ate coats shall be colored so that each layer is clearly distinguishable from the other.

948.02 – REQUIREMENTS FOR PAINT SYSTEMS.

Inorganic Zinc/Epoxy/Urethane (IZ-E-U) System. The IZ-E-U system shall comply with the system performance requirements for Performance Class 1. This system shall produce a tough, durable film of minimum 9 mils (230 µm) dry film thickness, each coat well bonded to the previous layer. Prepare each surface and apply paint in such a manner to assure bonding of each coat. Cure each coat according to the manufacturer' s recommendations prior to further coating. The dry film thickness of an individual coat shall be within -0.5/+2.0 mils (-15/+50 µm) of the specified coat thickness.

A) ***Inorganic Zinc-Rich (IZ) Primer.*** The first coat shall be an IZ primer conforming to the requirements of AASHTO M300, Type IA and the following: the primer shall have a Class B classification, with a minimum slip coefficient of 0.50, as tested by the "Test Method to Deter-mine the Slip Coefficient for Coatings Used in Bolted Joints" from the Research Council on Structural Connections. (See Appendix A of Allowable Stress Design Specification for Structural Joints Using ASTM A325 or A490 Bolts, published by the Research Council on Structural Connections.) Immediately prior to the application of the IZ primer, prepare the steel surface by the Steel Structure Painting Council' s preparation specification SSPC-SP10, Near-White Blast Cleaning. For new steel, the surface profile shall be 1 to 3 mils (25 to 75 µm) as determined by ASTM D4417, Method A, B, or C. For new structural steel, the IZ primer shall be applied in the shop. The dry film thickness of the IZ primer shall be 3 mils (80 µm).

B) ***Epoxy (E) Intermediate Coat.*** The epoxy-polyamide paint intermediate coat shall be applied over IZ primer-coated steel in plan position on the project and shall conform to the following requirements:

Epoxy (E) Intermediate Coat

Pot Life 4 hours, minimum SSPC Paint 22, Para. 5.5
Dry Through Time, 75°F (24°C), 45%R.H. 24 hours, maximum ASTM D 1640
Fineness of Grind, Hegman Units 3.0, minimum ASTM D 1210
Solvent Resistence (see test method) SSPC Paint 22, Para. 5.6
Test Panels (see test method) SSPC Paint 22, Para. 5.7
Elcometer Adhesion Test (see test method) SSPC Paint 22, Para. 5.8
Salt Spray Resistance (see test method) SSPC Paint 22, Para. 5.9
Dry Film Thickness 4 mils(100µm)

C) ***Urethane (U) Topcoat.*** The two-package, aliphatic urethane paint top coat shall conform to the requirements of the most recent edition of the Steel Structures Painting Council SSPC-PS Guide No. 17.00. The paint shall have a minimum 2-hour usable pot life at 77°F (2? ?C), and a maximum 4-hour dry-to-touch time at 77°F (2? ?C). The U topcoat shall be applied over E intermediate coat. The urethane topcoat also shall conform to the following requirements:.

Urethane (U) Topcoat

Characteristic	Value	Test Method
Solids by weight	67%, minimum	ASTM D 1644
Solids by volume	54%, minimum	ASTM D 1644
Specular Gloss,		ASTM D 4587, Method D
60° 85% minimum after drying, 70% minimum after 3,000 hours of weathering resistance testing		
Dry Film Thickness	2 mils(50 µm)	See ODOT Subsection 512.04(b)4

Single-Component Moisture-Cured Urethane (SC-MC-U) System. The SC-MC-U system shall

comply with the system performance requirements for Performance Class I. This system shall pro-duce a tough, durable film of minimum 10 mils (0.25 mm) film thickness, each coat well bonded to the previous layer. Prepare each surface and apply paint in such a manner to assure bonding of each coat. Cure each coat according to the manufacturer' s recommendations prior to further coating. The dry film thickness of each coat shall be within -0.5/+2.0 mils (-15/+50 µm) of the specified coat thickness. The first coat shall be either a zinc-rich or zinc/MIO primer. The primer shall be formulated with other synthetic or natural MIO. If approved, the primer may be two component. The intermediate coat and topcoat shall be formulated with natural micaceous iron oxide (MIO). The MIO intermediate coat shall be a SC-MC-U paint. The topcoat shall be a MIO-based SC-MC-Aliphatic-U paint. The SC-MC-U paint coats shall be formulated as follows:

	Zinc-Rich Primer	**Zinc/MIO Primer**	**MIO Intermediate Coat**	**MIO Topcoat**
Minimum Zinc Powder (mixed paint)	78% by weight	--	--	--
Minimum MIO Content	--	--	4lb/gal	--
Minimum Solids (mixed paint)	60% by volume	60% by volume	60% by volume	53% by volume
Pigment Type	zinc dust	zinc dust & MIO	--	--
Minimum Weight/Volume (mixed paint)	23 lb/gal	19 lb/gal	12 lb/gal	11 lb/gal
Minimum Zinc Content (dry film)	86% by weight	--	--	--
Dry Film Thickness	3.5 mils	3.5 mils	3.5 mils	3 mils

(c) **Repair Paint Systems.** The coating system for Category R applications as defined in Section 408.04.13 shall comply with Performance Class 2 requirements. The system may be comprised of one to three coats, but one coat systems may only be used when permitted in the plans.

SECTION 950 - MISCELLANEOUS WATER LINE MATERIALS

950.01 - BOLTS AND NUTS

All bolts used in underground fittings, flanges, hydrant risers, tapping sleeves and other underground locations shall be sherardized iron machine bolts or an equal quality, with hexagon nuts. Bolts for mechanical joints shall be high tensile strength cast iron, ACIPCO Ni-Resist, stainless steel, silicon bronze, or Corten steel, or an approved equal. Bolts and nuts installed for underground service shall have one of the following protective coatings in accordance with the manufacturer's instructions:

A) Texaco Rust Proof Compound "L"

B) NO-OX-ID "A"

C) Biturine #7105, Solution No. 5

D) Inertol 49

E) Hot Coal Tar Enamel, in accordance with AWWA Standard C-203-66

SECTION 960 - SEWER JOINT MATERIALS

960.01 - VITRIFIED CLAY OR CONCRETE PIPE JOINT MATERIALS

A) General - Jointing materials for vitrified clay or concrete pipe may consist of the materials hereinafter described. The type of materials to be used for each class of work to be in conformance

with these specifications. All bituminous joint materials shall adhere thoroughly to cold, vitrified clay or concrete pipe, be dense and resistant to root penetration, be chemically inactive to acids, alkalis and solvents found in sewage and sufficiently elastic and cohesive so that a slight movement of the pipe will not cause joint defects. The material shall set quickly so that backfilling may be completed promptly and, except in the case of plastic material, shall be strong enough to permit making joints outside the trench and to resist not less than fifteen (15) pounds hydrostatic pressure. Materials shall contain no filler which might settle out. All bituminous materials for joints shall be used as recommended by the manufacturer except as otherwise directed by the Engineer.

