

CITY OF LAKEWOOD WATER AND SEWER RULES AND REGULATIONS



LAKEWOOD

Engineering Division
Department of Public Works
City of Lakewood, Colorado

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CHAPTER 1 REVENUE AND FINANCE

Part 1 BUDGET

101.1. Budget. The City Council shall annually adopt a budget for the Water and Sewer Funds for the ensuing year.

Part 2 RATES, CHARGES, AND FEES

102.1. Water and Sewer Rates and Charges. The City Council shall establish standards of service and by resolution shall fix rates for water and sewer service. Rates shall be sufficient to pay for the operation, maintenance, reserves, debt service, additions, betterments, including those reasonably required for anticipated growth, and to provide for the general welfare. The rates shall also be sufficient to provide for the accumulation of reserves for improvements and obligations of such magnitude that they cannot be acquired from the surplus revenues in a single year. Rates and connection charges may vary according to demand, quality and volume, but shall be uniformly applied to the end that all persons receiving like services shall pay the same rates and connection charges except that a rate differential may occur to meet obligations which relate to a specific group of customers or properties. The City Council shall establish fees for the extension of service to properties not then being served by the City.

102.2. Rates for Service. Rates for water and sewer services will be established in accordance with Parts 3 and 4 of this chapter.

102.3. Charges for Extensions. The cost of extensions to the City's water distribution or sanitary sewer collection system will be borne by the applicant receiving the benefit. Included are the costs of design, inspection, construction, and other associated costs.

102.4. Fees. All tap, permit, inspection and other fees must be paid in advance of the service performed unless alternate payment arrangements are approved by the City.

102.5. Charges Applicable while Service Connected. In addition to usage charges, a fixed water and/or sewer charge will be made to all properties so long as the service lines to such properties are intact and available for service, regardless of the extent of occupancy or use of such property. The City, upon request of the owner and provided the property is not occupied, may inactivate water service when the turn-off fee is paid; however, the fixed service charge will continue.

102.6. Turn-On-/Turn-Off Fees. Fees for turning on and turning off water service shall be sufficient to compensate the City for actual cost and may be charged whether done at the request of the owner or in enforcement of these rules and regulations.

102.7. Fees for Other Services. The City may establish fees for other services provided that are not covered in these Rules and Regulations. All fees so established will be sufficient to reimburse the City for the actual cost of the services.

102.8. Billing Procedure. Rates, charges, and fees shall accrue for water and/or sewer service as either or both are utilized. Billings shall be prepared, issued, and become due and delinquent in accordance with the following:

- (a) Water and sewer service due when billed, delinquent if unpaid after 30 days.
- (b) Extension of services due and payable with application.
- (c) Meters and appurtenances due and payable with application.
- (d) Turn-on, turn off charge is due when levied, delinquent if unpaid after 30 days.(e) Charges for other services due and payable when charge is levied, delinquent if unpaid after 30 days.
- (f) Permit to tap and inspections due and payable with application.
- (g) Late charges due and payable as billed.
- (h) Fixed service charges shall begin upon final inspection and acceptance of a water or sewer tap by the City.

102.9. Responsibility for Payment. Owners of property receiving water or sewer service shall be responsible for payment of all rates, charges, and fees. The fact that the person receiving the service may not be identified on the billing by name shall not in any manner make the charge uncollectable or change the condition that the service is at the request of the property owner. As a convenience, billings to the owner may be made against tenants, lessee, or other non-owners when the property owner submits a request to the City. Whenever the term “owner” is used in the rules and regulations in reference to cost responsibility, the final cost responsibility shall accrue to the property owner.

102.10. Past Due Accounts. All money due the City for water or sewer service shall be due and payable on billing. If unpaid after 30 days from the billing date, the account will be considered past due.

(a) Special Billing. Accounts, which remain unpaid 30 days from date of billing, will be subject to a notice and special billing at 30-day intervals until collected.

(b) Collection Costs. Past due accounts will be assessed for the cost of special billing and collection. A fee for each special billing will be assessed in an amount sufficient to compensate the City for its expenses. If a past due account is turned over to an attorney for collection, attorney’s fees will be assessed in addition to accumulated charges. If an account is turned over to the county treasurer for collection, the treasurer’s cost of collection will also be assessed. All costs of collection through the courts will also be assessed.

(c) Order of Payment. Money received from a customer will be applied first to the

payment of special billing and collection costs; thereafter, the surplus shall be applied to payment of the sewer service; and thereafter the surplus shall be applied to payment of the water bill, if such exists.

(d) Enforcement of Charges, Discontinuance of Water Service. In addition to other means provided by law, the City may enforce the payment of any charges by discontinuing water service to the premises at which the charge arose without regard to the ownership or occupancy of such premises. Payment in advance or a security deposit may be required by the City to ensure prompt payment of amounts due for water or sewer service. Any discontinuance of water service shall occur only after notice has been provided to the customer and an opportunity for a hearing with the Director of Finance or his/her designee has been provided in accordance with this chapter.

(e) Waiving of Fees. All or a portion of the fee for turn-on, special billings, or costs of collection may be waived for good cause or other mitigating circumstances. Such waiver may be made only by the Director of Finance or his/her designee.

(f) Interest. Past due accounts will bear interest at 1.5% per month.

102.11. Enforcement of Charges. Collection of past due accounts may be done by any lawful method, including but not limited to the following:

(a) Liens. Charges for all water or sewer services or other services rendered shall be a charge upon the property to which service is delivered until paid. Connection of service shall be declaration by the owner of responsibility for payment of such charges, and billings of such service to other than the owner shall not release the owner from responsibility for such charges. The City will not release its charge upon the property upon change of ownership, until all past due accounts are paid or guarantee of payment made.

(b) Mechanics Liens. The City may file past due accounts as a lien on the property for collection and foreclosure as provided by the mechanics lien laws of Colorado. Such lien will not be released by the City until the account and all charges have been paid in full.

(c) Certified with Taxes. Past due charges for water or sewer services may be certified to the county commissioners and the county treasurer as part of the ad valorem taxes on such property. The county treasurer may sell the property to satisfy payment of the charges. The lien of the City will not be released until all past due charges are paid in full.

(d) Bankruptcy. In the event of the bankruptcy, insolvency, or receivership of the owner of property receiving service, the amounts due the City will be certified as a claim secured by the property receiving service.

(e) Collection through Court. The City may direct that the past due accounts be turned over to an attorney for collection by any lawful process. The City may incur attorney's fees to be assessed to the customer as part of the cost of collection. An amount ordered by judgment

may be recorded as a lien against the property and the property foreclosed to satisfy the judgment.

102.12. Review. Frequent adjustment of rates, charges, and fees is undesirable and should not be made more often than necessary. Consequently, rates, charges, and fees will be forecast to the extent possible to adjust costs and provide proper fiscal management. In the event an adjustment is made in the wholesale price of water or sewerage treatment, the wholesale portion of the price increase may be added to sewer or water rates by passage of a resolution as soon as reasonably possible after such wholesale price increase. All customers will be advised of the adjustment as soon as it is in effect and the adjustment will be applied to all service during the billing cycle in which the adjustment takes effect.

102.13. Adjustment of Billings. When it is called to the City's attention that the amount of a bill may be in error, charges will be reviewed. If it is determined that an error exists an adjustment will be made. If an error results in money due the City, the amount due will be reflected on the next regular bill. Should an error result in a refund, the amount will be credited to the customer's account or if requested, a refund payment will be made.

If the billing discrepancy is due to property owner or customer neglect or abuse of a water meter or any other device used to determine charges, the City will determine the charges to be made.

102.14. Payment of Account. If payment to the City is made on a non-existent account, with insufficient funds or other dishonored instrument the following will apply:

(a) If payment is for an account, which is not otherwise considered to be a delinquent account, the owner will be requested to make the payment good.

(b) If the payment is for an account which is otherwise considered delinquent, the owner will be notified and allowed one normal working day to make payment by cash, cashiers check, certified funds, or money order, or the delinquency will be treated as provided by that portion of these rules and regulations pertaining to delinquent accounts.

Part 3 WATER RATES

102.1. Owner Classes. All water owners shall be placed into one or more owner classes so that the costs of operating and maintaining the water system are fairly apportioned to each class of owner.

103.2. Billing Cycle. Billings for water and/or sewer service may be on a monthly, bimonthly or quarterly basis as determined most practical by the City. More frequent readings and billings may be requested and the cost charged to the owner.

103.3. Water Rates. The water rate is composed of two cost elements; a fixed service charge and a water usage charge for each whole 1,000 gallons used since the previous reading. The cost elements considered in developing rates may from time to time be adjusted or consolidated to

reflect appropriate cost accounting practices.

(a) Fixed Service Charge. A charge which varies by meter size shall be established for all owners of the water system, regardless of water usage. The fixed service charge shall reflect the costs of administration, meter reading, billing, accounting, and meter maintenance.

(b) Water Usage Charge. In addition to the fixed service charge a uniform rate of charge shall be established for each 1,000 gallons of water consumed.

103.4. Determination of Charges. The water bill for each customer will be calculated as follows:

(a) Fixed Service Charge. The fixed service charge will be the indicated charge for an owner based on meter size and billing frequency. The fixed service charge is also the minimum billing.

(b) Water Usage Charge. The water consumed will be determined from meter readings and a charge calculated using the established rate for each 1,000 gallons and the number of 1,000 gallon units in excess of the 1,000 gallon units shown on the previous reading.

(c) Total Water Bill. The total charges for water service will consist of the fixed service charge, water usage charge, and all other charges or fees then due the City.

(d) Partial Billing Period. Upon change of ownership or responsibility for payment, or when requested, the City will make final meter readings, and submit a bill to the responsible party. The bill will include the pro rata fixed service fee and the full charge for water consumption since the previous billing date.

103.5. Water Rates for Other Uses. The City will, by permit, make water available for construction, fire sprinkler, fire hydrants and other miscellaneous uses at rates sufficient to compensate for the actual cost of use. The conditions of service will be set forth at the time the permit is issued.

Part 4 SEWER RATES

104.1. Owner Classes. All sewer owners shall be placed into one or more classes of owners so that the costs of operating and maintaining the sewer system are fairly apportioned to each class of owner.

104.2. Billing Cycle. To the extent practical, billing for sewer services shall be combined with billing for water service. Billings for water and/or sewer service may be on a monthly, bimonthly or quarterly basis as determined most practical by the City. The City may contract with other agencies providing water service to submit to owners a combined water usage and sewer service billing.

104.3. Fixed Sewer Use Charge and Volume Charge. The total owner charge is composed of two cost elements; a fixed sewer charge and a wastewater volume charge for each 1,000 gallons of measured or estimated wastewater volume. The cost elements considered in developing rates may from time to time be adjusted or consolidated to reflect appropriate cost accounting practices.

(a) Fixed Sewer Charge. A fixed sewer charge, which varies by water meter size, shall be established for all owners of the sewer system, regardless of wastewater volume contributed. The fixed service charge reflects the costs of administration, billing, accounting, and customer related infiltration/inflow.

(b) Wastewater Volume Charge. A uniform rate of charge shall be established for each 1,000 gallons of normal domestic strength wastewater contributed to the sewerage system.

104.4. Commercial - Industrial. Owner costs for major commercial and industrial owners may be determined on an individual basis taking into consideration the impact the wastes and wastewater have on the collection system and wastewater treatment charges. When the costs of providing wastewater collection and treatment are not recovered in an equitable manner by the use of standard charges, actual costs may be determined on an individual basis or applied to all owners similarly situated. The costs may be based on equivalent household fixture units, seating capacity, number of meals served, flow, biological oxygen demand (BOD), chemical oxygen demand (COD), total Kjeldahl nitrogen, suspended solids (SS), grease, wastewater constituents, or any other reliable basis.

104.5. Experience Rating. All owners of sewer service who are provided water through a meter will have calculated or assigned an annual experience rating which will reflect the approximate volume of wastewater which is discharged into the sewer system.

(a) Water Usage History Available. The experience rating will be determined as the average of all water used during selected months in which substantially all water used will normally be discharged into the sewer system.

(b) Water Usage History Not Available. Owners who have not established an experience rating will be temporarily assigned a rating that will be based on the average of experience ratings of similar owners. When information is available to determine an experience rating, previous sewage service charges will be evaluated and if appropriate, billing adjustments initiated.

(c) Exceptions. When appropriate due to non-typical circumstances, the calculated experience rating may be adjusted on an individual basis. Either the City may initiate the establishment of such experience rating or the owner based upon information sufficient to determine accurately the amount of wastewater contributed to the sewer system.

104.6. Pretreatment. When directed by the City owners shall, through the use of owner installed owned and maintained pretreatment facilities, reduce strengths and constituents to levels

determined by the Metro Wastewater Reclamation District (Metro). Pretreatment facilities are subject to the provisions of these rules and regulations and the rules and regulations of Metro.

104.7. Other Charges. Other charges may include such items as fees for collecting past due accounts, turn-on, turnoff, repair and maintenance of owner owned equipment, or other non-typical contributions such as swimming pools. Charges for services outlined will be sufficient to compensate the City for providing the services.

Part 5 ENFORCEMENT OF WATER RESTRICTIONS AND SPECIAL PERMITS

105.1. General: It is a contract obligation of the City to enforce the curtailment of water usage when deemed necessary by the Denver Water Board.

105.2. Plan for Restriction: The City will review the Denver Water Board restriction program and as appropriate will adopt rules regarding restriction of water usage. The City reserves the right to adopt an alternate plan to meet the general needs of the City, while at the same time retaining the scopes, purpose and intent of a program for reduction in water usage. Should a customer fail to comply with the water restriction program the City may curtail water service.

105.3. Special Permits: The City may issue special permits for water usage in excess of the Denver Water Board's restriction program consistent with the program of the Denver Water Board. In order to compensate the City for providing this service, a charge will be levied for each permit issued.

Part 6 ADMINISTRATIVE APPEALS

106.1. Prior to the City discontinuing water service for failure of a customer to abide by City ordinances or rules and regulations, notice shall be sent to the customer informing him that water service will be discontinued if the customer does not come into compliance with the ordinances and/or rules and regulations within fourteen (14) days of mailing of said notice.

106.2. Said notice shall be sent to the customer's billing address and shall contain an itemization of the specific violations of the ordinances and/or rules and regulations which the customer has violated. Said notice shall further describe the customer's right to appeal.

106.3. Any person may appeal to the Director of Finance. Any person who wishes to appeal after receiving notice that his water service may be discontinued must file an appeal within fourteen (14) days of receipt of the notice to discontinue service. Said appeal shall be filed with the Director of Finance in written form.

106.4. The Director of Finance shall schedule a hearing date within ten (10) days of receipt of the notice of the appeal. At the hearing, the Director or his/her designee shall hear all relevant evidence and testimony presented by the appellant or his spokesperson and any other relevant evidence necessary to decide the appeal. The hearing will be informal in nature and will be recorded. The Director or his/her designee shall render a decision within ten (10) days of the

hearing.

106.5. The decision of the Director or his/her designee shall be sent by certified mail, return receipt requested, to the appellant. Any appeal from said decision shall be to Jefferson County District Court.

CHAPTER 2 EXTENSION OF SERVICES AND NEW SERVICE

Part 1 COSTS OF EXTENSIONS

201.1. Policy. It is the policy of the City to allow for extensions of the water distribution system and sanitary sewer collection system as necessary to provide for required expansion of service.

201.2. Cost of Extension. The cost of extensions to the City water distribution or sanitary sewage collection system will normally be borne totally by the applicant. The City may make a determination if cost sharing by the City is appropriate.

201.3. Oversizing. In those cases where it is desirable to oversize or install other system improvements, which exceed the owner's responsibilities, the City may participate in the costs of oversizing and improvements. Conditions, circumstances, and extent of City participation shall be determined when considering the application. The City may also authorize a partial or complete rebate program as described in this chapter.

201.4. Application. Prior to initiating design for system expansion, the owner will make application for system extension. The application will outline the proposed area of service, proposed facilities to meet anticipated demands, and compatibility with surrounding areas and service. The City Engineer will review the application to determine whether it meets proper criteria.

201.5. Curtailement of System Expansion. The City may curtail extensions for the following reasons:

(a) City facilities are not capable of accommodating the proposed extension. Curtailement of this nature will be for the time necessary to acquire funding and develop and install adequate capability.

(b) When the expansion of service area is restricted by agencies from which the City receives treated water or wastewater treatment service.

Part 2 ENGINEERING DESIGN

202.1. Design. The applicant will have a Professional Engineer licensed in Colorado perform and seal an engineering design for facilities required to provide the additional service. Design will take into consideration the applicant's area plus adjacent areas that would in the future be served by the system extension.

(a) Coordination. During preliminary design the applicant's engineer will coordinate with the City Engineer so that the proposed extension will be compatible with existing systems and an integrated water or sanitary sewer system.

(b) Oversizing. If the City Engineer determines that oversizing of facilities is needed, the

oversizing will be incorporated into the final design.

(c) Standards, Rules and Regulations. All designs for extending the City's system will be in accordance with City approved Water and Sewer Rules and Regulations, which are a part of Lakewood Engineering Regulations, Construction Specifications and Design Standards. The proposed design must also meet requirements of water supply and wastewater treatment agencies serving the area.

In order to accommodate unusual circumstances unique to a specific location, the applicant's engineer may request specific modification from design standards. Requests must be accompanied by a report that details the manner in which a proposed alternative is compatible with the intent of City design standards.

202.2. Project Engineering by the City. Design of system expansions and improvements may be undertaken by the City for the applicant after suitable contracting arrangements have been made. When performing engineering for the applicant, the City will secure all necessary approvals, except for those which must be received by the applicant, prepare bid specifications and perform construction inspection. A fee will be paid by the applicant in an amount necessary to reimburse to the City all engineering, other direct and indirect costs, and administrative overhead expended in order to accomplish the work.

Part 3 CONSTRUCTION AND ACCEPTANCE

203.1. Construction. All construction shall be done in conformance with the Water and Sewer Rules and Regulations, the Engineering Regulations, Construction Specifications and Design Standards of the City or other standards which the City Engineer shall prescribe.

203.2. Acceptance. Acceptance of improvements will follow the procedures in Chapter 14.13 of the municipal code and other applicable City rules and regulations.

Part 4 APPLICATION FOR NEW SERVICE

204.1. Policy. It is the policy of the City to provide water and sanitary sewer service to all those who apply for service within the service area managed by the City.

204.2. Applications for Water and Sewer Service. The owner or his authorized representative must complete and file with the City an Application for Service and pay the appropriate fees and charges.

Upon receipt of a request for sewer or water service, the City will evaluate the capability of the system to accommodate the new demand. If there are no system deficiencies or other causes for curtailment, a "Certificate of Availability" will be approved and issued to the owner/applicant. Prior to issuance of a Plumbing Permit the owner/applicant will pay all charges and fees and will receive permission to attach to the City water or sewer system. In the event service is not available the owner/applicant will be advised why service is not available, and the conditions

that must be satisfied in order to attach to the water or sewer system.

204.3. Limitation of New Water or Sewer Taps. In the event that the City is unable to authorize new taps onto its system by virtue of curtailments imposed by other agencies the following will be implemented:

(a) Applications for service will be considered on a first come, first serve basis with consideration given to prepaid taps, need and/or previous taps awarded to the owner/applicant. In order to be considered the owner/applicant must have first completed and filed with the City an Application for Service. The application will be noted as to date received. The date received will establish priority for service.

(b) The City will notify eligible applicants 30 days prior to the anticipated allocation date. No less than ten days prior to the allocation date the owner/applicant will deposit with the City funds sufficient to purchase taps of the number and size requested, calculated on the current schedule of rates, charges, and fees.

(c) If the denial of a tap results in a hardship, the owner/applicant may request that the particular situation receive additional review and consideration. Determinations made by the City are final.

(d) When the recipient of an approved tap is either unwilling or unable to utilize the tap in the time period allocated, the permit may be revoked and an award made to the next eligible applicant.

(e) In the event the owner/applicant does not obtain a tap from the supply agency, the deposit with the City shall be refunded.

(f) Applications with the City shall be recognized until the tap is secured or the application is withdrawn by the applicant. If the owner/applicant withdraws an application or does not purchase the tap when available, the application is deemed withdrawn.

204.4. Denial of Application for Service. The City can refuse to accept an Application for Service for the following reasons:

(a) City facilities are not capable of properly accommodating the proposed increase. Applications will be denied for the time necessary to acquire funding and develop and install adequate capability.

(b) When the application for service is restricted by agencies from which the City receives treated water or wastewater treatment services.

Part 5 SERVICE REQUIREMENTS

205.1 Requirement for Water Meters and Water Service Lines. Meters will be required and

water and sewer service provided under the following conditions:

(a) All connected water services will be metered by the installation of water meters provided by the City in accordance with City price schedules. Each meter will be the same size as the water service connection to the City main unless the City determines otherwise.

(b) Each building using water, regardless of occupancy or use, will be metered individually. Where more than one building is proposed on a single lot, an additional water service line and meter will be required for each additional building. In addition, buildings with multiple owners or tenants shall have a separate meter for each owner or tenant.

- (1) Exceptions may be granted in those instances where multiple buildings are under single ownership and included on a single legal description and may more reasonably be served by a single line.
- (2) In the event that multiple buildings served by a single meter are separated, each building under separate ownership or separate title will be required to have its own service and meter installed and be subject to charges, rules, and regulations in the same manner as if it were a new service.
- (3) An exception to the rule requiring separate meters may further be granted in case of condominium or similar multiple ownership in common of single or multiple structures provided that recorded declarations establish that a management entity exists for the structure or structures with power to enforce these Rules and Regulations including enforcement of charges. If a management agency does not exist, each living unit must have its own service line.
- (4) Party Wall Agreement. For a development where a “party wall” agreement is proposed, separate service lines and meters will be required for each unit. The city may also require that a master meter be installed immediately off the main public water line, upstream of the first individual meter and within the public right-of-way.
- (5) Auxiliary Dwelling Unit (ADU). When an ADU is proposed to be constructed on the same lot as an existing metered structure, a study will be required to determine if the existing water service line has the capacity to accommodate the additional use. If the existing service line has adequate capacity, a new water service line for the ADU may be connected to the existing water service on the structure side of the existing water meter. If the capacity of the existing service line is inadequate, a new water service line and water meter will be required and a connection made to the water main line. In the event the portion of the existing lot that the ADU is situated on is subdivided into a separate lot, a separate water service line and meter will be required to be installed to the existing ADU and a connection made to the

water main line. A single family tap fee will be required to be paid before a connection to the water min line can be made.

(c) The first and original meter pit, appurtenance facilities and piping will be purchased by the owner and become a part of the property served. This meter will be used to measure water use during construction, and subsequently the water delivered to the owner.

(d) The City may remove or exchange the meter for purposes of testing and servicing.

(e) The cost of meter pit repair and repair of all appurtenance facilities and piping shall be the responsibility of the owner.

(f) The cost of normal servicing, repairing, and replacement of water meters will be paid by the City. The cost of repairs resulting from abuse, freezing, hot water, or other causes will be paid by the owner.

(g) Water meters should not be installed in driveways, sidewalks, or parking lots. If there is no alternative location, then heavy duty recessed meter pit rings and lids will be used as specified in the City engineering specifications. All costs associated with relocating or upgrading existing meter pits to heavy duty shall be at the owner's expense.

(h) Water meters will not be allowed to be installed inside any structures. Remote readers for water meters are prohibited.

(i) The City, in accordance with industry standards, shall determine the meter flow accuracy limits.

(j) It is unlawful for any person to interfere with or remove a water meter from any service connection without first obtaining written approval from the City. Whenever any meter is removed with such approval, the meter will be immediately returned to the City. In the event that a meter is missing from a location where a meter had previously been installed, the owner of the premises shall be required to install a new meter and pay all costs for such installation.

(k) Water service lines to buildings for fire protection will be fitted with a detector check system. The owner will furnish engineering calculations to the City substantiating the fire flow requirements for sizing the tap and service line. The tap fee will be based on the domestic flow requirement and not the fire flow requirement.

(l) Should the City perform any work or incur any expense for the installation, removal, replacement, servicing, relocation, or maintenance of a water meter and any such work expense is deemed the responsibility of the owner, the City is authorized to recover the actual cost of such work or expense.

(m) Meter Reading. The amount shown on the meter shall be presumed to be the amount consumed by the owner unless the meter can be shown to be reading inaccurately.

(n) Access to Private Property. Application for or receipt of service from the City shall be deemed as permission by the property owner to allow City employees to enter the premises for the purpose of reading the water meter and when required, to make changes or repairs to the water meter. Denial of access during normal business hours or in case of an emergency, shall be cause for terminating service.

(o) It is the responsibility of the owner of property served by a water or sewer meter to provide the City with access to such meter. The City's duly authorized representatives will at all reasonable times have access to the customer's premises for the purpose of reading utility meters, for the purpose of inspection and repair of meters or the utility system or any part thereof, and for the purpose of connecting and disconnecting service. If the meter becomes obstructed by bushes or other material or if the owner of the property has otherwise failed to provide access to the meter within 14 days following written notification of the access problem from the City to the owner of the property, sent by certified mail; water service, if provided by the City, may be discontinued. The City may also cause such obstructions to be removed and levy the charge against the property owner. If the City provides water service, service will not be restored until access is provided to the meter and until the owner has paid the cost of disconnection and reconnection.

(p) Taps Onto Service Line. No taps will be made onto a service line which will allow for customer use of unmetered water, except in the case of an ADU, as described in 205.1.(a).(5) above. Service line taps ahead of the meter may be permitted only when a fire protection sprinkler system is used for which a monthly service charge is made, or under temporary, emergency circumstances when necessary to protect the public health, and only when authorized by the City. In these cases, a detector check system will be required to be installed on the fireline between the water service line tap location and the building connection.

205.2 . Requirements for Sanitary Sewer Service Lines. Each building being provided sanitary sewer service, regardless of occupancy or use, must have a separate service line. When more than one building is proposed on a single lot, an additional sanitary sewer service line will be required for each additional building, except as noted below.

(a) Multi-Family Usage. Service line configurations for multi-family will be determined in the following manner:

- (1) Condominium or similar multiple ownership in common of single structures may be served by a single service line, provided that recorded declarations establish that a management entity exists for the structure with the power to enforce these Rules and Regulations, including the enforcement of charges. If a management agency does not exist, each living unit must have its own service line.
- (2) Multi-family dwellings, which are under single ownership, may be served by a single service line; however, it is preferred that when possible, each living unit

be served by a separate line. As elsewhere stated by these rules and regulations, property owners are responsible for repairs and maintenance of service lines. The property owner will resolve disputes between lessees arising out of service line blockages.

- (3) Party Wall Agreement. For a development where a “party wall” agreement is proposed, separate service lines will be required for each unit. The city may also require that a sanitary sewer main line be extended and an easement be given to the city if this extension occurs on private property.
- (4) Auxiliary Dwelling Unit (ADU). When an ADU is proposed to be constructed on the same lot as an existing structure, a new separate sanitary sewer service line will be required to serve the ADU. This service line may be allowed to tie in to the existing sanitary sewer service line that serves the existing structure or it may be required to tie in to the sanitary sewer main line. The City will make this determination on a case by case basis. In either case, a multi-family tap fee will be required to be paid before the service line connection can be made.

205.3 Sewage Meters. When it is essential for purposes of establishing sewage collection and treatment charges to commercial or industrial owner, the City may require installation of a flow meter and/or sampler. The meter/sampler shall show all contributions to the sewage system from the metered property.

Part 6 LINE EXTENSION REBATE

206.1. General. When it is necessary to extend the City water or sewer systems to provide service, the City will determine whether the extension is primarily for the benefit of a specific property or to the City system as a whole. When it is determined that the benefit is primarily to a specific property, the City will not share in the costs of such extension and such extensions will be paid for by the property owner receiving the benefit.

When an extension benefits property other than that owned by the applicant, the applicant is eligible for reimbursement of certain costs incurred when facilities are 1) constructed at the applicants expense, 2) accepted by the City and 3) have the capability of serving property owned by others than the applicant.

This rule is formulated solely for the purpose of providing for the recovery of line extension costs incurred by the original applicant and is not to be considered as limiting or committing to the availability of service.

206.2. Recovery of Costs. Recovery of costs will be based on the total number of equivalent taps that the extension may serve, including the applicant’s. The number of taps and the recovery per tap will be determined by the City at the time the application to extend the system is approved. The total amount of recovery to which the applicant may be entitled shall not exceed the entire cost of design, construction and all other related costs, less that portion of the total cost

attributable to the applicant's property. Recovery of costs under this rule shall not be made after seven years from the date service is first received. If at the end of the seven-year period there remains potential for recovery, the applicant may request an extension for an additional 3 years.

206.3. Records and Collection of Money. The City shall keep records for those extensions where cost recovery is provided. The City will notify and assess future applicants for the amount to be paid and forward funds to the original applicant. The assessment amount shall be adjusted by the difference in the ENR Construction Cost Index from the time of original construction to the time of assessment. In the event the City is unable after a reasonable search to locate the original applicant, the funds shall be returned to the payee.

206.4. Responsibility of the Original Applicant. It shall be the responsibility of the original applicant, heirs or assigns to inform the City as to the name and address of persons who should receive payment. Should this not be done, rights to make a claim for reimbursement are waived.

**CHAPTER 3 WATER AND SEWER SYSTEM PLANNING, DESIGN AND
CONSTRUCTION CRITERIA AND STANDARDS**

Part 1 WORDS, PHRASES AND ABBREVIATIONS

301.1. General. Words, phrases and abbreviations used herein that are not defined below shall carry the meaning normally attributed to them in a technical and engineering capacity.

301.2. Definitions.

(a) Words & Phrases.

- (1) Average Daily Water Consumption. Average of the total amount of water consumed each day during a one-year period in the area being designed.
- (2) Average Daily Sewage Contribution. Average of the total amount of sewage contributed each day during a one-year period in the area being designed.
- (3) Cul-de-Sac. A dead-end local street with a special enlarged circular vehicular turn around at the closed end.
- (4) Lakewood. City of Lakewood.
- (5) Maximum Daily Consumption Rate. Rate of water used during the 24-hour day which is the maximum daily. This maximum daily consumption rate is also the average rate of consumption on the maximum day.
- (6) Peak Design Consumption Rate. The maximum rate of water consumption at the time of peak usage during the peak day or days when the maximum daily consumption occurs.
- (7) Peak Design Rate-Sewage Contribution. The maximum rate of sewage contribution at the time of peak flow during the peak day or days throughout the year when the flows are highest.
- (8) Sewage Contribution. Human wastes and wastewater conducted away from residences, public buildings, commercial buildings and industrial buildings. These wastes do not include storm waters.
- (9) Water Consumption. The amount of treated water used for domestic, public, commercial, industrial, irrigation and fire protection purposes.

(b) Abbreviations.

- (1) AWWA - American Water Works Association.
- (2) ASTM - American Society for Testing Materials.
- (3) CDPHE - Colorado of Public Health and Environment.
- (4) gpd - Gallons per day
- (5) gpm - Gallons per minute.
- (6) psi - Pounds per square inch.
- (7) WMFPD - West Metro Fire Protection District.

301.3. Modifications. The City Engineer may allow modification of these criteria and standards when necessary to accommodate site specific conditions and provided such modifications continue to provide water and sewer service conforming to the intent and purpose of these criteria and standards.

Part 2 WATER AND SEWAGE QUALITY STANDARDS

302.1 Water Standard. It is intended that these standards and criteria will result in a water supply and distribution system that will deliver domestic water of a quality meeting or exceeding the applicable provisions of the Laws and Regulations applying to Potable Drinking Water Systems, Potable Water Distribution Systems and Disinfection of Public Water Supplies as promulgated by the CDPHE.

302.2. Sewage Standard. It is intended that these standards and criteria will result in a sewage collection and disposal system that will remove sewage from the area under consideration in a manner that meets or exceeds the applicable provisions of the Criteria Used in the Review of Waste Water Treatment Facilities as promulgated by the CDPHE.

Part 3 PLANNING CRITERIA

303.1. Land Use Criteria.

(a) Land Use Designation.

- (1) Land use for design of new facilities will be based on the zoning classification as designated by Lakewood, modified to account for any foreseeable change in use that might take place within the next 10 years.

(b) Land Use Density. For residential zoning classification, population densities shown

in Table 303.1-1 will be used as a basis for evaluation and design.

TABLE 303.1-1			
Zoning Classification	Units Per Gross Acre	Persons Per Unit	Persons Per Gross Acre
R-1-43	1	3.25	3.3
R-1-18	2.4	3.25	7.8
R-1-12	3.5	3.25	11.4
R-1-9	4.8	3.25	15.6
R-1-6	7.3	3.25	23.7
R-2	8.7	2.5	21.8
R-MF	12.0	2.5	30.0
R-MH (single wide)	18.2	2.0	36.4
R-MH (double wide)	12.1	2.0	24.2
M-N	12.0	2.0	24.0
M-G	25.0*	2.0	50.0
M-C	35.0*	2.0	70.0
M-E	20.0*	2.0	40.0
M-R-S	5.0*	2.0	10.0
M-R-U	10.0*	2.0	20.0
M-R-T	30.0*	2.0	60.0

*These are the minimum values for these particular zoning classifications. Actual values shall be determined at time of property development.

(c) Other Residential. For uses or conditions not included or adequately covered by Table 303.1-1, a reasonable evaluation will be made for each use area using the specific land use proposed and the above tabulation as a guide to population densities.

(d) Office, Commercial, Industrial and Planned Development. For office, commercial,

industrial or planned development classifications, the proposed land use will be the basis for determining the water consumption and sewage contribution.

303.2 Water Usage Criteria.

(a) General. As set forth in this chapter, the water supply and distribution system shall provide each potential owner with a dependable supply of water, adequate in quantity and quality for all domestic, sanitation, and fire protection needs, and a reasonable level of irrigation at pressures as uniform as local conditions and topography permit. Sample calculations are shown as guidelines only. The City Engineer shall approve all design assumptions.

(b) Design of New Facilities. For design of new facilities, all components shall have adequate capacity to serve total ultimate development in conformance with the existing or planned zoning classifications and increased densities that reasonably could take place in the following 10 years.

(c) Quantity. The water supply and distribution system shall be adequate to supply and maintain the maximum daily consumption rate plus the required fire flow rate simultaneously, or the peak design consumption rate, whichever is greater. The City Engineer may modify these standards based on 1) conditions unique to a site and 2) sound engineering principles.

(d) Pressures. Water lines shall be adequately sized, and storage and pumping facilities located, so as to provide water to the owner at a minimum pressure of 35 psi during peak usage periods. Except in unusual cases, a minimum static pressure of not less than 50 psi and a maximum static pressure not to exceed 100 psi shall be maintained. Pressures are measured at the street side of the building site.

303.3 Residential Water Consumption. Residential water consumption for any given area will be determined by using the projected population in accordance with Part 3 of these standards and an average per capita consumption of 75 gpd. This consumption does not include such items as irrigation and fire protection use.

303.4 Office, Commercial, Industrial and Planned Development Water Consumption. Projected average daily consumption shall be based on projections of water consumption in the planned facilities. When the facilities are not known, Table 303.4-1 will be used to determine the average daily consumption rate of water:

Table 303.4-1

<u>Zoning Classification</u>	<u>Average Daily Consumption</u>
Office	* 2,000 gals per ac.
Commercial 1C to 5C	* 2,000 gals per ac.
Industrial IN	* 2,000 gals per ac.
PD	** Based on Official Development Plan Land Use

*Does not include water for irrigation, fire purposes, pipe line flushing and pipe line leaks.

303.5. Irrigation Consumption. Irrigation is the use of water from a public water system to enhance vegetation growth in connection with any land use. Daily consumption for irrigation use will be taken at 4,000 gpd per net acre of irrigable land. Rate of flow for the high day during the high week shall be taken at 1.5 times the average daily consumption or 6,000 gpd per net acre equivalent to 4.2 gpm per net acre. For the determination of net irrigable land Table 303.5-1 will be used. Acreages are gross zoned acres.

Table 303.5-1

IRRIGABLE LAND BY ZONE DISTRICT	
<u>Zoning</u>	<u>Irrigable Area (percentage of zoned area)</u>
R-1-43	65%
R-1-18, R-1-12, R-1-9	60%
R-1-6, R-2	50%
R-MF	30%
R-MH	25%
M-R-S	25%
M-N-S, M-G-S, M-E-S, M-R-U	20%
M-N-U, M-G-U, M-C-U, M-E-U, M-R-T	15%
M-N-T, M-G-T, M-C-T, M-E-T	10%
C-R, LI	20%
LI-RD	15%
PD	Based on Official Development Plan

303.6. Fire Protection Requirements. The fire district in which land is located will make determination of fire flows. For the majority of Lakewood, this agency is the West Metro Fire Protection District.

303.7. Unaccounted for Water. Unaccounted for water includes such items as water used for

fighting fires, pipe line flushing, leakage in piping, malfunctioning of meters, etc. For purposes of evaluation and design add 5% to average daily consumption rates of flow for domestic and irrigation purposes to account for this item.

303.8. Water Flow Calculations.

(a) Maximum Daily Consumption Rate. The following steps are involved in the determination of the maximum daily consumption rate:

- (1) Select the area to be considered for design.
- (2) By using the land use classification and the population density given in Table 303.1-1 and the water consumption for residential, irrigation, commercial and industrial classifications given in Paragraphs 303.3, 303.4 and 303.5 plus the unaccounted for water given in Paragraph 303.7 determine the maximum daily consumption rate. The total will be the maximum daily consumption rate imposed on the system.
- (3) Example of Calculation. For an example of the steps, assume an area of 520 acres in size with the following zoning classification and acreage's.

ZONE	AREA	PERSONS PER GROSS ACRE	POPULATION	PORTION OF AREA TO BE IRRIGATED	IRRIGATED ACRES
R-1-12	350 AC	11.4	3,990	.60	210
R-1-6	100 AC	23.7	2,370	.50	50
R-MF	35 AC	30.0	1,050	.30	11
C-R	15 AC	2,000 gpd/acre		.20	3
LI	20 AC	2,000 gpd/acre		.20	4
TOTALS	520 AC		7,410		278

Calculation of maximum daily consumption rate:

Residential:	7,410 persons x 75 gpd divided by 1440	386 gpm
C-R, Commercial:	15 acres x 2,000 gpd divided by 1440	21 gpm
LI, Industrial:	20 acres x 2,000 gpd divided by 1440	28 gpm
Irrigation:	278 acres x 4.2 gpm	1,168 <u>gpm</u>
Sub Total		1,603 gpm
Plus 5% for unaccounted for water		80 <u>gpm</u>
Maximum Daily Consumption Rate		1,683 gpm

(b) Required Fire Flow Plus the Maximum Daily Consumption Rate. Determine the required fire flow by referring to the appropriate fire protection district. There may be more than one rate within a given area.

(1) Example of Calculation. Continuing with the example: Assume that the required fire flow for the R-1-12 and R-1-6 areas is 1,500 gpm. Assume the required fire flow for the R-MF and Commercial and Industrial areas to be 3,000 gpm.

In order to evaluate or design the water system serving the subject area add the larger required fire flow to the maximum daily consumption rate.

Required Fire Flow	3,000 gpm
Maximum Daily Consumption Rate	1,683 <u>gpm</u>
Total	4,683 gpm

(c) Peak Design Consumption Rate. Determine the peak design consumption rate by using the maximum daily consumption rate and multiplying by a peak factor of 1.7. The result of this multiplication is the peak design consumption rate.

(1) Example of Calculation. Continuing with the example.

Maximum Daily Consumption Rate	1,683 gpm
Multiply by peak factor	<u>x 1.7</u>
Peak design consumption rate	2,861 gpm

(d) Conclusion:

Required fire flow plus the Maximum Daily Consumption Rate.	4,683 gpm
----------------------------------------------------------------	-----------

Peak Design Consumption Rate	2,861 gpm
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For the conditions assumed, the required fire flow plus the maximum daily consumption rate of 4,683 gpm would be used to design the piping system supplying water to the area.

303.9. Sewage Contribution Criteria.

(a) General. The sewage system shall provide dependable facilities having sufficient capacity to transport all domestic sewage, at time of peak flow, from all owners to the place of treatment or to the place where another entity accepts it for treatment. In some instances, sewage pumping stations or sewage treatment facilities may be a part of the sewage system in which case these facilities shall have capacities for the function they are to perform. The City Engineer shall approve all design assumptions.

(b) Design of New Facilities. For design of new facilities, all components shall have adequate capacity to serve total development in conformance to the existing zoning classifications and increased densities that reasonably could take place in the following 10 years.

(c) Supplemental Criteria. The entire sewage system including the collection sewer lines, pumping stations, outfall lines and treatment facilities shall be designed and constructed in accordance with these standards supplemented by the applicable provisions of Criteria Used in the Review of Waste Water Treatment Facilities published by the CDPHE.

303.10 Sewage Contributions. The following criteria will be considered as the acceptable minimum for design of the sewage system:

(a) Residential. Residential contribution will be based upon an average daily sewage contribution of 75 gallons per capita.

(b) Office, Commercial, Planned Development and Industrial. Table 303.10-1 will be used to determine the average daily rate of sewage contribution.

<u>Zoning Classification</u>	<u>Average Daily Contribution</u>
Office/Commercial/Retail	2,000 gal per ac. (Total Site Area)*
IN	2,000 gal per ac. (Total Site Area)*
PD	Based on Official Development Plan

*Alternate values of 4,000 gal per ac. (Gross Building SF) for Office/Commercial/Retail and 6,000 gal per ac. (Gross Building SF) for IN may be used.

(c) Infiltration. Infiltration for the construction of new sewer lines shall not exceed 200 gallons per day per inch of diameter per mile of sewer line.

(d) Peak Flows. The above contribution criteria are average daily flows. In order to use these flows for design purposes, they must be converted into flow rates expressed in gallons per minute (gpm). Further, the rates must be converted from average flow rates to peak flow rates as shown in the “Peak Flow Factors” in Table 303.10-2. Interpolation may be used for flows not listed in Table 303.10-2 or in the alternative, the formula at the bottom of the table may be used.