B) Compression Joints - shall comply with the requirements of ASTM C-425-77 or the latest revisions thereof.

960.02 - CAST IRON PIPE JOINT MATERIAL

A) Jute - Joint packing shall be of the best quality long fiber, clean, dry jute, either square braided or hard twisted, or an approved substitute acceptable to the Engineer. Unless otherwise permitted by the Engineer, all braided or hard twisted joint packing shall be not less than one-half (1/2) inch in size.

B) Lead - Lead used for filling bell and spigot joints shall be of the best quality soft pig lead, suitable for caulking and securing tight permanent joints and shall conform to the requirements of Federal Specification QQ-L-156, "Lead; Caulking".

C) Sulphur Jointing Compound - Sulphur compound for use in filling bell and spigot joints shall be of an approved make, brand and quality of established reputation such as "Leadite" or its equal. The compound shall be composed principally of an intimate mixture of sulphur, silica and lampblack. The silica may be either in silica sand or in ground crystalline silica form. Any other ingredients incorporated in the compound shall be of such nature that when exposed to the action of water, air or earth, they will have no deleterious physical or chemical effect on the joint compound or the pipe in which the compound is used. All joint compound shall be of a make, type and composition which has been in successful use in service similar to that which will be encountered in this work.

D) The manufacturer's recommendations for melting, manipulating and completing the joint with the sulphur compound, will be strictly followed.

960.03 - REINFORCED CONCRETE CULVERT PIPE JOINTS

Section 16, ASTM Designation C-76-60 Specifications shall be modified as follows: Joints shall conform to Section 3.3 of AWWA C-302-57

960.04 - JOINTS ON OTHER PIPE MATERIALS

Joints on other pipe materials conforming to appropriate ASTM Specifications and approved by the Engineer may be used.

SECTION 961 - POLYVINYL CHLORIDE SEWER PIPE

961.01 - DESCRIPTION

This section covers PVC Plastic Sewer Pipe intended to be used for the conveyance of sewage and industrial wastes.

961.02 - GENERAL

Polyvinyl Chloride sewer pipe, referred to hereinafter as PVC Plastic, shall conform to the requirements of ASTM Standard D-3034-73a and any subsequent revisions thereof together with requirements of special provisions and revisions contained in these specifications.

961.03 - MINIMUM BEDDING REQUIREMENTS

PVC plastic sewer pipe shall be embedded in accordance with the provisions of the "Standard

Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe".

To assure compliance, all PVC plastic pipe shall be inspected for deflection by pulling a sphere, cylinder, or other acceptable measuring device through the pipe. The maximum allowable pipe deflection for completely backfilled non-rigid sewer pipe shall not exceed five (5) percent of the nominal internal diameter.

961.04 - TYPE DESIGNATION

Unless specifically authorized by the Engineer, only Type PSM-35 PVC sewer pipe shall be considered as meeting the requirements of these specifications.

SECTION 962 - DUCTILE IRON PIPE

962.01 - DESCRIPTION

This section covers Ductile Iron Pipe intended to be used for the conveyance of sewage and industrial waste.

962.02 - GENERAL

Ductile Iron Pipe shall conform to the requirements of USASI A21.51 together with requirements of these specifications.

962.03 - MINIMUM BEDDING REQUIREMENTS

Class C bedding as outlined in Chapter 9, "Structural Requirements", Section D, pages 211 and 212, WPCF Manual of Practice No. 9, 1970, shall be used unless otherwise noted on construction plans.

962.04 - PROTECTIVE COATING - INTERIOR AND EXTERIOR

Ductile Iron Pipe shall be coated inside and out with standard coal tar pitch varnish for water service and conform to Federal Specification, WW-p-421a Pipe, "Water, Cast Iron (Bell and Spigot)".

SECTION 970 - TRAFFIC MATERIALS

Refer to Section 700 for specific specifications on items. All specifications shall apply to all projects with Section 700 items.

SECTION 971 - ADA COMPLIANT TACTILE WARNING

971.01 - DESCRIPTION

This section covers specifications for ADA compliant tactile warning surfaces

971.02.01 - ADA COMPLIANT TACTILE WARNINGS – PRE-FORMED MODULAR CONCRETE

A. Compressive Strength when tested by ASTM-D 695-91 shall be 10,000 PSI minimum.
B. Slip Resistance when tested by ASTM-C 1028 combined wet / dry friction coefficient shall be 0.70 on top of domes and remaining areas.
C. Color of cured material shall provide a minimum of 70% contrast with surrounding surfaces (light on dark or dark on light) as determined by:

$$\text{Contrast} = \frac{B_1 - B_2}{B_1} \times 100$$

where:

B1 – light reflectance value (LRV) of the lighter area

B2 – light reflectance value (LRV) of the darker area.

971.02.02 ADA COMPLIANT TACTILE WARNINGS – SURFACE APPLIED MATS

A. Tensile Strength of Matt when tested by ASTM-D412 shall be 1,100 PSI minimum.
B. Slip Resistance of Matt when tested by ASTM-C1028 combined wet / dry friction coefficient shall be 0.70 on top of domes and remaining areas.
D. Color of cured material shall provide a minimum of 70% contrast with surrounding surfaces (light on dark or dark on light) as determined by:

$$\text{Contrast} = \frac{B_1 - B_2}{B_1} \times 100$$

where:

B1 – light reflectance value (LRV) of the lighter area

B2 – light reflectance value (LRV) of the darker area.

Tactile warning surfaces that are stamped into the sidewalk or ramp surface, when wet, are not allowed.

SECTION 981 - STONE FOR MASONRY AND RIPRAP

981.01 - MATERIALS COVERED

This section covers stone for Ashlar Masonry, Mortar Rubble Masonry, Dry Rubble Masonry, Plain Riprap, Laid Up Riprap or Grouted Riprap, precast concrete blocks for Laid Up Riprap or Grouted Riprap, stone for Special Plain Riprap and material for Filter Blanket.

981.02 - ASHLAR STONE

The stone shall be tough, dense, sound, and durable, resistant to weathering action and shall be free from seams, cracks, or other structural defects. Preferably, stone shall be from a quarry the product of which is known to be of satisfactory quality. Stone shall be of such character that it can be wrought to such lines and surface, whether curved or plain, as may be required. Any stone having defects which have been repaired with cement or other material shall be rejected.

The individual stones shall be large and well proportioned. They shall not be less than twelve (12) inches or more than thirty (30) inches in thickness.

981.03 - RUBBLE STONE

Stone for mortar rubble or dry rubble masonry shall be of approved quality, sound and durable, free from segregations, seams, cracks, and other structural defects or imperfections tending to destroy its resistance to the weather. Stone for mortar rubble shall be reasonably free from rounded, worn or weathered surfaces and weathered stone shall be rejected. Selected stones with flat faces as nearly parallel as practicable shall be used.

Individual stones shall have a thickness of not less than four (4) inches and a width of not less than one and one-half (1 1/2) times the thickness. No stones, except headers, shall have a length less than one and one-half (1 1/2) times their width.

981.04 - RIPRAP STONE

Stone for riprap shall be hard, sound and durable and shall be approved by the Engineer prior to use. Samples of the stone to be used shall be submitted to and approved by the Engineer before any stone is used.

Tests for weight and absorption will be determined in accordance with ASTM C-97. The minimum weight shall be one hundred-forty (140) pounds per cubic foot and the maximum absorption shall be six

(6) percent.

The size of stone for the various kinds of riprap shall be as follows:

TABLE 981.04.01 Stone for Plain Riprap			
Riprap Thickness	**Maximum**	**Average Size**	**20 Percent Shall Weigh Less Than**
Inches	Pounds	Pounds	Pounds
12	150	30-50	20
18	350	70-125	30
24	1000	225-400	40
30	1000	225-400	40

When placed on the embankment the smaller stones shall be well distributed throughout the mass. Neither the breadth nor the thickness of any piece of riprap shall be less than one-third (1/3) of its length.

TABLE 981.04.02 Stone for Laid Up or Grouted Riprap		
12 Inch Thick:	Size of Stone 50 to 250 lbs.	with at least 60% weighing 100 lbs. or more
18 Inch Thick:	Size of stone 50 to 500 lbs.	with at least 60% weighing 150 lbs. or more

Slabs or sliver will be rejected. Spalls shall be well graded, of a suitable size for the work.

TABLE 981.04.03 Stone for Special Plain Riprap	
40 to 60 Percent	– 5 cf to 12 cf volume
5 to 15 Percent	– may be less than 0.25 cf in volume

981.05 - PRECAST CONCRETE BLOCKS

Precast concrete blocks for laid up riprap or grouted riprap shall have a vertical dimension of six (6) to eight (8) inches, a horizontal dimension of from eight (8) to sixteen (16) inches, and a dimension perpendicular to the slope of the wall of nine (9) inches.

Cement sand blocks will be permitted when composed of one (1) part cement to three (3) parts approved clean sand by volume.

981.06 - FILTER BLANKET MATERIAL

Material for a filter blanket shall consist of sand, gravel, crushed stone, or other approved materials processed, blended, or naturally combined. It shall be reasonably free from lumps or balls of clay, organic matter, objectionable coatings, or other foreign materials, and shall be durable and sound. Blanket material shall be reasonably free from flat and/or elongated particles in an amount exceeding twenty (20) percent. A flat or elongated piece is one where the length is greater than five (5) times the average thickness. The backing material in place shall be reasonably well graded within the following limits:

TABLE 981.06.01 Filter Blanket Material

Single Course Backing (Filter Blanket)		
Sieve Designation, U.S. Standard	Percent by Weight	
Square Mesh (Inch)	Passing	
4	100	
2	60-90	
1	40-70	
08-Mar	15-40	
No. 4	0-15	
Two Course Backing (Filter Blanket)		
Sieve Designation, U.S. Standard	Lower Course of 2 Layers	Upper Course of 2 Layers
Square Mesh (Inch)	Percent by Weight Passing	
6	-	100
4	-	90-100
2	-	65-85
1	-	40-70
3/8	100	15-35
No. 4	95-100	0-10
No. 8	80-90	-
No. 16	55-75	-
No. 30	30-60	-
No. 50	12-30	-
No. 100	0-10	-

SECTION 982 - METALS FOR GUARD RAIL AND FENCE

982.01 - DESCRIPTION

This section covers the requirements for metals for guard rail, bridge rail and fence.

982.02 - METAL BEAM RAIL STEEL

A) Beams - Corrugated steel beams shall conform to the requirements of AASHTO M180 for the gauge specified and modified to include sheet made with a basic oxygen furnace.

B) Posts - Steel posts and base plates shall be of the section and length as specified or as shown on the plans. Steel shall conform to the requirements of AASHTO M-183. Galvanizing shall conform to the requirements of AASHTO M-111.

C) Guard Rail Hardware - Offset brackets of the resilient and non-resilient types shall be of the type specified or as shown on the plans and shall meet the strength requirements specified.

Splices and end connections shall be of the type and design specified or shown on the plans and shall be of such strength as to develop the full design strength of the rail elements.

End spring assemblies, when specified, shall be positive and of a type and design coinciding with the intent, design and strength of the railing structure and shall be as specified or as shown on the plans.

End anchor rods and accessories shall be as specified or as shown on the plans and shall be of such size and strength as to develop the full design strength of the rail elements.

Unless specified otherwise all fittings, bolts, washers and other accessories shall be galvanized

in accordance with the requirements of AASHTO M-111 or M-232 whichever may apply. All galvanizing shall be done after fabrication.