Table 303.10-2

PEAK FLOW FACTORS			
AVERAGE FLOW GALLONS PER MINUTE	PEAK FLOW FACTOR	AVERAGE FLOW GALLONS PER MINUTE	PEAK FLOW FACTOR
80	5.08 (max)	400	3.87
96	4.93	560	3.66
112	4.80	720	3.51
128	4.70	880	3.39
144	4.60	1040	3.30
160	4.52	1200	3.22
176	4.45	1360	3.15
192	4.38	1520	3.09
208	4.33	1680	3.04
224	4.27	1840	2.99
240	4.22	2000	2.95
256	4.18	2400	2.86
272	4.13	3200	2.73
288	4.09	4400	2.58
312	4.04	5200	2.51

Peak Flow Factor = 10.66 divided by (Average Flow in gpm)^{0.169}

303.11 Sewage Contribution Calculations.

(a) Average Daily Contribution Rate. The following steps are involved in the determination of the average daily sewage contribution rate:

- (1) Select the area to be considered for design.

- (2) By using the land use classification and the population density given in Table 303.1-1 and in Table 303.10-1 determine the average daily sewage contribution. Convert this average daily contribution to an average rate in gallons per minute.
- (3) Enter Table 303.10-2 with the average rate to determine the peak factor. Multiply the average daily contribution rate by the peak factor to obtain the peak rate of sewage contribution.
- (4) Determine the amount of infiltration by actual length of line needed. In the event that actual length is undetermined at this design point, an assumed length of 150 feet per acre can be used. By using the length of pipe, assumed size of pipe and the infiltration rate per 303.10(c), the daily infiltration contribution can be calculated. This daily flow must be converted to gpm. This flow is fairly constant throughout the day, therefore no peak factor is applied.
- (5) Add the peak rate of sewage contribution to the rate of infiltration contribution to obtain the peak design rate of sewage contribution.

(b) Example of Calculations.

- (1) Assume an area of 585 acres, which will drain by gravity to a single point, with the following zoning classifications and acreages.

ZONE	AREA	PERSONS PER GROSS AREA	POPULATION
R-1-18	350 AC	7.8	2,730
R-1-6	100 AC	23.7	2,370
R-2	80 AC	21.8	1,744
C-R	35 AC	2,000 gpd/acre	
LI	20 AC	2,000 gpd/acre	
TOTALS	585 AC		6,844

(2) Calculate average daily contribution

6,844 persons x 75 gpd	513,300 gpd
35 Ac Commercial x 2,000 gpd	70,000 gpd
20 Ac Industrial x 2,000 gpd	40,000 <u>gpd</u>
Total Contribution	623,300 gpd

Average daily rate 623,300 gpd divided by 1,440 = 433 gpm

From Table 303.10-2 peak factor = 3.83 (by interpolation)

Peak rate of sewage contribution = 3.83 x 433 gpm = 1,658 gpm

(3) Approximate length of sewer line would be 585 acres x 150 feet per acre = 87,750 feet or 16.62 miles. Infiltration would be based on 200 gpd per inch-mile, or (assuming 8-inch pipe) 1,600 gal/mi/day. Infiltration = 16.62 miles x 1,600 gal/mi/day = 26,592 gpd divided by 1,440 or a rate of 18 gpm.

(4) To obtain the peak design rate of contribution add the following rates:

Peak rate of sewage contribution	1,658 gpm
Daily rate of infiltration contribution	<u>18 gpm</u>
Peak design rate of contribution	1,676 gpm

303.12 Sanitary Sewer Feasibility Study (Master Plan) Requirements.

(a) A feasibility study shall be submitted in cases where it is:

- (1) Required by the City of Lakewood in order to determine the feasibility of, or alternates for, providing sanitary service to a particular area, or
- (2) Desired by the developer/engineer to present to the City of Lakewood a concept for providing sanitary service to a particular area.

(b) The study must be prepared by a Professional Engineer, currently registered in the State of Colorado, whose seal and signature shall be affixed to.

(c) The narrative description of the project shall include:

- (1) Name, address and location of project.
- (2) Adjacent street names.
- (3) Legal description and/or vicinity map of site.
- (4) Existing or proposed zoning and land use for both the project area and adjacent areas.

- (5) Type and size of development:
 - (i) Residential – area and land use or, if known, number of units and projected population using this criteria.
 - (ii) Industrial or commercial – area and land use.
- (d) The study shall be accompanied by a vicinity map (suggested scale: 1" = 1000') which should include the following:
 - (1) Geographic location of site.
 - (2) Relationship to major arterial streets.
 - (3) Any other landmarks that may be helpful with site identification.
- (e) The flow calculations shall include the following information for each alternate considered:
 - (1) The quantity (average and peak) of sewage flow expected to be generated by the project using current City of Lakewood design criteria.
 - (2) The nature of wastes if not ordinary domestic sewage.
 - (3) The expected design point to design point flows in interceptor sewers (i.e., those major sewers greater than 12 inches in diameter as well as those which are expected to serve more than one phase or filing of the proposed development) shall be tabulated using the form in Table 303.12 or a similar form.
 - (4) In addition to the quantity of flow generated within a project, the impact of the project's expected peak flow on the sewer system downstream, from the point of connection to the first significant outfall, shall be investigated to ensure that adequate capacity is available not only for the proposed project, but for all present users of the existing public sanitary sewer system. Unless otherwise determined by the City of Lakewood, a significant outfall shall be considered to be any sewer or series of sewers which is continuously 12 inches or greater in diameter from the point in question to the Metro Wastewater Reclamation District's flow meter.
 - (5) If future development upstream of the project is anticipated, the estimated peak flow from such development is to be computed and routed through the

project to assess the impacts of such flows on the entire system to the point demarking the first significant outfall sewer. The Wastewater Collection System Master Plan, latest edition, may be consulted for this information.

- (6) The study should address the selection and evaluation of alternates, as well as phasing, and make recommendations as to the best plan to be selected for implementation.
- (f) Additional requirements may be added by the City of Lakewood in order to address special circumstances.
- (g) Any changes to the project which result in a revision of the information presented in the study shall be addressed in an amendment to the original feasibility study.
- (h) A site plan (1" = 200' suggested scale) which shall include:
 - (1) Study area boundaries.
 - (2) Proposed major sewer lines (i.e., those serving more than one phase or filing of any off-site area).
 - (3) Sub-area boundaries.
 - (4) A clear indication of how the sewage from each sub-area is to be conveyed to a proposed or existing major sewer.

303.13 Sanitary Sewer Study Requirements

- (a) A sanitary sewer study shall be submitted for all developments tributary to the Lakewood sewage collection system unless this requirement is waived by the City of Lakewood.
- (b) The study will be prepared by a Professional Engineer, currently registered in the State of Colorado, whose seal and signature shall be affixed to.
- (c) The narrative section shall include:
 - (1) Name, address and location of project.
 - (2) Adjacent street names.
 - (3) Legal description and/or vicinity map of the site.
 - (4) Existing or proposed zoning and land use for both the project and adjacent

areas.

(5) Type and size of development:

(i) Residential – Number of units and projected population using this criteria.

(ii) Industrial or Commercial – Building use and floor space (if known, otherwise land use and parcel area).

(d) A vicinity map (1" = 1000' suggested scale) shall accompany the study and include:

(1) Geographic location of the site.

(2) Relationship to major arterial streets.

(3) Any other landmarks that may be helpful.

(e) The site map (1" = 50' suggested scale, or 1" = 100' for larger projects) shall include:

(1) Lot lines and dimensions.

(2) Existing and proposed contours at two foot intervals.

(3) Sanitary sewer manhole inverts and rim elevations.

(4) Street names.

(5) Easement and right-of-way dimensions.

(6) Locations of curbs and sidewalks.

(7) Existing and proposed utilities (with storm and sanitary connections and appurtenances) dimensioned from the property lines.

(8) Sub-area boundaries for each design point studied on the existing or proposed sewer system.

(f) The flow calculations shall include:

(1) The quantity (average, peak and infiltration) of sewage flow expected to be generated by the project using this criteria calculated for each point of connection to the existing or proposed sewer system.

(2) For all proposed main-line sewers (at each design point), a tabulation of the expected flows (including upstream flows, see (6) below) using the form

illustrated in Table 303.12, or similar form.

- (3) The nature of wastes if not ordinary domestic sewage.
 - (4) The quantity and type of discharge of an unusual nature (e.g., swimming pool drainage, cooling water, commercial discharges, floor drains from auto repair garages, steam cleaning, chemical, dairy, food processing or service, car washes, metal treating or plating operations, etc.).
 - (5) In addition to the quantity of flow generated within a project, the impact of the project's expected peak flow on the sewer system downstream, from the point of connection to the first significant outfall, shall be investigated to ensure that adequate capacity is available not only for the proposed project, but for all present users of the existing public sanitary sewer system. Unless otherwise determined by the City of Lakewood, a significant outfall shall be considered to be any sewer or series of sewers which is continuously 12 inches or greater in diameter from the point in question to the Metro Wastewater Reclamation District's flow meter.
 - (6) If future development upstream of the project is anticipated, the estimated peak flow from such development is to be separately computed and routed through the project and existing system to assess the impacts of such flows on the entire system to the point of demarking the first significant outfall sewer. The Wastewater Collection System Master Plan, latest edition, may be consulted for this information.
 - (7) As required, the study should address the selection and evaluation of alternates, as well as phasing, and make recommendations as to the best plan to be selected for implementation.
- (g) Additional requirements may be added by the City of Lakewood in order to address special circumstances.
- (h) Any changes to the project which result in a revision of the information presented in the sanitary study shall be addressed in an amendment to the study.

303.14 Sanitary Sewer Design Report Requirements

- (a) At the discretion of the City of Lakewood, a design report may be required to be submitted with all major (generally greater than 12 inches in diameter) main-line sanitary sewer construction plans.
- (b) The report must be prepared by a Professional Engineer, registered in the State of Colorado, whose seal and signature shall be affixed to the report.

- (c) The report shall consist of:
- (1) A narrative description of the project.
 - (2) A vicinity map showing the location of the project (1" = 1000' suggested scale).
 - (3) A tabulation of the number of manholes and length of sewers of various sizes to be used in the project.
 - (4) A tabulation of sewer design flow conditions during "ultimate" periods for both average and peak flow using a form similar to that shown in Table 303.12 (Table 303.14 should be utilized in the calculation of sewer hydraulics at conditions less than full flow).
 - (5) Hydraulic grade line calculations for sewers 12 inches in diameter and greater which shall be presented as a line plotted on the sewer line profile drawing.
 - (6) An estimate of the cost of design and construction of the sewer system.
- (d) These requirements may be varied by addition or deletion at the discretion of the City of Lakewood.
- (e) The design report shall be incorporated into a sanitary study and/or submitted prior to the construction plans.
- (f) Any changes in the construction plans must be addressed in a revision to the design report.

Part 4 WATER SYSTEM FACILITIES DESIGN CRITERIA

304.1 General. The water supply and distribution system shall be designed as a whole with supply, treatment, transmission lines, pumping, reservoirs and distribution lines coordinated with each other to provide a totally integrated system. The total system shall provide adequate water to maintain the critical flows defined in section 303.8. All facilities shall conform to the Design Criteria for Potable Water Systems published by the CDPHE.

(a) Supply. Supply facilities include: diversion works at natural streams; supply ditches or conduits; wells, and raw water storage facilities.

(b) Treatment. Treatment facilities include any one or any combination of the controlled processes of coagulation, sedimentation, absorption, filtration, disinfection and other processes which are used to produce a water meeting the quality requirements of the CDPHE.

(c) Transmission Lines. Transmission facilities are pipelines and conduits that are used to transport treated water from treatment facilities to distribution reservoirs, or between distribution reservoirs. Transmission facilities may, under some conditions, be used as a part of the distribution system.

(d) Pumping. Pumping facilities are used to transport water from a supply source or a service level at a given elevation to a higher service level.

(e) Distribution Reservoir. Treated water storage facilities which are enclosed structures and are directly connected into the distribution system. They serve to stabilize pressure within a service level defined by a given differential in elevation.

(f) Distribution Lines. The distribution facility is that network of pipe lines that deliver water directly to the owner.

304.2. Supply Facilities.

(a) General. These criteria apply to water obtained from sources other than Denver Water.

(b) Adequacy of Supply. Generally a raw water supply is available physically because there is a legal right to divert, store and otherwise use the water. Ownership of water rights and facilities must be demonstrated by the water provider. Colorado water courts and the State Engineer determine the quantities of water, which may be legally diverted and/or stored without injury to other vested water owners. Proof of ownership, court decrees and administrative determinations, the amount of water physically available under the priority system and the number of equivalent single family taps is information that must be provided to and confirmed as correct by the City before issuing building permits.

Due to phasing or other conditions, there may not be a direct relationship between build

out design of a water system and the water supply initially available; however, any required water supply, whether for a phase or full build out, shall provide a perpetual water supply. In determining the realistic quantity of water that is available for domestic use, all decrees and administrative determinations that would affect the quantity must be considered. Design shall be based on allowable densities under the zoning classifications in effect or projected in relation to a perpetual water supply.

(c) Nothing contained herein shall be construed as a guarantee by the City of delivery of a given volume of water at a given pressure. This responsibility remains with the water supplier.

304.3. Treatment Facilities. Water treatment facilities, together with treated water storage reservoirs, shall be adequate to maintain design flows determined as required in Section 303.8.

(a) Fire Flow Requirements. The appropriate fire district shall determine duration and quantity of required fire flow.

(b) Storage and Replacement. The amount of storage and rate of replacement of water shall be determined as a function of treatment, pumping capacity and demand.

304.4. Transmission Lines, Pumping Facilities, and Distribution Reservoirs. These facilities shall be adequate to deliver the maximum daily consumption rate plus the basic fire flow, or peak design consumption rate, whichever is greater.

(a) Pumping Facilities. Pumping stations shall be provided with a minimum of two pumps for alternate operation and to accommodate pump repair or outage. Where reservoir storage or gravity supply is not available to provide service during a temporary electrical power failure, standby power shall be required.

(b) Storage Reservoirs. Provisions shall be made for continued service during the time a storage reservoir is out of service. Acceptable alternates are more than one reservoir in single service area; and/or pumping capacity to adequately serve facilities.

304.5. Distribution Lines. The lines in the distribution network shall have adequate capacity to deliver the required design flows to any given point.

(a) Minimum Line Sizes.

(1) Minimum size of lines in low density residential R-1-43, R-1-18, R-1-12, R-1-9, R-1-6 and R-2 areas shall be 8 inch.

(2) Minimum size of lines in other residential, office, commercial and all industrial areas shall be 8 inch.

(b) Depth. All distributions mains shall have no less than 5 feet and no more than 10 feet of cover, measured from the top of pipe to the final surface grade. Where final grades have not

been established, mains shall be installed deep enough to ensure acceptable cover below the future grade based on the best available information. Under no condition shall a main be installed with less than 5 feet of cover.

(c) Valve Spacing. Piping in the distribution system shall consist of a network of interconnected lines with valve spacing provided such that breaks or failures will not affect more than 500 feet of line in commercial and industrial districts or 800 feet of line in residential districts.

(d) Easements. Easement or rights-of-way widths shall conform to Denver Water Department Engineering Standards.

(e) Separations and Crossings.

(1) Horizontal Separation. The minimum parallel separation between water and sanitary sewer main lines and service lines, as measured outside of pipe to outside of pipe, shall be ten (10) feet horizontally. The minimum parallel separation between water mains and service lines and storm drainage mains and laterals, as measured outside of pipe to outside of pipe, shall be five (5) feet horizontally.

(2) Vertical Separation. The minimum vertical separation between water and sanitary sewer line crossings, as measured outside of pipe to outside of pipe, shall be eighteen (18) inches. The water line shall be constructed above the sanitary sewer line. The minimum vertical separation between water and storm drainage line crossings shall be eighteen (18) inches, measured from outside of pipe to outside of pipe.

Water lines shall be placed at least five (5) feet below the invert of an open drainageway or irrigation ditch and placed in a steel sleeve.

(f) Dead End Lines. Dead end lines not serving a fire hydrant shall be provided with a positive means of periodically flushing such lines.

(g) Fire Hydrant Spacing. The appropriate fire protection district shall determine fire hydrant spacing.

(h) Friction Coefficients. Evaluation and design of lines will be based on the following friction coefficient:

Ductile iron pipe (cement lined)	C=120
PVC pipe	C=140
Concrete Pipe	C=120
Steel pipe (cement lined)	C=120

(i) Taps. All taps less than 2” in size, approved onto an existing distribution main, will be made by the Denver Water Department, and shall be paid for by the applicant.

(j) Tracer Wire. Tracer wire shall be installed on all non-metallic water mains. The wire shall be AWG size #10, type UF or use cable, UL listed, with a single conductor.

Part 5 WATER SYSTEM CONSTRUCTION STANDARDS

305.1. General. Construction of public water system improvements shall be in compliance with these standards and the specifications found in Appendix A. All materials shall meet applicable AWWA, ASTM or ANSI standards. Construction specifications will be prepared for each project; however, pipe material for all lines 24 inch or smaller shall be ductile iron, PVC or cement lined steel. These rules and regulations shall be a minimum standard, which may be superseded. In the absence of water system construction standards and specifications within these rules and regulations, design and construction shall adhere to the Denver Water Department Engineering Standards or other provisions of the City of Lakewood Engineering Regulations, Construction Specifications and Design Standards. That document by reference adopts current editions of the Colorado Department of Transportation Standard Specifications for Road and Bridge Construction and the Colorado Department of Transportation Construction Manual.

305.2. Pipe.

(a) Soil Corrosion and Electrolysis. Metallic pipes are susceptible to electrolytic action. At locations where the history of performance indicates any degree of deterioration of the pipe or in areas where the reaction of the soil to metallic pipe is unknown, a soil resistivity survey shall be made. Based on the results of such a survey, a determination of the type of pipe, the need for protection of metallic pipe and the type of protection against deterioration of metallic pipe shall be made. All ductile iron pipe shall be wrapped in polyethylene encasement for purposes of minimum corrosion protection. Polyethylene material shall not be less than 8 mils in thickness and shall meet the requirements of ASTM D-1248, Type 1, Class A or C.

(b) Ductile Iron Pipe and Fittings.

- (1) Ductile Iron Pipe shall conform to AWWA C151, class 52 thickness, with the added requirement that all pipe shall have a standard thickness cement mortar lining conforming to AWWA C104.
- (2) Fittings for underground ductile iron pipe shall be ductile iron or cast iron fittings with mechanical joint ends and shall conform to AWWA C111 or C153.

(c) Plastic Pipe and Fittings.

- (1) 4-inch through 12-inch Polyvinyl Chloride (PVC) plastic pipe shall meet the requirements of AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe. Pipe pressure classes shall be selected to meet the design requirements of each application, but in no case shall be less than pressure class 200 (SDR14). The pipe shall also meet Uni-Bell Standard Uni-B-2-72.
- (2) 14-inch through 24-inch PVC pipe shall meet the requirements of AWWA C905, Polyvinyl Chloride Transmission Pipe. Pipe shall be selected to meet the design requirements of each application, but in no case shall be less than Pressure Class 200 (SDR18).
- (3) Fittings for plastic pipe shall be ductile iron or cast iron fittings with mechanical joint ends, and shall conform to AWWA C111 or C153.

305.3. Valves and Hydrants.

(a) Gate Valves. Gate valves shall be double-disc iron body, fully bronze-mounted, resilient seat with non-rising stem conforming to AWWA C500. Valve end connections shall be mechanical joint. Gate valves shall be provided with suitable valve boxes.

(b) Butterfly Valves. Butterfly valves shall conform to AWWA C504.

(c) Pressure Reducing and Regulating Valves. Pressure reducing and regulating valves that are a part of the distribution system shall be a type capable of maintaining preadjusted downstream pressures with varying rates of flow and upstream pressure without causing water hammer. Valves shall be piston type, not spring operated, with flanged end connections, globe body, fully bronze mounted, external pilot operated with the following requirements:

- (1) Installed in a concrete vault.
- (2) Be fully powered by water from the pipeline in which they are installed.
- (3) Pressure gages installed both upstream and downstream.
- (4) Not be dependent on diaphragms, liners or springs for piston movement or positioning.
- (5) Have an external valve piston position indicator.
- (6) Be constructed so as to facilitate repairs and internal dismantling without removal of valve from pipeline.

(7) Be constructed to provide easy access to the pilot to allow its removal while main valve is under pressure.

(8) Be provided with bypass of smaller pipe size with pressure reducing and regulating valve to accommodate low flows.

(d) Check Valves. Check valves shall be of the swing check type and shall be used wherever the flow of water must be in only one direction and reverse flow must be prevented. Check valves shall be of the outside spring and lever type. Check valves shall be furnished with flanged end connections and shall be installed in a concrete vault that allows easy access for inspection, adjustment and maintenance.

(e) Fire Hydrants. Fire hydrants shall be manufactured in conformance with AWWA C502. Hydrants shall be cast iron with full bronze mounting and shall have a bell opening to fit 6-inch branch pipe. The valve opening in the fire hydrant shall be not less than 5-inches in diameter. Hydrants shall have one 4 1/2 inch pumper connection and two 2-1/2 inch hose connections. Threads on the pumper and hose connections shall conform to the requirements of the fire department equipment of the area that they are to serve.

(f) Working Pressure Requirements. All piping, fittings, valves, hydrants and appurtenances in the water supply and distribution system shall conform to the following minimum working pressure:

Piping	150 p.s.i.
Fittings	250 p.s.i.
Valves	150 p.s.i.
Hydrants and appurtenances	150 p.s.i.