982.03 - METAL BEAM RAIL - ALUMINUM

A) Aluminum Beam Guard Railing and Fittings - The rail element shall be aluminum alloy 2024 T3 Sheet, ASTM B-209. The thickness of aluminum shall be as shown on the plans. All bolts shall be aluminum alloy 2024 T4, ASTM B-211. Bolt head and thread dimensions shall conform to the standard drawings. All nuts shall be aluminum alloy, 6262 T9 and shall be made from rod conforming to ASTM B-211. Nut and thread dimensions shall conform to the standard drawing.

B) Aluminum Alloy Guard Rail Post - Aluminum alloy posts for double faced aluminum beam guard rail shall be aluminum alloy 6061 T6, ASTM B-308. When set on concrete median strip the post shall be secured to the concrete median as shown on the plans. Structural shapes for fastening the post to the concrete median shall be alloy 6061 T6 or 2024 T4, ASTM B-211.

982.04 - METAL BRIDGE RAILING

A) Materials

1) Structural steel shapes for posts and rail shall meet the requirements of Section 946.

2) Metal beam shall meet the requirements of Subsection 982.02 for steel or 982.03 for aluminum alloy.

3) Aluminum alloy tubes for bridge railing shall meet ASTM B-221, alloy 6063 T6 or 6061 T6. Welding when shown on the plans or permitted shall be in accordance with Subsection 946.04.

4) A certificate of analysis executed by the producer shall be furnished the City, setting forth the chemical analysis and test results for tubes.

5) Cast aluminum alloy bridge railing posts shall meet the requirements of (Alloy A 344 T4) AASHTO M-913. Welding when shown on the plans or permitted shall be in accordance with Subsection 946.04.

982.05 - PIPE RAILING

A) Galvanized Steel Pipe and Fittings shall meet requirements of ASTM A-120, Standard Weight Pipe.

B) Black Steel Pipe and Fittings shall comply with the requirements of ASTM A-120, Standard Weight Pipe.

982.06 - WIRE CABLE AND FITTINGS

Materials shall meet the requirements of AASHTO M-30.

982.07 – FENCE MATERIALS

A) The woven wire shall be design number 832-6-12 1/2, Class 1 coating conforming to ASTM A-116 or ASTM A-584.

B) Barbed wire shall consist of two (2) strands of No. 12 1/2 gauge wire twisted with four (4) point barbs and Class 1 coating conforming to ASTM A-121, or ASTM A-585.

C) Steel tension wire shall be No. nine (9) gauge and develop an ultimate tensile strength of not less than sixty thousand (60,000) psi. Coating shall match the material and weight of coating of the woven wire fabric furnished.

D) Line posts shall be either steel or treated wood. The same kind of material shall be used throughout any one project.

Unless specified otherwise steel posts shall be seven and one-half (7 1/2) feet long studded "T"

weighing not less than 1.33 " 0.05 pounds per foot in the black, painted with a shop coat of red lead and a finish coat of aluminum weather resistant paint or galvanized by the hot-dip process at the rate of not less than two (2) ounces of zinc per square foot.

A primer coat of Federal Specifications TTP 636 which contains the proper amounts of zinc oxide and zinc chromate to give it rust inhibiting characteristics and a finish coat of orange red fence post baking enamel will also be acceptable. The primer and finish coats shall be applied by a modern flow coat system. After each application the post shall pass through a sufficient drip-off two hundred seventy-five (275) degrees F baking, and cooling zone appropriately designed to give suitable paint applications.

Unless specified otherwise wood posts shall be seven (7) feet long with a minimum diameter of three and one-half (3 1/2) inches. They shall be sound and reasonably straight commercial grade posts and shall be treated in accordance with Section 982.

E) Post tie wire of not less than eleven (11) gauge to tie the wire fabric to steel posts shall be commercial fasteners of galvanized wire approved by the Engineer.

F) The pipe for the gate frame shall be as specified in Section 982.

G) The frame shall be covered and braced as indicated on the plans. Fittings, latches and hinges shall be of a type approved by the Engineer before installation.

H) Staples used for fastening wire to wood posts shall be made of No. nine (9) gauge galvanized wire. They shall be one and one-half (1 1/2) inches long.

I) Nails shall be round or oval steel wire of the size shown on the plans unless otherwise directed by the Engineer.

982.08 - STANDARD CHAIN LINK FENCE, TYPE II

A) Description - This section covers the requirements for chain link fence fabric, line posts, terminal posts, post ties, tension wire, and gates for the construction of chain link type fence. The height of fence fabric required and the length and cross section of line and terminal posts shall be as shown on the plans or in the proposal.

B) Materials

1) Chain link fabric and accessories shall conform to the requirements of AASHTO M-181 for the kind of coating, sizes of wire and mesh specified. Unless otherwise provided the fabric shall be two (2) inch mesh Type I or Type II, nine (9) gauge minimum wire with aluminum or Class A zinc coating.

2) Pipe posts shall be galvanized and of the length required with a nominal inside diameter of one and one-half (1 1/2) inches and shall conform to the requirements of ASTM A-120. Posts shall be furnished with an approved type ornamental top of malleable cast steel or iron galvanized as required by the plans.

3) "H" column post shall be hot dipped galvanized to meet the requirements of AASHTO M-181 of the length shown on the plans. The minimum weight per linear foot of post shall be 3.26 pounds.

4) Roll formed line posts shall be hot dipped galvanized to meet the requirements of AASHTO M-181 of the length shown on the plans. The dimensions of the roll formed post shall be 1.625 x 1.875 inches and weigh more than two and one-fourth (2.25) pounds per linear foot.

5) Terminal posts shall be galvanized and shall be the length required with a nominal inside diameter of two (2) inches and shall conform to the requirements of ASTM A-120. Ornamental tops shall be of the same type and quality as tops for line posts.

6) All rails, posts, braces and gate frames shall conform to ASTM A-120 or ASTM A-501 with a nominal OD of 1.66 inches and a minimum weight of 1.81 pounds per linear foot.

7) Post ties shall be minimum nine (9) gauge aluminum, aluminum coated or galvanized steel wire for tubular and roll form line posts and minimum six (6) gauge galvanized steel clips for "H" column line posts. Connections to terminal posts shall be by stretcher bar and tension bands, all galvanized. Bands shall be twelve (12) gauge x one (1) inch wide and fabricated for minimum three-eighths (3/8) inch carriage bolts. The stretcher bar shall be not less than one-fourth (1/4) x three-fourths (3/4) inches flat. The ties and bands shall be spaced at fifteen (15) inch maximum.