305.4. Water Main Installation.

(a) Location. All water mains shall be installed to proper line and grade within dedicated roads, streets or public ways or within easements or rights-of-ways all or a portion of which are specifically for the purpose of water main construction, maintenance and operation. The desired location is to the north and east of the centerline of the road, street, public way, easement or right-of-way. The exact location will depend on conditions such as location of existing facilities to which the main is to connect, location of other existing or planned utility lines and location of existing or planned drainage facilities.

(b) Air Release. Twelve-inch and larger mains shall be constructed to slope continuously to air release valve assemblies installed at high points, to allow the expulsion of trapped air.

(c) Thrust Blocks and Harness Rodding. Concrete thrust blocks and/or harness rods shall be installed at all outlets, bulkheads, fittings, horizontal and vertical bends and branches. All concrete thrust blocks shall be designed for shape and size as required by internal pressure and load bearing capacity of the soil and shall in every instance bear against undisturbed earth. All

harness rods shall be designed to resist thrust resulting from internal pressure and shall be protected by means of polyethylene wrap in any soils. Polyethylene material shall not be less than 8 mils in thickness and shall meet the requirements of ASTM D-1248, Type 1, Class A or C.

(d) Megalugs: The use of megalug restraint systems may be used in lieu of harness rods.

Part 6 WATER SERVICE LINES - MATERIALS

306.1. General. All new or replacement water service lines and appurtenant fittings installed shall conform to the following minimum standards:

(a) Water Services Specifications in Appendix A.

(b) Uniform Plumbing Code, Denver Water Department Engineering Standards. The basis for these rules and regulations pertaining to devices required to protect the integrity of the potable water system and sizing of service lines is the most current Uniform Plumbing Code and Denver Water Department Engineering Standards, except as herein modified or changed.

Part 7 WATER SERVICE LINES - INSTALLATION

307.1 General Requirements. Only City of Lakewood licensed contractors, operating under a current City of Lakewood utility and/or public way permit shall install water service lines. Contractors shall be responsible for complying with all applicable state, county and city laws, ordinances and regulations. Permits will be issued only after all required fees, including tap fees, have been paid. All materials and workmanship shall be performed as specified in the most current edition of the Denver Water Department Engineering Standards and the Uniform Plumbing Code.

307.2 Location. That portion of the water service line between the main and the property line shall be in a continuous straight line at approximately right angles to the line of the main. Should a right angle installation be impractical, the owner will submit the proposed service line location and secure written authorization from the City to install the water service line at some angle other than perpendicular to the main. Water service lines will not be allowed to cross one lot to provide service to an adjacent lot.

(a) Corner Lots. In the case of corner lots the property may be served from either the side or front under the same regulations as above.

(b) Cul-De-Sac Streets. If service is requested for a lot at the end of a cul-de-sac street, the main to be tapped will generally be not more than 15 feet from the front property line at the end of the cul-de-sac. The service line between the main and the property line shall be in a continuous straight line and will, under most conditions, enter the property a minimum distance of 5 feet from the nearest lot corner.

307.3 Backflow Prevention. A backflow prevention device will be required on all new and existing service lines at the time of permit issuance for new construction or alterations to existing structures. This requirement applies to all commercial and multi-family domestic taps, taps where there is a dual water supply on the premises, and fire lines. Types and installation of backflow prevention devices shall be in accordance with the Denver Water Department Engineering Standards 5.05 and Chapter 11 of the Operating Rules.

307.4 Connection to Main. The connection to the water main will be accomplished and paid for by the owner.

307.5 Road Resurfacing Repair. Street pavements, curbs, gutters and sidewalks disturbed in the construction of water service lines shall be replaced and/or resurfaced as specified in the required Lakewood public way permit. Backfill and compaction of trenches under public streets shall be accomplished as specified in the required Lakewood public way permit.

Part 8 SEWAGE SYSTEM FACILITIES DESIGN CRITERIA

308.1. General. The sewage system consists of sewage collection lines, sewage pumping stations, sewage treatment facilities and outfall sewers.

(a) Sewage Collection System. The sewage collection system consists of a system of sewer pipes, with all the necessary appurtenances, used for the collecting and transporting of all domestic sewage from residences and buildings to a common outfall line or a treatment facility.

(b) Sewage Pumping Station. A sewage pumping station consists of pumping equipment and appurtenances and the structure housing the equipment and appurtenances, used for moving sewage to a higher level.

(c) Outfall Sewers. Outfall sewers are sewer lines used to carry sewage in the following ways:

- (1) From the collection system to the place where another entity accepts it for treatment;
- (2) From the collection system to the sewage treatment facility;
- (3) From the sewage treatment facility to the point of discharge into a receiving stream.

308.2. Systems Criteria.

(a) Sewage Collection System. All elements of the sewage collection system shall be designed to meet Design Criteria Considered in the Review of Wastewater Treatment Facilities

published by CDPHE. All sewers shall be designed to meet the criteria and carry design peak flow rates while flowing 80% full.

(b) Sewage Pumping Stations. Sewage pumping stations shall be evaluated and designed in accordance with the applicable provisions of Design Criteria Considered in the Review of Wastewater Treatment Facilities published by the CDPHE and subject to the following criteria:

- (1) All pumps in any pumping station shall be of the same design and manufacture and of equal capacity to facilitate interchange of repair parts.
- (2) Wet well type sewage pumping stations may be used provided that a) all pumping equipment and motors, except the impeller, pump shaft and assembly and all control equipment, except probes, be located above the wet well cover; b) that the entire pump assembly can be removed for maintenance and repair; c) that the pump impeller be open non-clog type; d) that the wet well cover be gas tight so that no gas can reach the operating floor from the wet well; and e) that the wet well and the operating section be separately and adequately ventilated.
- (3) Two separate power supplies or a stand-by generator are required.

(c) Collection Lines. The minimum size for sewage collection systems shall be 8 inches.

- (1) Alignment. Sewers will be laid with a straight alignment between manholes. No curved sewers will be allowed. Sewer lines may not be located within any designated or proposed floodway.
- (2) Depth. All collection mains shall have a minimum depth of cover of three and one-half (3.5) feet, and a maximum depth of cover of twenty (20) feet, measured from the top of pipe to the final surface grade. Where collection main depths are less than three and one-half (3.5) feet, and the main is located under a right-of-way, street, driveway, parking lot, or other areas where live loading is a concern, special pipe materials (such as ductile iron pipe or C-900 PVC) or other structural measures (such as concrete encasement) shall be provided.
- (3) Slopes. The slope of all main lines between manholes shall be uniform. All mains shall be designed with an adequate slope to provide flow velocities of two (2) feet per second during average flow conditions. If constraints exist that this minimum slope is not practical, upon approval of the City of Lakewood, slopes that provide peak design flow velocities of two (2) feet per second may be allowed.

The maximum allowable slope shall be based upon ten (10) feet per second maximum velocity at peak design flow

- (4) Separations and Crossings. A minimum lateral distance of ten (10) feet should be maintained between sanitary sewer lines and other utilities, especially gas and water mains.

Where sewer lines cross water mains or where they come within ten (10) horizontal feet of each other, the sewer pipe shall be a minimum of eighteen (18) inches clear distance vertically below the water main. If this clear distance is not feasible, the sewer pipe section must be designed and constructed so as to protect the water main. The following are acceptable protections:

(i) C-900 PVC pipe of the same diameter centered over the water main so that joints are at least ten (10) feet on either side of the water main crossing point. Suitable solid sleeve adaptors and encasement at the transition points shall be required.

(ii) Steel casing pipe completely encasing the sewer line, with appropriate spacers to provide proper support for the sewer pipe. The casing pipe shall extend a distance of ten (10) feet either side of the water main crossing point.

(iii) Concrete or vitrified clay sewer pipe shall be placed within a reinforced concrete encasement. The encasement shall be at least six (6) inches thick and extend a distance of ten (10) feet either side of the water main crossing point.

Sewer lines shall be placed a minimum of three (3) feet below the invert of an open drainageway or irrigation ditch, and at least eighteen (18) inches below the invert of a drainageway or irrigation ditch culvert. The sewer line shall be placed in a steel sleeve or, if approved by the City, may be encased in concrete. Minimum vertical separation from storm sewer pipe and other underground drainage facilities shall be eighteen (18) inches.

- (5) Ground Water Barriers. Where there exists a possibility that ground water may be diverted by the construction of new sewer mains, ground water barriers shall be constructed within the pipe trench to prevent ground water migration or diversion along the sewer main. The location and number of ground water barriers shall be determined by the City.

- (6) Inverted Siphons. Inverted siphons will not be allowed in the City of Lakewood.

(d) Manholes. Manholes will be provided at every change in slope, change in size of pipe, change in direction, and at connections with other main sewers. A manhole will also be provided at the end of a sewer line run. Manholes shall be required at all service connections for

wastewater service lines six (6) inches in diameter for larger. Manholes shall not be located within the limits of a detention pond.

- (1) In manholes where the downstream pipe is larger than the upstream pipe, the crown elevation of the two pipes will match.
- (2) Spacing. Maximum spacing of manholes will be 400 feet for 15-inch and smaller sewers, 450 feet for 18-inch and 21-inch sewers, and 500 feet for 24-inch and larger sewers.
- (3) Diameter. The minimum inside diameter of the manhole barrel will be 4 feet for 24-inch and smaller sewers, 5 feet for 27-inch through 36-inch sewers, and 6 feet for 42-inch through 48-inch sewers. Special manholes will be used for sewers larger than 54 inches.
- (4) Drop Manholes. Drop manholes shall be avoided whenever possible. When no other alternatives are available, an outside drop manhole shall be required where the invert of the upstream pipe section entering the manhole is greater than two (2) feet above the invert of the downstream pipe section exiting the manhole.
- (5) Flow Channels. Flow channels shall be required in all manholes, connecting the inverts of the upstream and downstream pipe sections. The flow channel shall be U-shaped and shall meet the following minimum heights:
 - (i) One-half of the diameter (or to pipe centerline) on collector pipes less than 15 inches in diameter.
 - (ii) Three-fourths of the diameter on collector pipes 15 inches and larger in diameter.The suggested drop through the flow channel, from entering pipe invert to exiting pipe invert, is as follows:
 - (i) Straight flow: 0.10 to 0.25 feet.
 - (ii) Angular flow: 0.20 to 0.50 feet.
- (6) Bench. The top of the manhole bench shall be at the same level as the crown of the highest sewer pipe entering the manhole (except for the upper connection of outside drop structures).
- (7) Maintenance Access. Direct access by maintenance vehicles shall be provided to each manhole. The access drive shall be an all-weather surface,

such as asphalt or concrete paving, adequate gravel base or turf block, and shall be capable of supporting maintenance vehicles weighing up to 14 tons.

- (8) **Covers.** Manholes that are not located within a public street, alley or driveway section shall be installed with a bolting-type cover to ensure safety and prevent vandalism.

Where manholes must be located within the 100-year floodplain, or in a location where runoff may accumulate and pond, a watertight, bolting-type cover shall be installed to prevent inflow/outflow. The manhole ring shall be bolted to the manhole cone to prevent possible damage due to surcharge.

(e) **Easements.** The minimum easement width shall be 20 feet. Wider easements may be required where the depth of the sewer line requires additional width to satisfy standards for utility separations, trenching excavations, or adequate maintenance access. Easements shall provide a minimum parallel separation of five (5) feet between the edge of the sewer line and the easement boundary. No trees or structures of any kind will be allowed within a sanitary sewer easement.

(f) **Outfall Lines.** Outfall lines conveying treated sewage will be evaluated or designed by standard engineering principles governing pipe lines.

(g) **Abandonments.** Requests to abandon an existing public or private sewer line must be submitted by the property owner(s), which are or could potentially be served by the facility to be abandoned, in writing to the City of Lakewood for approval. The request will provide a detailed site plan, along with justification for abandonment. Proof of property ownership must also be submitted.

The City Of Lakewood will review requests and determine if it can be granted. If permission to abandon can be given the City Of Lakewood will issue a Utility Permit. The owner, or his agent, is then responsible to schedule an on-site inspection through the City of Lakewood Utilities Department at least 48 hours in advance of the desired inspection time. All sewer work will be performed in accordance with the City Of Lakewood Water and Sewer Rules and Regulations and the contractor must be licensed to work in the public right-of-way.

Manholes to be abandoned in place shall have all pipes entering or exiting the structure plugged with a standard manufactured plug and lean concrete so they are water-tight. Manhole tops or cone sections shall be removed to the first full barrel diameter section and/or to a point not less than 24-inches below final grade. No sandbags are allowed to be used as permanent plugs. The structure shall then be backfilled and the backfill compacted in accordance with the Technical Specifications in Appendix A. Backfill material may be either select backfill, clean suitable excavated material, or controlled low strength material (flowfill). Manhole rings, covers, and cone sections will be removed and taken to the City Of Lakewood Utilities Maintenance Division unless they have been approved to be used elsewhere for sewer relocation.

Sewer lines to be abandoned in place shall be plugged with lean concrete and standard manufactured plugs or caps shall be installed at both the upstream and downstream ends of the abandoned section. If manholes are also abandoned in place, or if the structure is removed completely, all sewer lines shall be plugged upstream and downstream of the removed structure. Sewer lines to be abandoned with an internal diameter of 24-inches or larger shall be filled with sand, pumped grout mixtures, or flowable fill in order to minimize future subsidence attributable to the potential collapse of the abandoned facility. Sewer lines with an internal diameter of 21-inches and smaller shall be plugged at the entrance and exit ends with approved grout mixtures or concrete.

Part 9 SEWAGE SYSTEM CONSTRUCTION STANDARDS

309.1. General. Construction of public sanitary sewer system improvements shall be in compliance with these standards and the specifications found in Appendix B. Construction specifications will be prepared for each project; however, pipe material for all lines 24 inches or less in diameter shall be PVC unless loading requirements require pipe of greater strength. In the absence of sewer system construction standards and specifications within these rules and regulations, design and construction shall follow other provisions of the City of Lakewood Engineering Regulations, Construction Specifications and Design Standards. That document by reference adopts current additions of the Colorado Department of Transportation Standard Specifications for Road and Bridge Construction and the Colorado Department of Transportation Construction Manual.

309.2. Pipe.

(a) Plastic Pipe and Fittings. Polyvinyl Chloride (PVC) Sewer Pipe and Fittings shall conform to the requirements of ASTM Designation D3034, F679 or F794 as appropriate.

(1) Pipe shall have elastomeric gasket joints and have a minimum SDR of 35.

(2) Fittings shall have elastomeric gasket joints and have a minimum SDR of 35.

309.3. Pipe Joint Material.

(a) Plastic Pipe.

(1) PVC joints shall conform to the requirements of ASTM D3034, for elastomeric gasket joints only.

309.4. Stoppers and Closures. Stoppers shall be water tight when in place and capable of being removed for extension of the line.

309.5. Steel Pipe Casing. Steel pipe casing, to be used for encasement of sewers where boring under roadways, railroads, ditches, etc., is required and shall conform to the requirements of AWWA C200.

309.6. Manholes. Manholes shall be prefabricated concrete barrel sections having a cast in place concrete base with cast iron ring and lid, and aluminum or plastic steps. The cone portion of the manhole shall be eccentric for easier access. Manhole bases shall be monolithically cast in place a minimum of 6 inches above the largest pipe. Gasketed boots or “O” rings at all pipe connections are required.

(a) Precast Manholes. Precast manholes shall conform to the requirements of ASTM C-478 constructed with Type II cement. Pre-cast manhole bases may be allowed in certain circumstances and must receive approval from the City of Lakewood Engineering Division prior to installation.

(b) Manhole Ring and Cover. Manhole rings and covers shall be circular, provide a clear opening of 22 inches, have the word “SEWER” cast in the cover, have a ground seat and be cast iron.

(1) Cast iron manhole rings and covers shall be gray cast iron conforming to ASTM A-48.

(2) Manhole Steps. Manhole steps shall be one of the following types:

(a) Aluminum alloy conforming to Federal Specification QQ-A-200/8.

(b) Copolymer polypropylene plastic encapsulating a 3/8" Grade 60 steel bar, Model PS-2-PF, as manufactured by M.A. Industries, or equal.

309.7. Sewer Collection System Installation.

(a) Location. All sewer pipes shall be installed to proper line and grade within dedicated roads, streets or public ways or within easements or rights-of-ways specifically for the purpose of sewer line construction, maintenance and operation. The desired location is to the south and west of the centerline of the road, street, public way, easement or right-of-way. The exact location will depend on conditions such as location of existing facilities to which the main is to connect and location of other existing or planned utility lines. Sewer lines should be straight in alignment between manholes unless some unusual condition exists which will not permit straight alignment.

(b) Pipe Laying. Pipe shall be joined in the manner prescribed by the manufacturer of the joint being used. All surfaces shall be clean and free from dirt and water at the time the joint is made. Pipe shall not be laid in water or when the trench condition or weather is unsuitable for such work.

(c) Jacking or Boring. Pipe lines under railroads, streets and roads, ditches, etc., where open trench construction cannot be used shall be installed in a steel pipe casing that has been jacked or bored into place.

(1) Design of the casing shall be such that it will resist all superimposed loads as well as stresses resulting from the jacking or boring operation.

(2) Placing sewer pipe through casing shall be accomplished by a method whereby the skids or supporting means will become the permanent support for the pipe in the casing.

(d) Inspection. Backfilling shall not be done until the City makes final inspection for the entire sewer main line and all construction is found acceptable and approved. The contractor shall provide to the City "as-built" drawings showing the location, length of pipe, fittings, dimensions and all other pertinent information for all main line installations.

Part 10 SEWER SERVICE LINES - MATERIALS

310.1 General. All new or replacement sewer service lines shall conform to the following minimum standards.

(a) Size of Service Line. The sewer service line shall not be less than 4-inches in diameter and in no instance shall such service line be smaller than the building stack to which it connects.

(b) Sewer Pipe. Types of pipe and fittings that may be used for sewer service line construction are as follows:

(1) Plastic Pipe.

(i) ABS and PVC pipe and fittings are acceptable and shall be SDR 35 sewer pipe, meeting the requirements ASTM D3034, F679 or F794, or a minimum Schedule 40 classification.

(c) Pipe Joint Material. All piping and joints shall be capable of withstanding a hydrostatic head of 10 feet without exceeding the standards of Section 303.10 (c) for infiltration - exfiltration requirements.

(1) Plastic Pipe.

(i) ABS and PVC pipe joints shall be flexible to provide for longitudinal movement, and shall be locked in place with rubber sealing rings or glue. Joints and material shall be as recommended by the pipe manufacturer.

(2) Public Sewer Connection.

- (i) Connection at an existing wye branch will be made by using the appropriate type of joint herein outlined by a licensed contractor operating under a valid utility and/or public way permit. Where necessary to join unlike pipe, proper solid sleeve adapters or solid sleeve couplings shall be used. The resulting connection shall be watertight.

Alternatives to solid sleeve couplings shall consist of a rubber gasket or boot and a stainless steel tightening band with a continuous span across the pipe joint. The coupling shall conform to requirements of ASTM C425 and shall be "Mission" ARC or approved equal. Adapters manufactured by Onset Pipe Products, Inc. may be substituted as approved by the City Engineer.

- (ii) When connection to the public sewer is made by tapping the sewer main, a City of Lakewood licensed plumber operating under a valid utility and/or public way permit must perform the work. Fittings used at locations where the sewer main is tapped shall be cast aluminum alloy or plastic and shall be capable of receiving all normally used types of pipe and joints herein specified. The fitting shall be capable of being inserted into a mechanical drilled hole not exceeding 4 1/2 inches in diameter for 4-inch service line and not exceeding 6 1/2 inches in diameter for a 6-inch service line. The fitting used shall be made in such a manner as to insure that no protrusion of the fitting into the main sewer pipe will result and shall be bonded to the main sewer with stainless steel bands. The fitting shall fit the contour of the inside of the public sewer and shall be specifically designed to fit the particular size public sewer into which it is connected. The joint material connecting the fitting to the pipe shall be an epoxy material capable of making a completely waterproof joint and capable of withstanding any condition of stress or strain likely to be encountered in normal sewer service construction or maintenance.
- (iii) Prohibited Connections. No surface water, ground water, or cooling water may be discharged into the sewer service line. Prohibited connections include roof drains, storm inlets, foundation perimeter drains, area drains for open space patios or driveway entrances to parking structures, and ground water sump pump systems.

310.2. Grease and Sand/Oil Interceptors. Plans for proposed connections to the public sewer will be reviewed prior to issuance of a permit for such connections to determine if grease or sand/oil interceptors will be required. Interceptors may be required in order to prevent grease, fats, petroleum products, or deleterious substances from entering the public sewer system. The kind, nature and capacity of the grease or sand/oil interceptor to be installed shall conform to the applicable section of Chapter 4, Part 2.

310.3. Sewer Meters. If it is not possible or practical by means of water usage to determine the wastewater contribution of commercial or industrial customers, the City may require installation of a sewage flow-measuring device. The City must approve the style, type, and location prior to installation.

Part 11 SEWER SERVICE LINES - INSTALLATION

311.1. General Requirements. City of Lakewood licensed contractors, operating under a current City of Lakewood utility and/or public way permit shall install sewer service lines. Contractors shall be responsible for complying with all applicable state, county and city laws, ordinances and regulations.

Permits will be issued only after all required fees, including connection fees, have been paid.

311.2. Grade and Alignment. Service lines shall be laid on a uniform grade, and in straight alignment, free of abrupt bends. Grade shall not be flatter than 2% (1/4-inch per foot), without express written approval from the City of Lakewood Engineering Division. Such approval will only be granted based on sound engineering and plumbing practices.