8) The tension wire for chain link fence shall be either galvanized steel wire or aluminum coated steel wire of the same type coating as the fence fabric. Galvanized tension wire shall be 0.177 inch carbon steel wire conforming to the requirements of ASTM A-641, hard grade - eighty thousand (80,000) psi minimum tensile strength with Class 3 zinc coating. Aluminum coated tension wire shall be 0.177 inch carbon steel wire meeting the requirements of ASTM A-641, hard grade for tensile strength and shall have a minimum .40 ounce per square foot of surface area aluminum coating. Ties to top of fence fabric shall be with eleven (11) gauge galvanized hog rings on twelve (12) inch centers. Post ties shall be as specified for chain link fabric and shall be tied to the post separate from the fabric.

9) The pipe for the gate frame shall conform to ASTM A-120 or ASTM A-501 with a nominal OD of 1.66 inches and a minimum weight of 1.81 pounds per linear foot. The frame shall be covered with the above fence fabric connected by bar, tension bands and ties. The frame shall be braced with two (2) minimum three-eighths (3/8) inch diameter, diagonal galvanized steel rod braces. Fittings shall be of an approved type with galvanized steel hinges, catch stops and center rests.

982.09 - GLARE DEFLECTOR FENCE, TYPE IV

Unless otherwise provided all materials, except size of mesh, shall conform to the requirements of AASHTO M-181.

The chain link fence fabric shall have nine (9) gauge wire and one (1) inch mesh. If AASHTO M-181 Type I fence is used, the fabric shall have a Class A coating.

Line posts, terminal posts, rails, and braces shall be as specified in Subsection 982.08.

Tension wires, tie wires and hog rings shall be as specified in Subsection 982.08.

SECTION 983- GUARD RAIL POSTS AND GUIDE POSTS

983.01 - DESCRIPTION

This section covers the requirements for wood, concrete and steel posts used for guard rails and wood posts for guide posts.

983.02 - WOOD POSTS

Wood posts shall be of the length and size specified on the plans and shall be cut from live trees and shall be close grained. Posts shall contain only sound wood.

Both the outer and inner bark shall be completely removed from all round posts and all knots trimmed flush with the face. Defects of any kind which give any post an unsightly appearance will be sufficient ground for rejection.

The size of the post shall be determined at the treating plant immediately prior to treatment. The diameter of round posts shall be determined by means of a circumference diameter tape. Minimum diameter at the tip as measured with a circumference diameter tape shall not be less than the nominal diameter by more than one (1) inch and no actual diameter shall vary from the diameter as determined with the circumference diameter tape by more than one-half (1/2) inch over or under.

Sawed posts shall be of the dimensions and grade shown on the plans. They shall meet the

requirements of Section 983.

Wood posts shall be treated in accordance with Section 983. Sawing, chamfering, boring or cutting as shown on the plans shall be performed prior to treatment.

Spacer blocks shall be as shown on the plans and treated in accordance with Section 983.

983.03 - STEEL POSTS

Steel posts shall be of the length and size shown on the plans. Unless specified otherwise they shall be galvanized and meet the requirements of AASHTO M-111. Steel bases shall be as shown on the plans and galvanized in accordance with AASHTO M-111.

983.04 - CONCRETE POSTS AND SPACER BLOCKS

983.04.01 – MATERIALS

Materials shall meet the following requirements:

Concrete	935
Wire Stirrups	AASHTO M-32
Reinforcing Steel	940

983.04.02 – METHODOLOGY

Curing - Concrete posts and blocks will be cured in a manner that will produce thirty-five hundred (3500) psi minimum compressive strength at twenty-eight (28) days.

Tolerances - Dimensional tolerances not shown or implied on the plans are intended to be those consistent with the proper functioning of the posts and blocks, including appearance and accepted manufacturing practices.

983.04.03 – TESTING

Testing and Acceptance - One (1) set of cylinders will be cast and tested for each one thousand (1000) posts and blocks. Cylinders will be at seventy (70) degrees F, and one hundred (100) percent humidity or by immersion in water for twenty-seven (27) days. The basis of acceptance will be compliance with these specifications as evidenced by test reports and certifications where applicable. Posts that are honeycombed or have been broken or cracked will not be accepted.

SECTION - 984 – PAINT

984.01 – WOOD SURFACES

These formulas are intended for new wood structures or handrails. When white paint is specified it shall be ready mixed paint conforming to Federal Specification TTP 101-2. When a colored finish is specified the prime coat shall be as specified above. The finish coat shall conform to Federal Specification TTP 105-A with the necessary tint added.

984.02 – ZINC DUST, ZINC OXIDE PRIMER FOR GALVANIZED SURFACES

The material shall be a ready mixed paint conforming to Federal Specifications TTP 641, Class B, Type I.

SECTION 985 - SODDING, SPRIGGING, SEEDING AND FERTILIZER

985.01 - SODDING AND SPRIGGING MATERIALS

A) Bermuda Grass Sod or Sprigs to be used as source material shall be a thick stand of common bermuda grass growing on fertile topsoil. Types of bermuda grass other than "common" may not be used unless approved by the Engineer. The vegetative parts (Rhizomes, Stolons and Roots) of

bermuda grass shall be viable as indicated by a dense, deep-rooted stand.

The source for sod and sprigs shall be free of reproducing parts of weeds classified as "Prohibited Noxious" and shall be as free of other legally "Restricted Noxious" plant materials as required by the Oklahoma Department of Agriculture Seed Law. The proposed source of sod or sprigs will be approved by the Engineer before the beginning of sodding or sprigging operations. Prior to approval, the area shall not be tilled or mowed. However, all vegetative growth exceeding three (3) inches in height shall be mowed and the residue removed prior to harvesting the sod or sprigs.

The sod or sprigs shall be moist when excavated from the source and shall be kept moist until planted. Watering of the sod source, if to be measured for payment, shall be performed when and as directed by the Engineer. Sod in storage which becomes dry, shall not be remoistened and used, but shall be discarded.

B) Sodding - This material shall consist of vegetative parts (Rhizomes, Stolons and Roots) of bermuda grass with an appreciable quantity of adhering soil. Solid slab sod shall be rectangular slabs of bermuda grass having minimum dimensions designated on the standard detail. Bermuda grass vegetative parts shall exist throughout the slab, and shall be obtained from soils with a minimum P.I. of 3. The slab must have a dense vegetative growth and be capable of being transported in a condition closely resembling its original state.

C) Sprigging - This material shall consist of vegetative parts (Rhizomes, Stolons and Roots) of bermuda grass which has been separated from a majority of the adhering soil.

The sprigs for row-sprigging and broadcast sprigging shall be removed from the soil with an approved Automatic Sprig Harvester, which digs, cleans and loads the sprigs in one continuous operation. The vehicle in which the sprigs are loaded for transportation shall not have open sides.

As soon as the vehicle is loaded, the sprigs shall be wet thoroughly with water and then covered with a heavy canvas or other approved cover to reduce moisture loss. They shall be kept moist and covered until planted, and shall be planted within forty-eight (48) hours after removal from the soil.

985.02 - SEEDING MAT ERIALS

The kind and quantity of seeds to be planted per acre will be indicated on the plans or in the proposal. A list of seeds and the specifications for them are given in the Table 985.02.01 “Seed specifications”.

The seed shall be furnished in sealed bags, with each "lot" in separate bags even though mixtures may be called for on the plans. All labeling required by law shall be intact and legible.

The Contractor shall furnish the Engineer two (2) copies of the invoices for the seed. The invoice shall describe each specie by name, variety, if any, and treatment (hulled, scarified, etc.), if any.

Each "lot" of seed furnished shall have been officially sampled and tested by the Oklahoma State Board of Agriculture, and two (2) copies of the report shall be supplied to the Engineer by the Contractor. Each seed test shall have been completed not more than nine (9) months prior to delivery of the seed.

The information furnished in the seed report for a particular "lot number" shall agree with information appearing on the seed tags having the same "lot number" or the seed of that "lot" will be rejected.

The seed and tags shall not be removed from the original tagged and sealed bag until approved by the Engineer. After approval, the seed may be mixed, sacked and batched as required to facilitate planting, but shall be tagged for identification and weight. The mixing or sacking into batches shall be performed under supervision of the Engineer.

Table 985.02.01 Seed Specifications

Kind of Seed Common and Botanical Name	P.L.S. Index	Weed Seeds

	Min. Permitted [1]	Purity Min (%)	Germination Min. (%)	Max Permitted (%)
Bermuda Grass, Common (Cynodon dactylon) unhulled	80			0.2
Bermuda Grass, Common (Cynodon dactylon) hulled	82			0.2
Bluestem, big(Andropogon gerardi)[2]	20			
Bluestem,Caucasian(Andropogon caucasicus)	15			
Bluestem, Little(Andropogon scoparious)[2]	15			
Bluestem, Sand(Andropogon halli)[3]	20			
Bluestem, Yellow(Andropogon ischaemum)	18			
Brome, Smooth (Bromus inermis)	70			
Buffalograss (Buchloe dactyloides) [2 3]	55			
Burclover (Medicago hispida, arabica or rigidula)		98	85	1.0
Clover, Large Hop(Trifolium procumbens)[5]		95	85	0.5
Clover, Small Hop(Trifolium dubium)[5]		95	85	0.5
Dropseed, Sand(Sporobolus cryptandrus)	70			2.0
Fescue, Tall (Festuca arundinacea)	80			0.5
Grama, Blue(Boutelous gracilis)[2]	25			
Grama, Side-Oats (Boutelous curtipendula)[2]	30			
Indiangrass (Sorghastrum nutans) [2]	35			2.0
Lespedeza, Striata (Lespedeza straita)		97	90	0.5
Lespedeza, Korean (Lespedeza stripulacea)[5]		97	90	0.5
Lespedeza, sericea (Lespedeza cuneata)[5]		98	90	0.5
Lovegrass, Sand (Eragrostis trichodes)[2]	65			0.5
Lovegrass, Weeping (Eragrostis curvula)	80			0.3
Millet, German Foxtail (Setaria italica)		98	80	0.5
Native Grasses (Predominately little blue stem)[2]	15			
Oats (Avena sativa)		95	80	0.5
Rye (Secale cereale)		90	70	0.3
Ryegrass, Annual (Lolium multiflorum)	85			0.2
Ryegrass, Perennial (Lolium perenne)	85			0.2
Sudangrass (vulgare sudanense)		98	80	0.5
Switchgrass (Panicum virgatum)	60			2.0
Wheat (Triticum aestivum)		96	80	0.1
Wheatgrass, Western (Agropyron smithii)[2]	56			1.0

[1] The P.L.S. Index (Pure Live Seed Index) shall be calculated from information given on the seed tag, as follows:

$$\frac{\text{Percent Purity} \times (\text{Percent Germination} + \text{Percent Firm Seed})}{100} = \text{P.L.S. Index}$$

The pounds of seed shown on the plans are stated as pounds of bulk seed. If the P.L.S. index of any "seed lot" furnished exceeds the minimum P.L.S. index specified by twenty-five (25%) percent or more, the pounds of bulk seed to be planted will be adjusted by using the following formula:

$$(S \times C) / F = P$$

Where:

S= P.L.S. index specified,

C = pounds of bulk seed called for,
F = P.L.S. index furnished, and
P = pounds of bulk seed to be planted.

[2]The seed source shall be Oklahoma, Texas or New Mexico.
[3] The seed shall have been prechilled and treated with potassium nitrate in accordance with the Hays Treatment Technique.
[4] The seed shall contain no Johnson grass seed. (This note applied to all seed).
[5] The seed shall be treated with an approved nitrogen fixing inoculant, such as manufactured by commercial laboratories suitable for the particular legume. The inoculant shall be stored and handled in accordance with the manufacturer's direction.

985.03 - FERTILIZER AND AGRICULTURE LIMING MATERIALS

A) Fertilizer - This material shall be a commercial fertilizer composed of the standard materials and conforming to the grade specified. The term "grade" shall mean the percentages of "total nitrogen", available "phosphoric acid", and "soluble potash", respective, in accordance with the requirements of Oklahoma Department of Agriculture.