311.3. Location. The portion of the sewer service line between the main and the property line shall be in a continuous straight line at approximately a right angle to the sewer main. Written permission must be obtained from City of Lakewood Engineering Division to install a sewer service line at any other angle to the main.

Sewer service lines shall maintain a minimum separation of ten (10) feet from water service lines for that portion of the service line that is located in the public right-of-way or easement.

311.4. Excavation. All excavations shall be open cut except at sidewalks, curbs, or other buried utility lines. Width of trench excavation shall be a minimum of 2 feet. The foundation in the trench shall be firm earth, free from water. The pipe shall be bedded in approved bedding material, extending to a minimum of 6 inches above the top of the pipe.

311.5 Connection to Public Sewer. Each connection to the public sewer shall be made at the wye designated for that property. If no wye is designated, or if the wye cannot be located within three feet of the point of measurement furnished by the City of Lakewood Engineering Division, or if the applicant for good reason does not wish to use the wye designated for that property, and this is approved by the City, the public sewer shall be mechanically tapped. At locations where the public sewer main line is 2" or less in diameter larger than the sewer service line, the connection shall be made to the main line by a manhole. All other sanitary sewer service line connections shall be connected to the sanitary sewer main between manholes, and shall be spaced a minimum of eighteen (18) inches apart and a minimum of two (2) feet away from any manhole. All connections to the wye branch, all tapping operations, including affixing the tapping saddle, and/or construction of a manhole at each connection to public sewer will be accomplished and paid for by the owner.

(a) Connection at a Manhole. Attachment to the system may be made at a manhole only with prior approval from the City of Lakewood Engineering Division.

(1) Construction. All service lines attached at a manhole must meet the following:

- (i) The service line must approach the manhole in the direction of flow. The angle measured between the service line and the main line must not exceed 80 degrees; preferred is 45 degrees.
- (ii) The new service line shall rest directly on the original bench and provide for a smooth, continuous flow into the main line invert. Alteration of the original bench will not be allowed. Discontinuity or abrupt changes in flow lines will not be permitted.
- (iii) The manhole barrel must be core-drilled in a workmanlike manner to accommodate the service line, which shall extend into the manhole barrel at least 4 inches. The service line shall be grouted in place forming a watertight seal. Leakage or infiltration will be cause for repairs at the expense of the applicant/owner.

311.6. Laying of Pipe. Pipe laying shall progress upstream from the public sewer to the building. Pipe joints shall be made in strict accordance with the recommendations of the pipe manufacturer. Tracer wire shall be attached directly to the pipe, from the main line to the foundation, in order to permit surface detection of the pipe after backfilling. The wire shall be AWG size #10, Type UF or cable, UL Listed, with a single copper conductor. One end of the wire is to be inserted inside the upper part of a cleanout installed on the service line just outside the foundation wall.

311.7 Clean-Outs. At a minimum, a single sweep clean-out shall be installed on the service line just outside of the foundation wall and should be accessible for cleaning purposes. The clean-out shall be installed with the top approximately 6" above finished grade with a screw-on cap and the direction of the sweep oriented toward the main line.

Clean-outs are also required at not-to-exceed intervals of 100' on service lines between the connection to the main line and the building foundation, and when the angle of the total aggregation of bend exceeds 135°.

311.8. Inspection. Backfilling shall not be done until the City makes final inspection for the entire sewer service line and connection onto the main sewer line and all construction is found acceptable and approved. The contractor shall provide to the City "as-built" drawings showing the location, length of pipe, fittings, dimensions and all other pertinent information for all service line installations.

311.9. Backfilling and Compaction. Care shall be exercised in backfilling along the sides of the

pipe to properly support the pipe. Approved bedding material shall be placed and solidly hand tamped up to the top of the pipe. To protect the pipe from breaking or cracking during the remainder of the backfill operations, hand backfill using approved bedding material shall be continued at least 6 inches above the top of the pipe. The remainder of the trench shall be filled with the excavated material in layers of approximately 12 inches and compacted by mechanical tamping equipment that will insure a completely filled trench that will not result in a settlement. Backfill material shall be compacted at or near optimum moisture content. If necessary, water shall be added to the backfill to obtain near optimum moisture content. Backfill under public streets shall be accomplished as specified in the required street cut permit.

311.10 Road Resurfacing Repair. Street pavements, curbs, gutters and sidewalks disturbed in the construction of sewer service lines shall be replaced and/or resurfaced as specified in the required Lakewood public way permit. Backfill and compaction of trenches under public streets shall be accomplished as specified in the required Lakewood public way permit.

311.11 Pipe Bursting. Pipe bursting of existing service lines for repair and/or replacement may be allowed in certain circumstances. Approval from the City of Lakewood Engineering Division must be obtained before this type of service line repair/replacement can begin.

The following procedures will be required during the pipe bursting process:

- (a) A TV inspection of the existing service line shall be made in the presence of a City of Lakewood Engineering Division representative.
- (b) Based on the results of the TV inspection, the pipe bursting process may be allowed to proceed or another form of repair/replacement will need to be performed.
- (c) A clean-out will be required to be installed on the service line per Section 311.7 above.
- (d) Upon completion of the pipe bursting process, a TV inspection of the installation shall be made in the presence of a City of Lakewood Engineering Division representative. Any bellies or sags exceeding 1/4" shall be repaired by open excavation and replacement of the defective section(s).

311.12. Stub-Out. In order to eliminate future excavation in the public way, the owner may make application for and install stub-outs to serve buildings for which platting has been approved zoning. Stub-outs will extend to the property line, will be marked with a location pin on surface, and be subject to the same construction, inspection, and workmanship standards cited above.

- (a) Infiltration. Particular care must be exercised when plugging a stub-out at the property line to eliminate the infiltration of sub-surface waters.

- (b) Fee. A stub-out fee may be levied for each stub-out, as set forth by a schedule of rates, charges, and fees for sanitary sewer service.

311.13 Abandonments. Requests to abandon an existing private sewer service line must be submitted by the property owner(s) in writing to the City of Lakewood for approval. The City of Lakewood will review requests and determine if it can be granted. If permission to abandon can be given the City of Lakewood will issue a Utility Permit. The owner, or his agent, is then responsible to schedule an on-site inspection through the City of Lakewood Utilities Department at least 48 hours in advance of the desired inspection time. All sewer work will be performed in accordance with the City Of Lakewood Water and Sewer Rules and Regulations and the contractor must be licensed to work in the public right-of-way.

Existing sewer service lines shall be abandoned at the physical tap location on the main sewer line. The service line shall be cut and separated from the tap on the main line and either a cap shall be secured to the existing tap or a cured-in-place point repair shall be made inside the main line at the service tap location.

CHAPTER 4 WASTEWATER TREATMENT CRITERIA

Part 1 CONTROL OF WASTEWATER

401.1. Policy. The City shall not permit the introduction of substances into the sewage system which may result in physical damage to the structures, interference with operation of the sewer system, cause excessive maintenance, or interfere with sewage treatment.

(a) Normal Domestic Wastewater. As used herein, “normal domestic wastewater” means wastewater which does not exceed a biochemical oxygen demand strength index of 250 parts per million by weight or a suspended solids strength index of 300 parts per million by weight. Concentrations in excess of either or both the above are deemed “unusual concentrations.”

(b) Items of Concern. Curtailment, cost recovery for treatment, or pretreatment of wastes may be required for wastes which exceed the composition of normal domestic wastewater, and which may have any adverse effects upon the collection system, treatment process, treatment works, or receiving waters, according to the following guidelines:

- (1) The quantity, composition, and strength of wastes should not interfere with the normal collection and treatment process.
- (2) Wastes should not create or increase any chemical, radiological, biological, explosive or health hazards to equipment, operating personnel, or the general public.
- (3) Wastes should not cause the treatment works to produce an effluent of such type, composition, or strength, which will not meet the water quality standards of the receiving waters, except those failures which are due to the inability to treat normal domestic wastewater.
- (4) Clear water inflow should be reduced through the elimination of non-polluted waters, unauthorized drains and surface water entry.
- (5) Wastes should not reduce the hydraulic capacity of the sewage system below designed capacity such as, but not limited to, the sudden release of large volumes of water into the system, or build-up of deposits which reduces the carrying capacity of lines.

401.2. Prohibited Wastes. The following shall not be discharged into the sanitary sewer system:

(a) Water. Foreign water including storm water, surface water, ground water, roof runoff, subsurface drainage, unpolluted cooling water, industrial process waters, sump pump discharges, or drainage from swimming pools, excluding swimming pool cleaning and filter wash waters.

(b) Chemicals.

- (1) Flammable substances, such as gasoline, benzene, naphtha, fuel oil, or any other flammable or explosive liquid solid or gas.
- (2) Toxic or poisonous solids, liquids or gases in such quantity, either singly or by interaction with other wastes as to injure or interfere with any sewage treatment processes, constitute a hazard to humans or animals, create a public nuisance or create any hazard in the receiving waters, including but not limited to cyanides or compounds capable of liberating hydrocyanic acid, hydrogen sulfide, and sulfur dioxide.
- (3) Corrosive waters or wastes having a pH lower than 5.5 or having other corrosive properties capable of causing damage or hazards to structures, equipment, and personnel.
- (4) Solid or viscous substances, organic or inorganic, dissolved or suspended, in quantities of such size as to cause obstructions to the flow in sewers or which otherwise interfere with the proper operation of the sewage works. Such substances either whole or ground by grinders, include, but are not limited to, ashes, cinders, sand, mud, straw, shavings (wood or metal), metal, glass, rags, feathers, tar, plastics, wood, garbage, whole blood, manure, hair and fleshings, entrails, paper dishes, cups, milk containers, snow or ice, food processing solids, or debris in quantities not found in normal domestic wastewater.
- (5) Sludge or other materials removed from industrial waste at waste treatment plants or water treatment plants.

(c) Prohibited Connections. Roof drains, storm inlets, foundation perimeter drains, area drains for open patios or driveway entrances to parking structures, and ground water pump systems.

401.3. Controlled Wastes. Certain wastes may be discharged into the sewage system only if it is determined that such wastes will not harm the sewers, sewage treatment equipment or process, and will not have an adverse effect upon the receiving waters or will not otherwise endanger life, or constitute a nuisance.

(a) Approval. Any person, firm, business, or corporation, which anticipates discharging any substance or material listed in (c) of this section into the sewage system, shall first make application to the City and receive approval. Evaluations for approval will give consideration to quantity of given waste in relation to existing flows and velocities, materials of construction, nature of collection system, nature of treatment process, capacity of treatment plant, degree of treatability of wastes and other pertinent factors.

(b) Alternatives. If the waters or wastes which are proposed to be discharged contain substances or possess characteristics which may have a deleterious effect upon the collection system, sewage works, processes, equipment or receiving waters or may otherwise constitute a public nuisance, any one or a combination of the following alternatives may be applied to the application:

- (1) Rejection of the wastes.
- (2) Requirement of pretreatment to an acceptable condition prior to discharge into the sewage system, but such pretreatment shall not include diluting wastes with domestic water.
- (3) Requirement of controls over quantities and rates of discharge.
- (4) Requirement of payment for the added costs of handling and treating wastes which costs may include, but are not limited to, treatment plant modifications.

(c) Restricted Wastes. Those wastes for which approval must be secured from the City prior to discharge and the circumstances under which they may be discharged are:

- (1) Any liquid or vapor having a temperature higher than 150°F (65°C).
- (2) Any wastes containing fats, wax, grease, or oils, whether or not emulsified, in excess of 100 milligrams per liter, or containing substances which may solidify or become viscous between 32 and 150°F (0 to 65°C).
- (3) Improperly shredded garbage.
- (4) Wastes containing undiluted acid, iron pickling wastes or concentrated plating solutions, whether neutralized or not.
- (5) Wastes containing arsenic, barium, cadmium, cyanide, lead, selenium, silver, metallic salt solutions or suspended metals or minerals, iron, chromium, copper, zinc, and similar objectionable or toxic substances.
- (6) Wastes containing phenols or other taste or odor producing substances in such concentrations that the effluent would not meet requirements of the receiving waters with regular sewage treatment of normal domestic wastewater.
- (7) Radioactive wastes or isotopes of such half-life or concentration that exceed the limits of state and federal regulations.
- (8) Wastes having a pH of 9.5 or greater, or a pH less than 5.5.

(9) Wastes which cause or contain:

- (a) Unusual concentrations of inert suspended solids such as fullers earth, lime slurries, or residues.
- (b) Unusual concentration of dissolved solids such as sodium sulfate, sodium chloride, or calcium chloride.
- (c) Excessive discoloration such as dye wastes.
- (d) Unusual concentrations of BOD, COD, which would cause a significant load or chlorine requirement on the treatment works.
- (e) Unusual volume of flow or concentration of wastes constituting "slugs," generally defined as a greater than normal release at one time of liquids or concentrations into the sewer system.

(10) Waters or wastes containing substances which are not readily treated or reduced by the normal sewage treatment process, or are capable of such limited treatment that the plant effluent would not meet water quality requirements of the receiving waters in the absence of restrictions on discharge.

401.4. Pre-treatment of Wastes. In order to prevent overloading of the treatment works or to limit the necessity of excessive preventive maintenance to the sewage collection system, the City may require installation of pre-treatment facilities. Cost of such treatment facilities are to be borne by the owner and the design approved by the City prior to installation.

(a) Types of Pre-treatment. Pre-treatment facilities shall be designed, installed, and maintained to effectively remove the offending materials or reduce their concentrations to levels treatable as normal domestic wastewater or otherwise within the capacity of the treatment process, collection system and receiving waters. The pre-treatment process will be that which has been proved to be effective, is in common usage or may be demonstrated to be effective to provide the pre-treatment required, and may include chemical processes such as adjustment of pH; or grease, oil, and sand interceptors.

(b) Maintenance. All pre-treatment facilities will be properly maintained by the owner, records maintained, and will be subject to inspection by the City.

(c) Previously Installed Devices. The City may inspect and evaluate all existing pre-treatment facilities and determine if the device is adequately performing the intended pre-treatment.

When it is determined through evaluation of wastes discharged or problems associated with collection system maintenance or treatment plant operation that the device is not adequate

or properly maintained, the City may require installation of a new or modified device, modification of the processes, or institution of other procedures. The person responsible for the existing pre-treatment installation will be given a reasonable time to comply, considering requirements of state and federal law, public health, and the economic value of the facility.

401.5. Control Manholes. When needed to secure valid waste sampling and flow measurements, the owner, at his expense, may be required to install a suitable control manhole, together with all necessary meters and other appurtenances. The City therein shall approve design of the manhole and facilities prior to installation.

401.6. Measurements, Tests, and Analysis. All samplings, measurements, tests, and analyses of the characteristics of waters and wastes shall be made and determined in accordance with the latest edition of "Standard Methods for the Examination of Water and Wastewater," published by the American Public Health Association, approved procedures of the Colorado Water Quality Control Commission, the Environmental Protection Agency, or other customarily accepted methods.

(a) Sampling Location. To the extent possible, samples will be taken at control manholes or other reasonably accessible and suitable locations. If a control manhole is not available at the site, sampling may be taken at the next downstream manhole. To the extent possible, the discharge being evaluated will be isolated from other wastewater by temporarily blocking lines or estimating contributions.

(b) Sampling Techniques and Frequency. Sampling shall be determined on an individual basis.

401.7. Coordination with Owners. All aspects of the City's program to eliminate deleterious materials from entering the system; classification of wastes, pre-treatment, and sampling will be coordinated with the affected owner. In addition to the City sampling, the owner may at his own expense have a separate evaluation performed. If separate data and conclusions are presented by the owner, the City will consider such data together with its own, giving due weight to each, prior to making a final determination; however, the City is not obligated to recognize those results as being more accurate than its own.

401.8. Fines and Termination of Service. The City will make every effort to assist the owner in identifying prohibited and controlled wastes and arrive at a mutually agreeable solution. Failure to comply with these rules and regulations or directives of the City, may result in imposition of additional charges. If the owner fails or refuses to comply with these rules and regulations or to institute the changes needed to meet these rules and regulations, the City may terminate service or take other corrective or legal action as the circumstances may require.

401.9. Discharge of Septic or Holding Tank Wastes. No person shall discharge septic tank waste into the City's sewer system unless a permit is granted and required fees and charges paid. Before the granting of a permit will be considered, all requirements of Section 401.10 below must be met. Discharge of holding tank wastes into the City's sewer system is prohibited.

401.10. Owner Information. In order to properly evaluate the effect of sewage upon the collection system and treatment plant, establish fair and equitable owner's charges, or determine conformity with these rules and regulations, the City may require that certain information be furnished as follows:

- (a) Peak discharge rate and volume.
- (b) Chemical analysis of wastewater.
- (c) Information on raw materials, manufacturing processes or products.
- (d) Details of wastewater pre-treatment facilities.

401.11. Volume Control. Variability in quantity or flow rates of wastewater may require the installation of equalizing or holding tanks or flow control devices in order that the capacity of the collection system or treatment works are not exceeded. Installation of such devices, as required by the City, shall be the responsibility of the owner. Such installation shall be approved in advance by the City.

401.12. Accessibility. Duly designated City employees are authorized to enter all properties for the purposes of conducting inspections, observation, measurement, sampling and testing pertinent to the owner's discharge of wastes or wastewater into the City's systems. Information, the public disclosure of which would reveal a trade secret or process, shall be preserved as confidential from unauthorized persons.

Part 2 SANITARY SEWER SYSTEM PRE-TREATMENT DEVICES

402.1. General. The City shall require the installation of a pre-treatment device when the strength per unit time and/or constituents of the wastewater discharge into the public sanitary sewer system exceeds that which is generally accepted to be "normal domestic wastewater" as defined in 401.1 (a) of this Chapter. The owner, renter, or lessee of the establishment shall be responsible for installing pre-treatment devices adequate to pre-treat the establishment's sewage contribution to acceptable standards.

Establishments that provide food serving, food preparation, food catering, meat cutting, animal slaughtering and other establishments capable of discharging grease into the public sanitary sewer system shall be required to install a grease interceptor.

Establishments that provide automotive repair services, truck and car wash facilities, vehicle maintenance facilities, machine shop facilities and other establishments capable of discharging grease, oil, sand and/or flammable wastes into the public sanitary sewer system shall be required to install a sand/oil interceptor.

When a pre-treatment device is required, it shall be based on one of the following determination methods:

(a) Direct Sample. A direct sample shall be used wherever possible. A sample taken at a monitoring point shall be analyzed and tested by the City.

(b) Comparison. A comparison with other businesses or industrial establishments that use similar processes and which the City has determined discharge wastewater of a similar nature, composition and volume to that of the establishment in question.

(c) Best Judgement. Best judgement shall be made where it is not possible to sample and where a similar process to which a comparison may be made does not exist. Best judgement shall be made on a reasonable knowledge of the processes involved, the nature of the wastewater produced by such processes and the amount of water consumption.

402.2 Definitions. The following definitions are applicable to pre-treatment devices:

(a) Fixture Unit. A rating in terms of gallons (gpm) per minute representing the maximum amount of water that can drain from a fixture or piece of equipment in one minute. The value of one fixture unit (F.U.) is equal to 7.5 gpm.

(b) Grease Interceptors - Type A & B. Two compartment interceptors normally located outside a building and of the following sizes:

(1) Type "A" 320-1250 gallons capacity (Design Std. No. SA-17, Appendix C)

(2) Type "B" 1565-3445 gallons capacity (Design Std. No. SA-18, Appendix C)

(c) "In Line" Grease Trap. A prefabricated unit, generally made of metal that normally is set indoors under a sink or near the fixture connected to it, for the trapping of grease and oils.

(d) Monitoring Point. A point in the owner/operators sewer service line that is accessible for monitoring, sampling and testing the wastewater flow from an establishment.

(e) Pretreatment Facilities. Structures, devices or equipment for neutralizing or removing deleterious wastes from wastewater generated from a premise prior to its discharge into a public sewer.

(f) Sampling. A periodic collection of wastewater as it flows through a sewer.

(g) Sand/Oil Interceptors - Type I & II. Two compartment interceptors normally located outside a building and of the following sizes:

(1) Type "I" 320-1250 gallons capacity (Design Std. No. SA-19, Appendix C)

(2) Type "II" 1565-3445 gallons capacity (Design Std. No. SA-20, Appendix C)

(h) Testing. The analysis of wastewater.

402.3 Plan Submittal and Plan Review. If any waters or wastes are discharged, or are proposed to be discharged to the public sewers that may potentially contain substances or possess the characteristics enumerated in Part 1 or Part 2 of this chapter, it shall be the responsibility of the owner, renter, lessee or authorized representative to contact the City for the purpose of plan submittal. The plan submitted shall determine the need, method, and size of pretreatment facility required by these rules and regulations to pre-treat or otherwise control the wastes to make them acceptable for discharge into the City's sanitary sewer system. Plans for all significant owners must be reviewed and approved by Metro Wastewater.

The City may require additional plans and/or information to determine the impact on the public sanitary sewer system by the proposed wastes and to assist with calculating the size of the pretreatment facilities.

402.4 Limitations on Wastewater Strengths. Wastewater discharge into the sanitary sewer system shall not have or contain:

(a) Those constituents enumerated in Part 1 of this chapter.