Fertilizer furnished in standard, factory-sealed containers shall have all labeling required by the Oklahoma Department of Agriculture, intact and legible until the contents are used.

Each vehicle load of fertilizer furnished in bulk form shall be accompanied by two (2) copies of the purchase receipt, which shall be given to the Engineer upon delivery of the fertilizer. Each receipt shall show the weight, the brand name, grade of the fertilizer and the guaranteed analysis showing the minimum percentage of plant food in the fertilizer. The name and address of the person, firm, or corporation registering or guaranteeing the fertilizer with the Oklahoma Department of Agriculture shall also be shown.

The fertilizer to be broadcast dry shall be in a pelleted or other approved granular form and the material to be applied by power spray shall be soluble in water and uniform in suspension.

A fertilizer with an identical NPK ratio but of a higher grade than specified may be furnished, provided the application rate is adjusted to the equivalent number of pounds of each plant food element per unit of area as would have been applied with the specified grade. In the event such a substitution is made, the following formula shall be used in determining the new application rate:

Grade of Specified Fertilizer x Specified Rate = Pounds of Actual Plant Food
(Converted from Percent to Decimal) (N, P2O5, K20)
Pounds of Actual Plant Food (N, P205, K20) = New Application Rate
New Grade (Converted from Percent to Decimal)

B) Agricultural Liming Material - This material shall consist of either "agriculture limestone" or "hydrated lime" or shall meet the requirements of Section 985.03. When agriculture limestone is called for, seventy (70) pounds of hydrated lime may be substituted for one hundred (100) pounds of agriculture limestone. Agriculture limestone shall not be substituted for hydrated lime.

1) Liming material furnished in standard factory-sealed containers shall have all labeling required by the "Oklahoma Agricultural Liming Materials Act" intact and legible until the contents are used.

2) Each vehicle load of liming material furnished in bulk form shall be accompanied by two (2) copies of the purchase receipt. this receipt shall be given to the Engineer upon delivery of the liming material. Each receipt shall include: the name of the liming material, the brand or trade name, the net weight, the percent ECCE (Effective Calcium Carbonate Equivalent) and the name and address of the manufacturer, producer or distributor.

SECTION 986 - MASONRY BRICK

986.01 - DESCRIPTION

This section covers the requirements for masonry brick manufactured from either concrete or clay or shale. The particular type will be specified on the plans or in the proposal, and shall comply with the requirements set out below for each type.

986.02 - MASONRY BRICK MADE FROM CLAY OR SHALE

Masonry brick of this type shall comply with the requirements of AASHTO M-114 for building brick. Unless shown otherwise on the plans, grade "MW" brick shall be used.

986.03 - CONCRETE BUILDING BRICK

Concrete building brick shall conform to the requirements of ASTM C-55. Unless shown otherwise on the plans, Type I, Grade S-1 shall be used.

Concrete brick shall not be used in the construction or reconstruction of sanitary sewer manholes.

SECTION 988 – GEOTEXTILES AND FILTER FABRIC

988.01 – GEOTEXTILES FOR SUBSURFACE DRAINAGE PURPOSES.

A) General. This Subsection covers geotextiles to be used in conjunction with pipe underdrain and other drainage systems. The fabric shall meet the requirements of AASHTO M 288. In addition, use AASHTO M288 Subsurface Drainage, Table 2 with 15% to 50% of in situ soil passing the No. 200 sieve.

B) Acceptance. Furnish a type D material certification for the fabric in accordance with Section 109.17. Also, furnish a 3 square yard sample of the fabric for testing to the Materials Specialist from each lot or shipment by the Engineer.

C) The geotextile shall be of nonwoven needlepunched construction and consist of long chain polymeric fibers composed of polypropylene, polyethylene, or polyamide. The fibers shall be oriented into a multi-directional stable network whereby they retain their positions relative with each other and allow the passage of water as specified. The fabric shall be free of any chemical treatment or coating which reduces permeability and shall be inert to chemicals commonly found in soil. The geotextile shall conform to the physical property requirements listed in Table 988.01.01.

Table 988.01.01 Geotextile For Subsurface Drainage

Acceptable Typical Physical Property	Test Method	Test Results
Tensile Strength, wet, lbs.	ASTM D-1682	90 (*minimum)
Elongation, wet, %	ASTM D-1682	40 (*minimum)
Coefficient of Water Permeability, cm/sec		0.1
Constant Head	ASTM D-7511	40 (minimum)
Puncture Strength, lbs.		40 (maximum)
Pore Size-EOS, US Standard Sieve	Corps of Engineers CW-00215	

*Minimum is the minimum value in any principal direction for the typical fabric weight.1Tension testing machine with ring clamp; steel ball replaced with a five-sixteenth (5/16") inch diameter solid steel cylinder with hemispherical tip centered within the ring clamp.

The geotextile shall be furnished in a protective wrapping which shall protect the fabric from ultraviolet radiation and from abrasion due to shipping and handling.

The drainage fabric shall be placed in the manner and at the locations shown on the project plans. The surface to receive the fabric and/or the trench into which the fabric is to be placed shall be prepared to a smooth condition free of obstructions and debris.

The drainage fabric shall be covered with a permeable material within two (2) weeks of its placement. Should the fabric be damaged during construction, the torn or punctured section shall be repaired by placing a piece of fabric that is large enough to cover the damaged area and to meet the overlap requirement. Adjacent borders of the geotextile shall be overlapped a minimum of twelve (12) inches or sewn. The preceding roll shall overlap the following roll in the direction the material is being placed.

The quantity of drainage geotextile to be paid for will be measured by the square yard of area covered, not including additional fabric for overlap. The contract price paid per square yard for drainage geotextile shall include full compensation for furnishing all the work involved in placing the drainage geotextile, complete in place, as shown on the plans and as directed by the Engineer.

988.02 - GEOTEXTILE FOR EMBANKMENT/RIPRAP STABILIZATION

The geotextile shall be of monofilament woven or needlepunched nonwoven construction and consist of long-chain polymeric filaments or fibers composed of polypropylene, polyethylene or polyamide. The filaments and fibers shall be orientated whereby they retain their relative positions with each other and allow the passage of water as specified.

The fabric shall be mildew, insect, and rodent resistant and shall be inert to chemicals commonly found in soil. The geotextile shall conform to the physical property requirements listed in Table 988.02.01.