(b) Any water or wastes containing grease, oil, hydrocarbons, fatty acids, soaps, fats or waxes which exceed 100 mg/l as determined by solvent (Freon) extraction;

(c) Any wastewater capable of raising the Lower Explosive Limit (L.E.L.) of the ambient atmosphere in any sewer to 5% for any two successive readings or to 10% for any single reading on an explosion hazard meter. Prohibited materials include, but are not limited to, gasoline, kerosene, naphtha, benzene, toluene, xylene, ethers, alcohols, ketones, aldehydes, peroxides, chlorates, perchlorates, bromates, carbides, hydrides and sulfides.

402.5 Previously Installed Pre-Treatment Devices. If it becomes necessary for the City to require an existing business or industrial owner to install suitable waste pre-treatment units, a written explanation for the requirement shall be furnished to the owner or his authorized agent. Such a requirement may arise when it becomes apparent that the existing pretreatment facility is deficient in size, or waste emanating from the business or industry violates these rules and regulations and/or may cause harm to the public sewer system or to persons entering said system to perform maintenance, or to the treatment process and/or environment.

(a) Exceptions. The owner, renter, or lessee may request relief of the requirement to replace a previously installed pre-treatment device. The request must include a detailed plan of the proposed method of removing deleterious wastewater constituents. The proposal must assure wastewater discharged into the public sewer system is of "normal domestic strength." Should a conflict arise as to wastewater strength and/or constituents, the burden of proof for determination of strength and/or constituents will rest with the owner, renter, or lessee.

- (1) The City will periodically inspect the facility granted the exception for conformance to the approved plan. Should operations deviate from the approved plan, the City may take whatever action it deems appropriate, which may include the levying of an administrative fine or the immediate installation of an approved interceptor.
- (2) Attachment to and continued use of the public sanitary sewer system is evidence of permission to grant access to City inspectors to determine continued conformance to the approved plan.

402.6 Grease Interceptors.

(a) Location/Design.

- (1) All grease interceptors shall be located outside, between 5 feet and 30 feet from the building, unless the City specifically authorizes a variance. The interceptor shall be easily accessible at all times for inspection and maintenance.
- (2) All cast-in-place grease interceptors shall be concrete with wall and floors of a single pour and shall be constructed in accordance with the detailed drawings. (See Design Standards SA-17 and SA-18, Appendix C)
- (3) In-line grease traps are not permitted unless specifically approved by the City.
- (4) Garbage disposal grinders are required to discharge to the grease interceptor if volumetric capacity of the interceptor is greater than 1,000 gallons.

(b) Calculating Interceptor Size. Size calculations are to be prepared by the owner, renter or lessee and submitted to the City per the following methods:

(1) Where the seating capacity can be determined, compute:

(a) Number of seats x a full capacity factor of 0.9 x turnover rate of 2.2 per meal period = number of meals served per meal period.

(b) Number of meals served per meal period x 2.5 gallons per meal = volumetric water capacity of the grease interceptor.

(2) Where food is prepared and where seating capacity or number of meals cannot be adequately determined, the following rule shall apply:

(a) Table 402.6-1 establishes the fixture unit values for various pieces of equipment that may require connection to a grease interceptor.

- (b) The total number of fixture units shall be multiplied by 7.5 gpm to determine maximum rate of flow into the grease interceptor. The volumetric water capacity of the unit shall be 8 times the maximum flow rate.

Table 402.6-1		
Type of Fixture	Minimum Trap Size (Inches)	Fixture Units
Floor Drains	2	2
	3	3
Laundry Tubs	1-1/2	3
Clothes Washers	2	2
Receptors (floor sinks), indirect waste receptors for refrigerators, coffee urn, water stations, etc.	1-1/2	1
Receptors, indirect waste receptors for commercial sinks, dishwashers, etc.	2	3
Sinks, bar, private (1-1/2 inches minimum waste)	1-1/2	2
Sinks, commercial or industrial, schools, etc. including dishwashers, wash-up sinks (2 inches minimum waste)	2	3
Sinks, service	2	3
Wash basin (lavatory) single	1-1/4	2
Wash basins, in sets	1-1/2	2

The unit equivalent of fixtures and devices not shown on Table 402.6-1 shall be based on the rated discharge capacity in gpm in accordance with Table 402.6-2.

Table 402.6-2	
Discharge Capacity (in gpm) For Intermittent Flow Only	
0 - 7.5 gpm	1 Fixture Units (F.U.)
8 - 15 gpm	2 Fixture Units (F.U.)
16 - 30 gpm	4 Fixture Units (F.U.)
31 - 50 gpm	6 Fixture Units (F.U.)

Note: For a continuous flow into a drainage system, two F.U. shall be assumed for each gpm of flow.

402.7 Sand/Oil Interceptors.

(a) Location/Design.

- (1) All sand/oil interceptors shall be located outside, between 5 feet and 30 feet from the building, unless the City specifically authorizes a variance. Interceptors shall be easily accessible at all times for inspection and maintenance.
- (2) All cast-in-place sand/oil interceptors shall be concrete with walls and floors of a single pour and shall be constructed in accordance with the detailed drawings. (See Design Standards SA-19 and SA-20, Appendix C).
- (3) The minimum sand/oil interceptor shall be 320 gallons capacity.

(b) Calculating Interceptor Size:

Size calculations are to be prepared by the owner, renter or lessee and submitted to the City per the following method:

- (1) Total fixture units connected x 7.5 gpm x 5 minutes = interceptor size.
- (2) The total fixture unit values shall be based on the Table 402.7-1 on the following page:

Table 402.7-1	
Type of Fixture	F.U.
Floor Drain:	
3 inch trap	6
4 inch trap	8
Vehicle Wash Drain	8
Service bay with trough drain:	
380 S.F. or less	6
381 S.F. through 760 S.F.	12
761 S.F. through 1140 S.F.	18
etc.	

402.8 Specialized Pre-Treatment Devices. Certain chemical compounds, metals, and other substances have a deleterious effect upon the public wastewater treatment process. When such substances are identified, the owner, renter, or lessee shall be responsible at their expense to install a suitable pre-treatment device which effectively removes the deleterious substance or renders the sewage contributed to the public sanitary sewer system as being of "normal domestic strength" as defined in 401.1 (a) of this chapter.

402.9 Pre-Treatment Device Maintenance and Inspection. It shall be the responsibility of the owner, renter, or lessee of the establishment to clean, repair and maintain the pre-treatment device in an unobstructed and efficient functioning order. The owner, renter, or lessee shall maintain a record of periodic scheduled maintenance. The City will make periodic inspections to ensure compliance with the following:

(a) Grease interceptors and sand/oil interceptors shall be fully pumped and completely cleaned of all the accumulated waste every three months, or more frequently, as determined by the City's representative, to ensure maximum operating efficiency.

402.10 Violations and Enforcement. Failure to comply with these rules and regulations shall constitute violation of provisions set forth in the City of Lakewood Municipal Code. Non-conforming establishments will be issued a citation. The owner, renter, or lessee in violation will be responsible for fines, additional charges, and applicable fees; and prosecuted in the City of Lakewood Municipal Court or such other legal remedies as the City Attorney should deem appropriate.

CHAPTER 5 MAINTENANCE STANDARDS

Part 1 MAINTENANCE OF THE WATER DISTRIBUTION SYSTEM

501.2. Responsibility. Responsibility for maintenance and repairs of the water distribution system is as outlined below:

(a) Service Lines. The property owner shall be responsible for maintenance and repairs to that portion of the service line between the building connection and the meter pit. The City will maintain and repair that portion of the domestic service line between the meter pit and the connection to the water main or fireline. The City will also repair curb stops located between the meter pit and the connection to the water main.

(b) Meters. The City will ordinarily maintain and repair water meters at no expense to the property owner. In the event condition of the meter is such that further repair is impractical, the City will replace the meter at City expense.

(c) Meter Setting Hardware and Vaults. The repair and maintenance of all equipment and hardware used to install the meter and all associated vault or meter pit materials shall be the responsibility of the City.

(d) Distribution System. The City shall be responsible for repairs and maintenance of the water distribution system except as noted above.

(e) Fire Lines. The property owner shall be responsible for maintenance and repairs to the portion of the fire line between the building connection and the tap-in valve on the main water line.

Part 2 MAINTENANCE OF THE SANITARY SEWER COLLECTION SYSTEM

502.1 General. The capacity of the sanitary sewer system is protected by a program of maintenance and repairs and by limiting the discharge of wastes that would block or damage the system.

502.2. Responsibility. Responsibility for maintenance and repairs of the sanitary sewer system is as outlined below:

(a) Service Lines. The service line is that portion of the collection system located between the building connection and the line's attachment to the sanitary sewer main. The property owner is responsible for correction of stoppages and any repairs needed in the total length of the service line. The City is not responsible for any repairs to service lines.

(b) Sanitary Sewer Mains and Appurtenances. The City is responsible for the operation

and maintenance of all sanitary sewer mains, outfall lines, meter stations, and other system appurtenances such as lift stations and manholes, except as stipulated by other agreements or contracts.

(c) Service Line Meters. The owner is responsible for the repairs and maintenance of service line meters.

APPENDIX A
WATER SYSTEM CONSTRUCTION SPECIFICATIONS

Title	Section
Excavation and Embankment	02315
Trench Excavation and Backfill.....	02320
Testing of Water Pipelines.....	02601
Buried Ductile Iron Pipe	02614
Steel Pipe	02615
Buried Polyvinyl Chloride (PVC) Pressure Pipe	02619
Water Services	02620
Gate Valves.....	02641
Butterfly Valves	02642
Tapping Sleeve and Valve	02643
Fire Hydrants	02645
Combination Air Valve.....	02646
Disinfection of Water Lines.....	02675

SECTION 02315

EXCAVATION AND EMBANKMENT

PART 1: GENERAL

1-1 Description:

This Work shall consist of excavation; embankment fill; removal and disposal of all debris; stripping and stockpiling topsoil; the handling, storage, transportation, and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property; backfilling; construction of fills and embankments; surfacing and grading; compaction of all material encountered within the limits of work, including excavation and fill for structures; and other appurtenant work. The excavation shall include, but is not limited to, the native soils which must be excavated for the Project Work. All Work shall be completed in accordance with these Specifications and the lines, grades and typical cross-sections shown on the Drawings.

All excavation will be classified, "unclassified excavation," or "muck excavation" or "rock excavation," as hereafter described. All embankment will be classified "embankment material" as hereafter described.

1-2 Definitions:

- A. Unclassified Excavation shall consist of the excavation of all materials of whatever character required of the Work, obtained within the Project limits.
- B. Muck Excavation shall consist of the removal of mixtures of soils and organic matter not suitable for foundation material and replacement with approved material.
- C. Rock Excavation shall consist of igneous, metamorphic and sedimentary rock which cannot be excavated without the use of rippers, and all boulders or other detached stones each having a volume of one-half ($\frac{1}{2}$) cubic yard or more, as determined by physical or visual measurement. It shall also include replacement with approved material as required.
- D. Embankment Material shall consist of approved material acquired from

excavation or from outside sources, hauled and placed in embankments.

1-3 Submittals:

Samples of all materials specified in this section shall be submitted to the Engineer in accordance with Section 01300. The quantity of material samples required will be specified by the Engineer. Where gradations or other material properties are specified, information certifying these properties shall also be submitted. All gradation and samples of materials submitted must be approved by the Engineer before incorporated into the work.

1-4 Reference Standards:

American Association of State Highway and Transportation Officials (AASHTO), American Society for Testing and Materials (ASTM), Colorado Department of Transportation (CDOT) Standard Specifications for Road and Bridge Construction.

1-5 Safety:

With reference to the terms and conditions of the construction standards for excavations set forth in the OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, the Contractor shall employ a competent person and, when necessary, a registered professional engineer, to act upon all pertinent matters of the work of this section.

1-6 Quality Assurance:

All tests required for preliminary review of materials shall be made by an acceptable independent testing laboratory at the expense of the Contractor. Two initial gradation tests shall be made for each type of pipe bedding, fill, or backfill material, and one additional gradation test shall be made for each additional 500 tons of each material. Initial moisture-density (Proctor) tests and relative density tests on the materials, and all in-place field density tests, shall be made at the expense of the Owner. Retests of samples failing initial tests shall be at the expense of the Contractor.

Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.

Final topography and/or cross-sections will be surveyed of areas that are to finished grade and compared to the design section for accuracy. Final grade shall match design grades within the tolerances discussed in PART 3 EXECUTION.

1-7 Related Sections:

- A. Section 02230 – Clearing and Grubbing
- B. Section 02240 – Water Control and Dewatering
- C. Section 02320 – Trench Excavation and Backfill

PART 2: MATERIALS

2-1 General:

- A. Embankment material may consist of approved material acquired from excavations or material hauled from outside the Project limits. Suitable material identified on-site shall be used first for embankments and backfill. Excess excavated native soils which are not used as embankment or backfill shall become the property of Contractor and shall be disposed of off-site by Contractor, in a location acceptable to Engineer.
- B. Muck excavation shall also include the replacement of excavated muck with uniformly graded rock, riprap, on-site or imported soils, or other material, whichever is most suitable for the specific situation encountered. Engineer will determine which type of aggregate or other material which shall be used after observing the specific site conditions.
- C. Gradation for structural backfill shall conform to the following:

<u>Sieve Size</u>	<u>By Weight Passing Square Mesh Sieves</u>
2 inch	100
No. 4	30 – 100
No. 50	10 – 60
No. 200	5 – 20

Structural backfill shall have a liquid limit not exceeding 35 and a plastic limit not exceeding 6 when determined in conformance with AASHTO T 89 and T 90, respectively. Refer to Section 2-7 for additional requirements.

PART 3: EXECUTION

3-1 General Excavation/Embankment:

- A. **General.** The excavation and embankment should be finished to reasonably smooth and uniform surfaces. Variation from the subgrade plane shall not be more than 0.08 foot in soil or more than 0.08 foot above or 0.50 foot below in rock. Where bituminous or concrete surfacing materials are to be placed directly on the subgrade, the subgrade plane shall not vary more than 0.04 foot. Materials shall not be wasted without permission of Engineer. Excavation operations shall be conducted so that material outside of the limits of slopes will not be disturbed. Prior to beginning grading operations in any area, all necessary clearing and grubbing in that area shall have been performed in accordance with Section 02230 of these Specifications.

Contractor shall notify Engineer in sufficient time before beginning excavation or embankment such that the necessary topography and/or cross-sections may be taken. Contractor shall not excavate beyond the dimensions and elevations established, and material shall not be removed prior to surveying the site.

When Contractor's excavating operations encounter remains of pre-historic people's dwelling sites or artifacts of historical or archaeological significance, the operations shall be temporarily discontinued. Engineer will contact archaeological authorities to determine the disposition thereof.

When directed, Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and shall remove them for delivery to the custody of the proper state authorities. Such excavation will be considered and paid for as extra Work.

All sites that will be occupied by permanent construction, embankments, or as called out on the construction drawings, shall be cleared of all logs, trees, roots, brush, tree trimmings, and other objectionable materials and debris. All stumps, roots, foundations, and debris shall be removed to a minimum of 24 inches below final grades (grubbed). Backfill foundations, stumps and root holes with approved materials and compact per this specification. Subgrades for fills and embankments shall be cleaned and stripped of all surface vegetation, sod, and organic topsoil. All waste materials shall be removed from the site and disposed of by and at the expense of the Contractor.

In natural areas where excavation will occur, strip all topsoil, or in the absence of topsoil, strip the top 6 inches of surface material and store separately from other excavated materials.

For concrete walks, roadways, parking areas and road crossings, cut existing pavement full depth to a true line before excavation.

B. Excavation

1. **Unclassified:** All excess suitable material excavated from the Project site and not used for embankment shall be removed from the Project site and become the property of Contractor. Where material encountered within the limits of the Work is considered unsuitable for embankment (fills) on any portion of this Project Work, such material shall be excavated as directed by Engineer and replaced with suitable fill material. All unsuitable excavated material from excavation consisting of any type of debris (surface or buried), excavated rock, bedrock or rocks larger than six (6) inches in diameter, and boulders shall be hauled from the Project site and disposed of by Contractor at Contractor's expense. Debris is defined as "anything that is not earth which exists at the job site."
2. **Muck:** Where excavation to the finished grade section results in a subgrade or slopes of unsuitable soil, Engineer may require Contractor to remove the unsuitable materials and backfill to the finished graded section with approved material. Disposal of the unsuitable material and replacement with suitable material shall be at Contractor's expense.

Good surface drainage shall be provided around all permanent cuts to direct surface runoff away from the cut face.

3. **Rock:** Unless otherwise specified, rock shall be excavated to a minimum depth of 0.5 foot below subgrade within the limits of the channel area, and the excavation shall be backfilled with material shown on the DRAWINGS or as designated by Engineer. Disposal of material and replacement with suitable approved material shall be at Contractor's expense.

Blasting or other use of explosives for excavation will not be permitted.

4. **Shoring:** As needed, all excavations shall be properly sheeted and braced to meet Federal, State and local laws in regard to safe working conditions. The shoring shall be arranged so as not to place any stress on portions of the completed work until the general construction thereof has proceeded far enough to provide ample strength. Any damage to pipes or structures resulting from settlements, heaving, water or earth pressures, slides, caving, or other causes, due to lack

of shoring, sheeting, or bracing, or due to failure of shoring, or due to improper shoring, or due to any other negligence on the part of the Contractor, shall be repaired by the Contractor at his own expense.

Shoring shall be removed as the work progresses, unless left in place by written order of the Project Manager. The Contractor will be paid for shoring so ordered left in place on the basis of invoice material cost only. Trench sheeting shall not be pulled before backfilling unless the pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting, nor shall sheeting be pulled after backfilling. Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.

5. **Water Control and Dewatering:** Dewatering equipment shall be provided to remove and dispose of all surface water and groundwater entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

All excavations for concrete structures or trenches which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level beneath such excavations 12 inches or more below the bottom of the excavation.

Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

- C. **Storage of Excavated Materials.** Excavated material shall be stockpiled near the immediate construction area in a confined configuration. For storage of excess excavated material suitable for backfill, Contractor shall obtain and pay for a storage site. All transportation to and from (including loading) storage site and temporary land/site acquisition is included in the work.

All excess excavated material at the completion of the work and all debris, stones, logs, stumps, roots, and other unsuitable materials shall be removed from the site and disposed of by, and at the expense of, the Contractor.

- D. **Embankment Construction.** Embankment construction shall consist of constructing all fill areas, including preparation of the areas upon which they are to be placed, the placing and compacting of approved material within areas where unsuitable materials have been removed, and the placing and compacting of embankment material in holes, pits and other depressions within the Project area. Only approved materials shall be used in the construction of embankments and backfills.

Approved materials shall consist of clean on-site cohesive soils or approved imported soils. Additional material shall be provided as required. After preparation of the fill or embankment site, the subgrade shall be leveled and rolled so that surface materials of the subgrade will be compact and well bonded with the first layer of the fill or embankment.

All material deposited in fills and embankments shall be free from rocks or stones, brush, stumps, logs, roots, debris, and organic or other objectionable materials, and shall be wetted or dried as required and thoroughly mixed to ensure uniform moisture content. On-site cohesive soils or imported soils should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift and embankment height. On-site or imported cohesive soils should be compacted within a moisture content range of two percent (2%) below, to two percent (2%) above optimum moisture content and compacted to ninety-five percent (95%) of the Maximum Standard Proctor Density (ASTM D698).

When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is built one-half ($\frac{1}{2}$) width at a time, the slopes that are steeper than four-to-one (4.1) when measured longitudinally or at right angles to the adjacent ground shall be continuously benched over those areas where it is required as the Work is brought up in layers. Benching shall be well "keyed" and where practical a minimum of eight (8) feet. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus cut out shall be recompacted along with the new embankment material at Contractor's expense.

The ground surface underlying all fills shall be carefully prepared by removing all organic matter, scarification to a depth of eight (8) inches and recompacting to ninety-five percent (95%) of the Maximum Standard Proctor Density (ASTM D698) at optimum moisture content + or - two percent (2%) prior to fill placement.

Embankment material shall be placed in horizontal layers not exceeding 8 inches (loose measurement) and shall be compacted to ninety five percent (95%) of the Maximum Standard Proctor Density (ASTM D698) at optimum moisture content + or - two percent (2%). Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting. As the compaction of each layer progresses, continuous leveling and manipulating will be required to assure uniform density.

For embankments which serve as berms, the downstream portion shall be keyed into the subsurface soils a minimum of three (3) feet to enhance the stability of the slope.

Materials which are removed from excavations beneath the water table may be over the optimum moisture content and will require that they be dried out prior to reusing them.

Cross hauling or other action as appropriate will be ordered when necessary to insure that the best available material is placed in critical areas of embankments, including the top two (2) feet of all embankments. No additional payment will be made for cross hauling ordered by Engineer.

Frozen materials shall not be used in construction of embankments. Backfilling and construction of fills and embankments during freezing weather shall not be done except by permission of the Engineer. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.

During the construction of the channels, the channel bottom shall be maintained in such condition that it will be well drained at all times.

Excavation or embankment (fill), and structural backfill Work either completed or in a stage of completion that is either eroded or washed away or becomes unstable due to either rains, snow, snow melt, channel flows, or lack of proper water control shall be either removed and replaced, recompacted, or reshaped as directed by Engineer and in accordance with the Drawings and Specifications at Contractor's sole expense. Removed unsuitable materials shall be hauled away and disposed of at Contractor's expense. Placing of replacement materials for removed unsuitable materials shall be purchased, placed, and compacted at Contractor's expense.