Table 988.02.01 Geotextile For Embankment/Riprap Stabilization

Acceptable Typical Physical Property	Test Method	Test Results
Tensile Strength, wet, lbs.	ASTM D-1682	200 (*minimum)
Elongation, wet, %	ASTM D-1682	15-90
Puncture Strength, lbs.	ASTM D-7511	100
Mullen Burst Strength, psi	ASTM D-3786	350
Coefficient of Water Permeability, cm/sec	Constant Head	0.03 (minimum)
Abrasion Resistance, lbs.	ASTM D-1175	55 (*minimum)
Taber Test	1000 revolutions	1 kg load/wheel
Pore Size-EOS, US Standard Sieve	Corps of Engineers CW-00215	40 (maximum)

*Minimum is the minimum value in any principal direction for the typical fabric weight.

[1]Tension testing machine with ring clamp; steel ball replaced with a five-sixteenth (5/16") inch diameter solid steel cylinder with hemispherical tip centered within the ring clamp.

The geotextile shall be furnished in a protective wrapping which shall protect the fabric from ultraviolet radiation and from abrasion due to shipping and handling. If the geotextile is to be exposed directly to sunlight in excess of two (2) weeks, the fabric shall be ultraviolet stabilized.

The embankment/riprap stabilization fabric shall be placed in the manner and at the locations shown on the project plans. The surface to receive the geotextile shall be prepared to a smooth condition free of obstructions, depressions and debris. The fabric shall be placed loosely, not in a stretched condition. The riprap shall be placed so that the geotextile is not punctured. The riprap shall complete cover the fabric.

The fabric shall be placed on the slopes so as to provide a minimum overlap of eighteen (18) inches. The geotextile shall be placed parallel to the direction of the flow and the upstream or higher panel shall overlap the downstream or lower panel. At the top of the embankment the fabric shall be keyed into the ground a minimum of eighteen (18) inches. If a cushion layer is placed, the bottom toe shall be finished by lapping the fabric back onto the cushion layer and securing with riprap.

Quantities of the geotextile placed as shown on the plans or as directed by the Engineer, will be determined from measurements taken of the area covered by the fabric, with no allowance for laps or toe-in anchorage.

The contract price paid per square yard for embankment/riprap stabilization geotextile shall include full

compensation for furnishing all labor, materials, tools, equipment and incidentals. The price per square yard also includes doing all the work involved in installing the geotextile, complete in place, as shown on the plans and as directed by the Engineer.

988.03 - PAVEMENT REINFORCING FABRIC

Description. This Section covers fabrics to be used for reinforcement of asphalt pavements.

A) General. The fabric shall meet the requirements for paving in AASHTO M 288.

1) Packaging and Storing. The fabric shall be supplied by the manufacturer in rolls of standard widths and lengths uniformly wound onto suitable cylinder forms or cores to aid in handling and unrolling by the use of mechanical laydown equipment. The rolls that are supplied shall provide full coverage of the pavement with a minimal number of joint splices. Wrap the rolls of fabric for protection against sunlight and moisture. When stored outdoors, elevate the rolls and cover them with a tarpaulin.

2) Sampling and Testing. Furnish a type A materials certification for the reinforcement fabric in accordance with Section 109.17.

B) SEPARATOR FABRIC FOR BASES.

1) General. This Subsection describes a pervious fabric to be used under base courses for separation. The fabric shall meet the requirements for separation in AASHTO M 288. A non-woven fabric is required.

2) Acceptance. Furnish a type A certification for the fabric in accordance with Section 109.17.

988.04 – FILTER FABRIC FOR SILT FENCE

A) General. This Subsection describes fabric to be used for the removal of soil particles from water flowing through the fence. The fabric shall meet the requirements for temporary silt fence in AASHTO M 288. In addition, use AASHTO M288, Table 6, Unsupported Silt Fence with an elongation less than 50%.

B) Acceptance. Furnish a type D material certification for the fabric in accordance with Section 109.17.

Summary of Amendments and revisions to the Standard Specifications

- Add provision for interpreters. Section. 103.01.03.
- Add provision for addendums to be verified by e-mail. Section 103.02.02.
- Detail the instructions for filing a bid. Section 103.05.04.
- Change the instructions to reflect proper way to fill out the revised "Business Relationship Affidavit". Section 103.11.
- Add section defining Oklahoma City Small and Disadvantaged Local Business Subcontracting Program. Section103.14.
- Add language describing proper display of "Notice of Equal Employment Opportunity" poster. Section 105.01.
- Amend instructions regarding the number of contracts that need to be delivered. Section 107.01.02.
- Change the term of maintenance bonds on all street, bridge and environmental projects from five (5) years to two (2) years and clarify that a maintenance bond is required for all improvements owned or operated by the City or its trusts regardless of whether it is funded by federal, state, local government or private entity. Section 107.02.03.
- Amend language to specify the term of the defect bond is to coincide with the maintenance bond. Section 107.02.04
- Clarification of authorization needed for approval. Section 108.03.
- Redefine the elapsed time allowed for inspection. Section 109.09.
- Add section for Storm Water Activities permit. Section 109.09.02.
- Correct typographical error. Section 109.11.
- Add section for final acceptance of private development projects. Section 109.24.
- Add language to further define the contractor's responsibility to maintain project site conditions and approval needed for use of City property on any construction project. Section 110.06.02.
- Correct typographical error. Section 110.06.03.
- Revise language to coincide with project specifications. Section 110.21.
- Revise language to reflect changes in State law. Section 110.22.
- Clarification of language. Section 110.23.
- Add section to provide consistency for the closeout of building and facility projects. Section 111.13.
- Correct typographical error. Section 215.01.
- All changes made are to remove obsolete materials/equipment and to specify new materials/equipment and/or ADA compliant equipment. Sections 715.02.06-715.02.08, 723.01-723.07, and 726.01-726.07.
- Add section defining mobilization. Section 809.01-809.03.
- Add section specifying ADA compliant material. Section 971.01-971.02.02.
- All changes made to sections 500 and 600 were to remove obsolete materials, specify new materials, correct language regarding errors and omissions, clarify terms, and comply to applicable standards.

Contact the City Engineer if additional information is needed.