- E. **Proof Rolling.** Proof rolling with a heavy rubber tired roller will be required, if designated on the Drawings or when ordered by Engineer. Proof rolling shall be done after specified compaction has been obtained.

Areas found to be weak and those areas which failed shall be ripped, scarified, wetted if necessary, and recompactd to the requirements for density and moisture at Contractor's expense.

Proof rolling shall be done with equipment and in a manner acceptable to Engineer. Proof rolling as shown on the Drawings or as ordered by Engineer shall not be measured and paid for separately, but shall be included in the unit prices bid for the work.

3-2 Excavation and Backfill for Structures:

Excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.

Conform to elevations and dimensions shown within a tolerance of 0.10 feet. In excavating for footings and foundations, take care not to disturb the bottom of the excavation. Excavate by hand tools to final grade just before concrete is placed. Trim bottoms to required lines and grades to leave a solid base to receive concrete. Protect excavation bottoms against freezing when atmospheric temperature is less than 35° F.

The quality and moisture content of materials for backfill around and outside of structures shall conform to the requirements for materials used for backfills and structural backfill. Backfill materials shall be deposited in layers not to exceed 8 inches in uncompacted thickness and compacted to at least 95 percent of maximum density at optimum moisture content as determined by ASTM D698. Compaction of structure backfill by rolling will be permitted, provided the desired compaction is obtained and damage to the structure is prevented. Compaction of structure backfill by inundation with water will not be permitted.

No backfill shall be deposited or compacted in water.

Particular care shall be taken to compact structure backfill which will be beneath pipes, drives, roads, parking areas, walks, curbs, gutters, or other surface construction or structures. Place backfill evenly, adjacent to structures, to required elevations. Carry material uniformly around the structure to approximately the same elevation in each lift. In addition, wherever a trench is to pass through structure backfill, the structure backfill shall be placed and compacted to an elevation not less than 12 inches above the top of pipe elevation before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.

Poor foundation material for any of the Work shall be removed, by Contractor as directed by Engineer. Contractor will be compensated for removal and

replacement of such materials in accordance with Muck Excavation.

Contractor is cautioned that construction equipment may cause the natural soils to pump or deform while performing excavation Work inside and on footings, structural floor slabs, or other structure foundation areas.

Contractor shall remove and replace at Contractor's expense any foundation materials which are: a) saturated by either surface or subsurface flows due to the lack of adequate water control or dewatering work by Contractor; b) frozen for any reason; or c) disturbed by Contractor's Work or caused to become unacceptable for foundation material purposes by means of Contractor's equipment, manpower, or methods of Work.

Dewatering should not be conducted by pumping from inside footings, structural floor slabs, or other structure foundation limits. This may decrease the supporting capacity of the soils.

Care should be taken when excavating the foundations to avoid disturbing the supporting materials. Excavation by either hand or careful backhoe soil removal, may be required in excavating the last few inches of material to obtain the subgrade of any item of the concrete Work.

Subgrades for concrete structures and trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workmen.

Subgrades for concrete structures or trench bottoms which are otherwise solid, but which become mucky on top due to construction operations, shall be reinforced with crushed rock or gravel. The stabilizing material shall be spread and compacted to a depth of not more than four inches; if the required depth exceeds four inches, the material shall be furnished and installed as specified for stabilization material. The finished elevation of stabilized subgrades shall not be above subgrade elevations indicated on the drawings.

Any over-excavated subgrades that are due to Contractor's actions, shall be brought back to subgrade elevations by Contractor and at Contractor's expense in the following manner:

- A. For over-excavations of two (2) inches or less, either backfill and compact with approved granular materials; backfill with one-half ($\frac{1}{2}$) inch crushed rock; or fill within concrete at the time of the appurtenant structure concrete pour.
- B. For over-excavations greater than two (2) inches, backfill and compact with an approved granular material.

All granular footings, structural floor slabs, or other structure areas shall be compacted with a vibratory plate compactor prior to placement of concrete, reinforcing, or bedding materials.

Backfill, and fill within three (3) feet adjacent to all structures and for the full height of walls, shall be selected non-swelling material. It shall be granular, well graded, and free from stones larger than two (2) inches. Material may be job excavated, but selectivity will be required as determined by Engineer. Stockpiled material, other than topsoil from the excavation, shall be used for backfilling unless an impervious structural backfill is specified. The backfill material shall consist of either clean on-site granular material free of stones larger than two (2) inches in diameter with no more than twenty percent (20%) passing the No. 200 sieve, or equivalent imported materials. All backfill around the structures shall be consolidated by mechanical tamping. The material shall be placed in six-inch (6") loose lifts within a range of two percent (2%) above to two percent (2%) below the optimum moisture content and compacted to ninety-five percent (95%) of Maximum Standard Proctor Density (ASTM D698) for cohesive soils, or to seventy-five percent (75%) relative density for pervious material as determined by the relative density of cohesionless soils test, ASTM D4253.

When specified on the Drawings or as required by Engineer, Class I structural backfill shall meet the following gradation requirements:

<u>Sieve Size</u>	<u>% By Weight Passing Square Mesh Sieves</u>
2-inch	100
No. 4	30 - 100
No. 50	10 - 60
No. 200	5 - 20

In addition, this material shall have a liquid limit not exceeding thirty five (35) and a plasticity index of not over six (6).

Impervious structural backfill, where shown or specified, shall consist of material having one hundred percent (100%) finer than two (2) inches in diameter and a minimum of thirty five percent (35%) passing a No. 200 U.S. Standard Sieve. The material shall be placed in six-inch (6") loose lifts within a range of two percent (2%) above to two percent (2%) below the optimum moisture content and compacted to ninety five percent (95%) of Maximum Standard Proctor Density for cohesive soils as determined by ASTM D698.

3-3 Restoration:

- A. Streets and Roadways. Any pavements disturbed during construction shall be repaired in accordance with Detail Drawings and Specifications Sections 02511, 02512 and 02513 for Aggregate Base Course, Bituminous Prime Coat and Hot Bituminous Pavement.

All streets and paved surfaces shall be restored within two (2) weeks of their excavation. All dirt and debris, including dust shall be removed from streets and paved surfaces within three (3) days of the restoration of streets and paved surfaces. Initial removal of dirt and debris shall be made using a vacuum sweeper, after which the paved surfaces shall be cleaned using water hoses.

- B. Concrete Walks, Curb and Gutter, Fencing and Culverts. Restore all existing structures to conditions equal to or exceeding existing structures and according to local requirements.

- C. Landscape. After other outside work has been finished, and backfilling and embankments completed and settled, all areas which are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas which have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least 4 inches. Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth.

Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to hand work. All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least one percent shall be provided.

Final grading and surfacing shall be smooth, even, and free from clods and stones larger than one inch in greatest dimension, weeds, brush, and other debris.

The top portion of backfill beneath established lawn areas shall be finished with at least 12 inches of topsoil corresponding to, or better than, that underlying adjoining lawn areas.

- D. Other Items. The Project Manager will clarify restoration of other minor items as construction proceeds. Such items must be restored to equal or exceed existing conditions.

3-4 Cleanup:

Prior to final inspection and acceptance, the Contractor shall remove all rubbish and excess materials and leave area in a neat, satisfactory condition.

3-5 Maintenance of Backfill:

All backfill shall be maintained in a satisfactory condition and all places showing signs of settlement shall be filled and maintained during the life of the Contract and for a period of one year following the date of final acceptance of all work performed under the Contract. When the Contractor discovers or is notified by the City that any backfill is not in compliance with the provision of this Contract, the Contractor shall correct such conditions. Any utilities and road surfacing damaged by such settlement shall be repaired by the Contractor to the satisfaction of the City. In addition, the Contractor shall be responsible for the cost to the Owner of all claims for damages due to settlement of backfilled areas.

END OF SECTION

SECTION 02320

TRENCH EXCAVATION AND BACKFILL

PART 1: GENERAL

1-1 Description:

This Work shall consist of all labor, equipment and materials necessary for excavation; trenching; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property; pipe embedment; construction of fills and embankments; surfacing and grading; and backfilling for utility lines and other related Work.

1-2 Submittals:

Samples of all materials specified in this section shall be submitted to the Engineer in accordance with Section 01300. The quantity of material samples required will be specified by the Engineer. Where gradations or other material properties are specified, information certifying these properties shall also be submitted. All gradation and samples of materials submitted must be approved by the Engineer before incorporated into the work.

1-3 Reference Standards:

American Association of State Highway and Transportation Officials (AASHTO), American Society for Testing and Materials (ASTM), Colorado Department of Transportation (CDOT) Standard Specifications for Road and Bridge Construction.

1-4 Safety:

With reference to the terms and conditions of the construction standards for excavations set forth in the OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, the Contractor shall employ a competent person and, when necessary, a registered professional engineer, to act upon all pertinent matters of the work of this section.

1-5 Quality Assurance:

In-place moisture density tests will be performed to ensure trench backfill complies with specified requirements. The following minimum tests should be expected to be performed.

1. Trench bedding – one per two hundred (1 per 200) feet
2. Backfill - 1 per 200 feet

Two initial gradation tests shall be made for each type of pipe bedding, fill, or backfill

material, and one additional gradation test shall be made for each additional 500 tons of each material.

Backfill compaction tests will be performed until compaction meets or exceeds requirements. The cost of "passing" tests shall be paid by Owner. Costs associated with "failing" tests shall be paid by Contractor.

Pipe bedding shall be tested prior to placement of backfill.

Testing of all bedding and backfill material shall be done in compliance with Occupational Safety & Health Administration (OSHA) - Excavations.

1-6 Protection:

- A. **Sheeting and Shoring.** Contractor shall protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent any excessive widening or sloughing of the trench which may be detrimental to human safety, to the pipe or appurtenances being installed, or to existing facilities or structures. The latest requirements of OSHA shall be complied with at all times including trenching and confined space entry requirements.

Contractor shall be responsible for underpinning adjacent structures which may be damaged by excavation Work, including service utilities and pipe chases.

- B. **Weather and Frost.** Contractor shall protect bottom of excavations and soil adjacent to and beneath foundations from frost.

1. Do not place backfill, fill, or embankment on frozen surfaces.
2. Do not place frozen materials, snow, or ice in backfill, fill, or embankments.
3. Do not deposit, tamp, roll, or otherwise mechanically compact backfill in water.

- C. **Drainage and Groundwater.** The excavation shall be graded to prevent surface water runoff into trench or excavation.

1. Maintain excavations and trenches free from water during construction.
2. Remove water encountered in trenches to the extent necessary to provide a firm subgrade, to permit joints to be made in the dry, and to prevent the entrance of water into the pipeline.
3. Divert surface runoff and use sumps, gravel blankets, well points, drain lines, or other means necessary to accomplish the above.
4. Maintain the excavation or trench free from water until the structure, or

pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

5. Prevent water from entering into previously constructed pipe.
6. Do not use the pipe under construction for dewatering.

1-7 Related Work:

- A. Section 02240 – Water Control and Dewatering
- B. Section 02315 – Excavation and Embankment

PART 2: MATERIALS

2-1 General:

All bedding and backfill material shall have the approval of the Engineer and shall be included in the unit price for the pipe unless otherwise specified and indicated in the Proposal. All bedding and backfill material shall be free of frozen material, organic material and debris.

- 2-2 Muck Excavation.** Muck excavation shall also include the replacement of excavated muck with uniformly graded rock ranging from three-quarter ($\frac{3}{4}$) inch to one-and-one-half ($1\frac{1}{2}$) inches or as required by Engineer. Engineer shall determine which type of aggregate or other material shall be used after observing the specific site conditions.

2-2 Pipe Bedding:

Bedding materials both below and above the bottom of the pipe, classes of bedding to be used, and placement and compaction of bedding materials shall conform to the following requirements:

Bedding materials shall contain no cinders or other material which may cause pipe corrosion.

- A. Concrete Arch Encasement. Concrete arch encasement is not required unless improper trenching or unexpected trench conditions require its use as determined by the Engineer.
- B. Granular Bedding Material for Ductile Iron Pipe and PVC Pressure Pipe. Granular bedding material shall consist of washed chips, nominal size $\frac{3}{8}$ " meeting the following gradation:

Sieve Size	Percent Passing by Weight
1/2-inch	100
3/8-inch	85-100
No. 4	10-30
No. 8	0-10
No. 16	0-5

If approved by the Engineer, squeegee sand conforming to the gradation in D. below may be used for ductile iron pipe only. All granular bedding material shall be placed in not more than 6" layers and compacted by slicing with a shovel or vibrating.

- C. Granular Bedding Material for PVC and HDPE Sewer Pipe. This material shall be imported, crushed, angular quarry rock and meet the following gradation (ASTM D448, No. 67):

Sieve Size or Designation	Total Passing (% by Weight)
1- inch	100
$\frac{3}{4}$ - inch	90-100
3/8 - inch	20-55
No. 4	0-10
No. 8	0-5

- D. Granular Bedding Material for RCP Sewer Pipe. This material shall be squeegee sand meeting the following gradation:

Sieve Size	Percent Passing by Weight
3/8-inch	100
No. 200	0-5

Note: It shall be the responsibility of Contractor to locate material meeting the Specifications, to test its ability to consolidate to at least seventy five percent (75%) relative density, and to secure approval of Engineer before such material is delivered

to the Project. Relative density shall be determined as stipulated in ASTM D4253.

2-4 Trench Backfill:

Trench backfill refers to material placed above the pipe bedding. Trench backfill shall be finely divided job excavated material free from debris, rubbish, clods, roots, brush, frozen lumps of earth, organic material and large stones unless otherwise specified, and shall be moistened as required. Flowable fill, as specified in Section 2-6, or granular backfill material, as specified in Section 2-7, may be used if approved by the Engineer.

If the job excavated material proves to be unsuitable for backfill, the contractor may, at his option and if approved by the Engineer, use a pit-run material consisting of rocks less than 3" in diameter and a maximum of 20 percent passing a No. 200 sieve.

2-5 Stabilization Material:

Stabilization material shall be placed on suitably prepared subgrades and compacted by vibration. Stabilization material shall be crushed rock or gravel; shall be free from dust, clay, or trash; and shall be graded 1-1/2 inch to No. 4 as defined in ASTM C33 and shall be compacted to not less than 70 percent relative density as determined by ASTM D4253 and D4254.

2-5 Groundwater Barrier Material:

Groundwater barrier material shall meet AASHTO soil classification SC or CL, free from stones, organic material or debris, or flowable fill may be used as specified in Section 2-6.

2-6 Flowable Fill:

Flowable fill shall meet the following requirements and shall be used for trench backfill when specified in the contract or by the Engineer, or as a groundwater barrier.

<u>Ingredients</u>	<u>Lbs/CY</u>
Cement	50
Coarse Aggregate (AASHTO No. 57 or 67)	1700
Fine Aggregate (AASHTO M 6)	1845
Water	325 (or as needed)

The amount of water shall be such that the flowable fill flows into place properly without excessive segregation. Approximately 39 gallons of water per cubic yard of flowable fill is normally needed.

The Contractor may use aggregate which does not meet the above specifications if the

cement is increased to 100 pounds per cubic yard and the aggregate conforms to the following gradation:

<u>Sieve Size</u>	<u>% Passing</u>
1 inch	100
No. 200	0 – 10

The Contractor may substitute 30 lbs/cy of cement and 30 lbs/cy of fly ash for 50 lbs/cy of cement or may substitute 60 lbs/cy of cement and 60 lbs/cy of fly ash for 100 lbs/cy of cement.

The Owner reserves the right to review the use of recycled broken glass (glass cullet) as part or all of the aggregate. Proposed mix design must be submitted in accordance with Section 01300, Submittals.

Compaction of flowable fill shall be done by means of vibration. The flowable fill shall be vibrated until the fill has lost sufficient moisture to be walked on without indenting more than 2 inches.

The maximum depth of trench in which flowable fill may be used shall be 3 feet. With trench depths greater than 3 feet, a combination of backfill materials may be used. An aggregate base course material, compacted by traditional methods and equipment, may be used for depths exceeding the flowable fill limits, and topped off with a flowable fill cap of 3 feet in depth. The flowable fill shall be placed so that it heaps over the top edge of the trench. This is required so that, when the fill is vibrated, the excess water can rise to the surface and flow away from the trench. Any damage resulting from the placing of the flowable fill, or from not providing sufficient consolidation shall be repaired at the contractor's expense.

2-7 Granular Backfill Material:

Granular backfill material shall be an imported graded material meeting the 57/67 size requirements of ASTM C33 or the requirements for stabilization material as specified in Section 2-4.

If approved by the Engineer, granular backfill material may be finely divided job excavated material free from debris, rubbish, clods, roots, brush, frozen lumps of earth, organic material and stones larger than 6 inches and with no more than 50 percent by weight passing the No. 200 sieve.

2-9 Cut-Off Walls

1. Clay Cut-Off Walls: More than fifty percent (50%) shall pass a No. 200 Sieve. The plasticity index shall be greater than twelve (12).
2. Controlled Low Strength Material Backfill: (Flo-Fill - See Section 02321).

PART 3: EXECUTION

3-1 General:

The following procedures shall be followed by Contractor in sequencing the Work:

- A. No more than one hundred fifty (150) feet of trench shall be left open at any time. The entire trench shall be backfilled to within fifty (50) feet of the open trench upon conclusion of each day's Work. The trench shall not be backfilled until the pipe installation is reviewed by Engineer.
- B. Trench shall be backfilled within one hundred (100) feet of the pipe installation at all times.
- C. Clean-up shall be maintained within four hundred (400) feet of the trench excavation.

Prior to placement in the trench, all pipes, fittings, and appurtenances shall be cleaned and examined for defects by Contractor. If found defective, Contractor shall reject the defective pipe, fitting, or appurtenance. Contractor shall advise Engineer of all defective materials.

All surplus excavation shall be placed, in an orderly manner. If material is stockpiled on private property, written permission must be obtained from the property owner and provided to Engineer.

All muck excavation, bedding, and pipe zone material shall be imported unless otherwise designated by Owner's geotechnical engineer.

Upon completion of the Work, all plants, rubbish, unused materials, concrete forms, and other like material shall be removed from the job site. The site shall be left in a state of order and cleanliness.

3-2 Maintenance and Correction:

- A. Scarify surface, reshape, and compact to required density completed or partially completed areas of Work disturbed by subsequent construction operations or by adverse weather.
- B. Maintain and correct backfill, fill, and embankment settlement and make necessary repairs to pavement structures, seeding, and sodding which may be damaged as a result of settlement for the guarantee period.
- C. Such maintenance and correction may be performed by subcontract.

3-3 Obstructions and Disposal of Waste Material:

Contractor shall remove obstructions that do not require replacement from within the trench or adjacent areas such as tree roots, stumps, abandoned piling, buildings and concrete structures, frozen material, logs, and debris of all types without additional compensation. Engineer may, if requested, make changes in the trench alignment

to avoid major obstructions, if such alignment changes can be made within the Work limits without adversely affecting the intended function of the facility. Excavated materials unsuitable for backfill or not required for backfill shall be disposed of in accordance with local regulations.

3-4 Shoring:

As needed, all excavations shall be properly sheeted and braced to meet Federal, State and local laws in regard to safe working conditions. The shoring shall be arranged so as not to place any stress on portions of the completed work until the general construction thereof has proceeded far enough to provide ample strength. Any damage to pipes or structures resulting from settlements, heaving, water or earth pressures, slides, caving, or other causes, due to lack of shoring, sheeting, or bracing, or due to failure of shoring, or due to improper shoring, or due to any other negligence on the part of the Contractor, shall be repaired by the Contractor at his own expense.

Shoring shall be removed as the work progresses, unless left in place by written order of the Project Manager. The Contractor will be paid for shoring so ordered left in place on the basis of invoice material cost only. Trench sheeting shall not be pulled before backfilling unless the pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting, nor shall sheeting be pulled after backfilling. Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.

3-5 Water Control and Dewatering:

Dewatering equipment shall be provided to remove and dispose of all surface water and groundwater entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

All excavations for concrete structures or trenches which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level beneath such excavations 12 inches or more below the bottom of the excavation.

Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

The Contractor shall be responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipe or conduit shall be left clean and free of sediment.

3-6 Trench Excavation:

Trenches shall be excavated so that pipes can be laid in accordance with the profiles, grades, elevations and minimum cover as shown on the drawings or specified herein. No trenches or excavation shall be left open after working hours.

- A. Excavation in Streets and Other Paved Surfaces. The excavation in streets with asphalt paving must be confined to a minimum width as required to maintain a safe trench condition. The pavement shall be cut vertical and on a straight line.

Regardless of the amount of pavement damaged or removed during installation of the pipelines, except for pipe 36" diameter and greater, the maximum width of pavement replacement that will be paid for will be up to 30 inches on either side of the pipe centerline and a maximum total width of 60 inches if pavement is excavated on both sides of the pipe centerline and shall include all base course, cleaning, prime coats and asphalt pavement.

- B. Minimum Cover. Where pipe grades or elevations are not definitely fixed by the contract drawings, trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill cover over the top of the pipe of 54 inches. Sanitary sewer mains require a minimum of 42 inches of cover; storm sewers require a minimum of 12 inches of cover.

- C. Trench Widths. The minimum clear trench width measured at the top of the pipe barrel shall not be less than the outside pipe diameter, plus 16-inches.

For all pipe, the maximum clear trench width measured at a point 12-inches above the top of the pipe barrel shall be not greater than the trench width shown on the following table:

Pipe Diameter Inches	Maximum Trench Inches	Pipe Diameter Inches	Maximum Trench Inches
4	24	24	48
6	26	27	52
8	28	30	56
10	30	33	60
12	34	36	68
14	36	39	72
15	37	42	76
16	38	48	82
18	40	54	90
20	42	72	110
21	44		

If the stated maximum trench widths are exceeded, either through accident or otherwise, and if the Project Manager determines that the combined dead and live loads will exceed the design loadings on the pipe, the Contractor shall either cradle the pipe in concrete, or use a pipe of a stronger class, as required by the Project Manager. The cost of such remedial measures shall be entirely at the Contractor's expense.

Cutting trench banks on slopes to reduce earth load to prevent sliding and caving shall be done only in areas where the increased trench width will not interfere with surface features.

- D. Trench Walls. The Contractor may slope or bench the trench sidewalls in areas where an increased trench width will not interfere with surfaces features or other utilities. Such sloping or benching shall terminate at a depth not lower than one foot above the top of the pipe barrel, and from that point down, the trench wall shall be vertical. The trenching operation, including the spoil bank and sloping of the trench sidewalls shall be confined to the width of the permanent and temporary rights-of-way, if any.

A clear area shall be maintained a sufficient distance back from the top edge of the excavation to avoid overloading which may cause slides or caving of the trench walls. The excavated material shall be kept trimmed in such a manner as to be of as little inconvenience as possible to the public and adjoining property owners. Unless otherwise authorized by the Project Manager, all public thoroughfares and crossroads shall be kept open to traffic. Bridging shall be

used when authorized by the Project Manager at street crossings, sidewalks and other points where necessary, to prevent serious interruption of travel and to provide access to fire hydrants and public and private premises.

- E. Trench Depth. The trenches shall be excavated to such depths that the pipeline can be laid at the elevation of the grade lines shown on the Drawings, or at the depths or covers specified herein. If unauthorized over-excavation occurs, the Contractor shall place and compact stabilization material at no additional cost to the City.

The pipe trench shall be excavated to a depth as shown on the drawings below the bottom of the pipe and backfilled with the specified granular bedding material and compacted to the requirements of Section 3-10.

- F. Trench Preparation. The trench shall be excavated only so far in advance of pipe laying as permitted by the Project Manager. The trench wall shall be so braced that the workmen may work safely and efficiently. All trenches shall be drained so that pipe laying may take place in un-watered conditions. Trench preparation shall also conform to the details shown on the Drawings.

Trenches above a point 12-inches above the top of the pipe shall be of such extra width, when required, as will permit the convenient placing of timber supports, sheeting and bracing, and the handling of special units as necessary.

Bell holes in the trench bottom shall be provided at each joint to permit the jointing to be made properly and to prevent the pipe from bearing on the pipe bells.

After excavation, the trench bottom shall be uniformly graded and hand-shaped so that the pipe barrel (exclusive of the joint) will have uniform and continuous bearing on thoroughly compacted pipe bedding material throughout the length of the pipe. The trench grade shall permit the pipe spigot to be accurately centered in the preceding laid pipe joint, without lifting the pipe above the grade and without exceeding the permissible joint deflection. If it is necessary to raise the pipe subgrade, approved, compacted bedding material shall be used at the Contractor's expense.

- G. Excavation Material. Excess excavated material suitable for backfill shall not be disposed of until all backfill operations are complete. If excavated material unsuitable for backfill is encountered, the excess material from other locations in the project shall be used for backfill at no additional cost to the City.
- H. Rock Excavation. In the event of rock excavation, the bottom of the trench shall be lowered so that the bottom of the trench is 6 inches below the outside surface of the pipe. The space between the rock and the pipe shall be filled with granular bedding material. The bedding material shall be compacted to a density equal to or greater than 90% of the maximum laboratory density. During compaction, the bedding material shall be shaped to provide support along the full length of pipe.

3-7 Storage of Excavated Material:

Excavated material shall be stockpiled near the immediate construction area in a confined configuration. For storage of excess excavated material suitable for backfill, Contractor shall obtain and pay for a storage site. All transportation to and from (including loading) storage site and temporary land/site acquisition is included in the work.

All excess excavated material at the completion of the work and all debris, stones, logs, stumps, roots, and other unsuitable materials shall be removed from the site and disposed of by, and at the expense of, the Contractor.

3-8 Foundations on Unstable Soils:

If the bottom of the excavation is soft or unstable, and in the opinion of Engineer, cannot satisfactorily support the pipe or structure, a further depth and width shall be excavated and refilled to six (6) inches below grade with rock uniformly graded between three-quarter ($\frac{3}{4}$) inch and one and one-half ($1\frac{1}{2}$) inches or other approved material to provide a firm foundation for the pipe or structure. From six (6) inches below grade to grade, the appropriate bedding material shall be placed to provide support for the pipe or structure.

3-9 Installation of Pipe Bedding:

Pipe Bedding material shall consist of the material on which the pipe is placed (refer to 2-2 above). Bedding material shall be placed to a minimum of 4-inches below the pipe invert. Tamping equipment shall be used to thoroughly tamp the bedding material. The moisture content of the material shall be within 2 percent of optimum.

After bedding material has been placed and has been approved and after the pipe has been installed and approved, the granular bedding material shall be installed to an elevation 12-inches above the top of the pipe. For RCP sewer pipe, granular bedding material shall be installed to the springline of the pipe. The granular bedding material shall be placed and compacted in distinct, separate lifts not to exceed 6-inches of loose depth; except that the first loose lift shall not be higher than the pipe centerline (springline). Compaction shall meet the above requirements utilizing T-bars or mechanical tamping equipment.

3-10 Installation of Trench Backfill:

Unless accurate results cannot be obtained, the compaction requirements shall conform to maximum dry density according to ASTM D698, Moisture-Density Relations of Soils (Standard Proctor). When the ASTM D698 test is not applicable, the percentage compaction requirements shall conform to ASTM D2049 Test for Relative Density of Cohesionless Soils.

When required by the Engineer the Contractor shall excavate backfilled trenches for purposes to perform compaction tests at locations and depths determined by the

Project Manager. The Contractor shall be responsible for reinstalling and compacting the test excavations at no additional cost to the City.

All backfill above the bedding installation shall be carefully placed and compacted. Compaction shall be by mechanical tamping in 8-inch maximum horizontal, loose lifts using mechanical or hand tampers, suitable for material being compacted, or vibratory rollers. All other means must be approved in writing by the Project Manager. All backfill shall be compacted to 95% of maximum laboratory dry density or 70 percent relative density. The material shall be within 2.0 percent of optimum moisture content.

The Contractor may request approval of alternate means of compaction. Such request must be submitted to the Project Manager in writing. Approval of the compaction method will be made by the Project Manager only in writing. Use of specified or approved compaction methods does not relieve the Contractor from providing a complete project meeting the intent of this Specification.

A layer of backfill material not more than 8 inches deep may be placed over concrete arch encasement or concrete reaction blocking after the concrete has reached its initial set, to aid curing. No additional backfill shall be placed over arch encasement or blocking until the concrete has been in place for at least three days.

3-11 Restoration:

- A. Streets and Roadways. Any pavements disturbed during construction shall be repaired in accordance with Detail Drawings and Specifications Sections 02511, 02512 and 02513 for Aggregate Base Course, Bituminous Prime Coat and Hot Bituminous Pavement.

All streets and paved surfaces shall be restored within two (2) weeks of their excavation. All dirt and debris, including dust shall be removed from streets and paved surfaces within three (3) days of the restoration of streets and paved surfaces. Initial removal of dirt and debris shall be made using a vacuum sweeper, after which the paved surfaces shall be cleaned using water hoses.

- B. Concrete Walks, Curb and Gutter, Fencing and Culverts. Restore all existing structures to conditions equal to or exceeding existing structures and according to local requirements.

- C. Landscape. After other outside work has been finished, and backfilling and embankments completed and settled, all areas which are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas which have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least 4 inches. Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth.

Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to hand work.

All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least one percent shall be provided.

Final grading and surfacing shall be smooth, even, and free from clods and stones larger than one inch in greatest dimension, weeds, brush, and other debris.

The top portion of backfill beneath established lawn areas shall be finished with at least 12 inches of topsoil corresponding to, or better than, that underlying adjoining lawn areas.

- D. Other Items. The Engineer will clarify restoration of other minor items as construction proceeds. Such items must be restored to equal or exceed existing conditions.

3-12 Cleanup:

Prior to final inspection and acceptance, the Contractor shall remove all rubbish and excess materials and leave area in a neat, satisfactory condition.

3-13 Maintenance of Backfill:

All backfill shall be maintained in a satisfactory condition and all places showing signs of settlement shall be filled and maintained during the life of the Contract and for a period of one year following the date of final acceptance of all work performed under the Contract. When the Contractor discovers or is notified by the Owner that any backfill is not in compliance with the provision of this Contract, the Contractor shall correct such conditions. Any utilities and road surfacing damaged by such settlement shall be repaired by the Contractor to the satisfaction of the Owner. In addition, the Contractor shall be responsible for the cost to the Owner of all claims for damages due to settlement of backfilled areas.

END OF SECTION

SECTION 02601
TESTING OF WATER PIPELINES

PART 1: GENERAL

1-1 Description:

The work of this section consists of testing water pipe.

PART 2: MATERIALS

2-1 Test Equipment:

The contractor shall provide all necessary test equipment including test pumps, pipe, connectors, meters, gauges, instruments, and other equipment required. Pressure gauges used shall be graduated in increments not greater than 5 psi and shall have a range of approximately twice the test pressure. Gauges meters and other instruments shall be calibrated prior to testing.

PART 3: EXECUTION

3-1 Notification and Witness:

The Contractor shall notify the Project Manager of all tests at least 48 hours prior to testing so that the Project Manager can witness the tests.

The pipe may be subjected to hydrostatic pressure and inspected and tested for leakage at any convenient time after the trench has been partially backfilled, except at the joints, or backfilled as permitted by the Project Manager. Where any section is provided with concrete thrust blocks, the pressure test shall not be made until at least two days have elapsed after the concrete was installed.

3-2 Pressure Test:

All new pipe shall be pressure tested prior to connection to the existing system. All pipe shall be tested at a pressure of 150 psi at the lowest point in each section or 1-1/2 times the working pressure, whichever is greater.

Prior to testing, all equipment which would be damaged by the test pressure shall be removed. This equipment shall be replaced in the system after testing is complete. All pipe and appurtenances shall be backfilled except for joints unless otherwise permitted by the Project Manager.

The Contractor shall slowly fill the pipe with water prior to testing and remove all air from the piping system. Each valved section, unless otherwise directed by the Project Manager, shall be tested prior to connection to the existing system. The duration of each pressure test shall be at least two (2) continuous hours. Test time will be accrued only while full test pressure is on system. All water used in testing the pipelines shall be provided by the Contractor from a potable water source.

The specified test pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Project Manager. The Contractor shall furnish all necessary labor, equipment, and connection corporation stops to the pipeline to perform the test.

No testing shall be permitted against valves or fittings that are part of the existing system unless specifically approved by the Project Manager. All exposed pipes, fittings, valves, hydrants, and joints will be carefully examined during the test. Any cracked or defective pipe, fittings, valves, or hydrants discovered during the pressure test shall be removed and replaced by the Contractor with sound material. The test shall be repeated until the test is satisfactory to the Project Manager.

3-3 Leakage Test:

A leakage test shall be conducted after the pressure test has been completed unless the pressure test indicates that there are no leaks. The contractor shall furnish the pump, pipe, connections, meters and all other necessary apparatus, and shall furnish all necessary assistance to conduct the test. The duration of each leakage test shall be two hours, and, during the test, the main shall be subjected to a hydrostatic pressure specified.

No pipeline installation will be accepted until the leakage is less than the amount computed by the following formula:

$$L = \frac{SD(P)^{0.5}}{133,200}$$

L = Allowable leakage in gallons (per hour)

S = Tested length of pipe (feet)

D = Nominal diameter of pipe (inches)

P = Average test pressure during the test (psi)

Should any test of pipe disclose leakage greater than that specified above, the Contractor shall, at his own expense, locate and repair the points of leakage until the leakage is within the specified allowance.

END OF SECTION

SECTION 02614
BURIED DUCTILE IRON PIPE

PART 1: GENERAL

1-1 Description:

The work of this section consists of providing and installing buried ductile iron pressure pipe and fittings.

1-2 Reference Standards:

American Society for Testing and Materials (ASTM)
American National Standards Institute (ANSI),
American Water Works Association (AWWA),
Federal Specifications (FS),

1-3 Submittals:

In accordance with Section 01300, submit certificates of compliance and manufacturer's literature.

1-4 Product Handling:

Handle pipe carefully to ensure delivery in a sound, undamaged condition with pipe coating uninjured. Contractor shall replace damaged pipe at no additional expense to City. Do not store materials directly on the ground.

PART 2: MATERIALS

2-1 Buried Ductile Iron Pipe:

Unless revised on the Drawings the ductile-iron pipe shall conform to ANSI A21.51, AWWA C151, Class 52 thickness. The interior of each length of pipe shall have a cement-mortar lining, conforming to the requirements set forth in ANSI A21.4, AWWA C104, of standard thickness. The exterior of the pipe shall be coated with standard bituminous coating approximately one mil thick.

Unless otherwise specified the pipe joint shall be the "push-on" type, made in accordance with ANSI A21.11, AWWA C111, and the gaskets shall be standard for buried water service and as provided by the pipe manufacturer.

The fittings shall be ductile-iron or cast-iron conforming to the requirements set forth in ANSI A21.10, AWWA C111 or ANSI 21.53, AWWA C153. All cast-iron fittings 12 inch and smaller shall be Class 250, and fittings larger than 12 inches

shall be Class 150. The interior of the fittings shall be cement-mortar lined, as is required for the pipe with a 1 mil bituminous exterior coating. The fittings shall have mechanical joints in accordance with ANSI A21.11. The gaskets for the joints shall be suitable for potable water service.

2-2 Polyethylene Encasement:

The ductile-iron pipeline and fittings shall be encased in polyethylene film in accordance with the following requirements of ANSI A21.5, AWWA C105.

- A. Polyethylene. The polyethylene film shall be manufactured of virgin polyethylene material conforming to the requirement of ASTM D-1248. The raw materials shall be Type 1, Class A (natural) or C (Black) Grade E-1 with flow rate of 0.4 maximum of dielectric strength of 10^{15} ohm-cm³ minimum.

The finished polyethylene film shall have a minimum nominal thickness of 0.008-inch (8 mil), and the minus tolerance on thickness shall not exceed 10 percent of the nominal thickness. The film shall have a minimum tensile strength of 1200 psi with an elongation of 300 percent minimum. The dielectric strength shall be 800 volts/mil thickness minimum.

- B. Tube Size or Sheet Width. The tube size or sheet width for each pipe diameter shall be listed in the following table.

<u>Nominal Pipe Diameter (In.)</u>	<u>Minimum Width (In.)</u>	
	<u>Flat Tube</u>	<u>Sheet</u>
4	16	32
6	20	40
8	24	48
10	27	54
12	30	60
14	34	68
16	37	74
18	41	82
20	45	90
24	54	108
30	67	134
36	81	162
42	95	190
48	108	216
54	121	242

2-3 Thrust Restraint:

Where designated on the Drawings or where existing conditions do not permit the use of concrete thrust blocks, fitting restraints shall be provided as follows:

Alternative A: Tie rods and pipe clamps or special fitting bolts. Tie rod restraint systems shall have a minimum of 2 bolts or rods per joint or clamp. Minimum tie bolt/rod sizes are as follows:

<u>Pipe Size</u>	<u>Bolt Diameter</u>
4"-8"	5/8"
10"-14"	3/4"
16"	1"
18"-20"	1-1/4"
24"	1-1/2"

All materials shall be fabricated from "Cor-Ten" steel or equal according to the requirements of ASTM A-242 with a minimum yield stress of 46,000 psi.

Alternative B: Pacific States Lock Mechanical Joint with Tyton Joint Core or equal. Assembly of the Tyton Joint portion of the product shall be in accordance with AWWA C600-77. Fittings with the joint restraint feature shall be ductile iron and shall conform to ANSI Standard A21.10. Push-on joints for such fittings shall be in accordance with AWWA Standard A121.11.

2-4 Water Services:

Water services shall be installed as indicated on the Drawings. The general locations of the service lines are shown on the Drawings. The actual locations shall be determined in the field by the Contractor.

2-5 Connections to the Existing System:

Operation of the existing system must at all times remain under the control of the City. The Contractor shall operate no valves or hydrants on the system without permission of the City.

All points at which the existing water systems are to be disconnected and connected to the new mains are shown on the Drawings.

The Contractor shall take precautions as necessary to minimize interruption of all utility services and will be responsible for restoration of service. The Contractor shall schedule existing valve locates with the City at least three days before

scheduling a shutoff.

Unless otherwise specified, at any time a customer on the existing system will be deprived of a supply of water, the Contractor shall advise such customer in writing 48 hours in advance of when the supply will be disconnected and when the supply will again be available.

PART 3: EXECUTION

3-1 General:

Sizes as shown. Lay to the grades and lines shown in accordance with pipe manufacturer's specifications. Rest each section upon the pipe bed for full length of the barrel with recesses excavated to accommodate joints. Take up and re-lay any length that has had its line, grade, or joint disturbed after laying. Thoroughly clean pipe interiors of foreign matter before lowering into trench. Replace with new pipe any section of pipe found damaged or defective.

3-2 Installation of Ductile Iron Pipe:

Except as specified herein or unless specifically authorized by the Project Manager, all installation of pipe shall conform to the recommendations contained in "A Guide for Installation of Ductile-Iron Pipe," published by the Ductile Iron Pipe Research Association. A copy shall be available at the job site.

- A. Pipe Laying. Pipe shall be laid with bell ends facing in the direction of laying, unless directed otherwise by the Project Manager. Pipe shall be laid on the bedding with support over the full length of the pipe barrel.

Pipe joint deflections shall not exceed the amount shown in the following table:

DUCTILE-IRON PIPE DEFLECTION

Approx. Radius of Curve Produced by

<u>Size of Pipe</u>	<u>Bend in One Joint</u>	<u>Deflection in 18-Foot Length</u>	<u>One Succession of 18-Foot Joints</u>
4"	4°	15"	250'
6"	4°	15"	250'
8"	4°	15"	250'
10"	4°	15"	250'
12"	4°	15"	250'
14"	2°	7.5"	510'
16"	2°	7.5"	510'
18"	2°	7.5"	510'
20"	2°	7.5"	510'
24"	2°	7.5"	510'
30"	2°	7.5"	510'
36"	2°	7.5"	510'
42"	1-1/2°	5"	690'
48"	1-1/2°	5"	690'

The information in the columns referring to the deflection and the approximate radii shall be adjusted for pipe lengths different than 18-foot lengths. To lay pipelines on curved alignment with shorter radius if called for on the Drawing, the Contractor will be required to use shorter pipe lengths. No increase in the proposal unit price shall be allowed for use of shorter pipe lengths. Double hubs may be used to lay pipelines on curved alignment.

Vertical deflections shall not exceed any of the above values.

When pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Project Manager.

The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or cement lining so as to leave a smooth end at right angles to the axis of the pipe. The flame cutting of pipe by means of an oxyacetylene torch will not be allowed. The pipe end shall be bevelled and free of sharp edges that could damage the gasket during installation.

B. Jointing of Mechanical Joints. The last 8 inches of the pipe spigot and the inside of the bell of the mechanical joint shall be thoroughly cleaned to

remove oil, grit, tar (other than standard coating), and other foreign matter from the joint, and then painted with a soap solution made by dissolving one-half cup of granulated soap in one gallon of water. The cast-iron gland shall then be slipped on the spigot end of the pipe with the lip extension of the gland toward the spigot end. The gasket shall be painted with the soap solution and placed on the spigot end of the pipe to be laid, with the thick edge toward the gland.

The entire section of the pipe being laid shall be pushed forward to seat in the spigot end of the bell of the pipe in place. The gasket shall then be pressed into place within the bell, being careful to have the gasket evenly located around the entire joint. The cast-iron gland shall be moved along the pipe into position for bolting, all of the bolts inserted, and the nuts screwed up tightly with fingers. All nuts shall then be tightened with a suitable (preferably torque-limiting) wrench. The torque for various sizes of bolts shall be as follows:

<u>Size (Inches)</u>	<u>Range of Torque ft.-lb.</u>
5/8	45-60
3/4	75-90
1	100-120
1-1/4	120-150

Nuts spaced 180° apart shall be tightened alternately to produce an equal pressure on all parts of the gland.

- C. Jointing of Push-On Joints. In jointing the pipe, the exterior 4 inches of the pipe at the spigot end and the inside of the adjoining bell and particularly the groove for the gasket shall be thoroughly cleaned to remove oil, grit, tar (other than standard coating), and other foreign matter. The proper gasket supplied with the pipe shall be placed in the bell as described by the pipe manufacturer so it will spring into its proper place inside the pipe bell. A thin film of the pipe manufacturer's joint lubricant shall be applied to the gasket over its entire exposed surface. The spigot end of the pipe shall then be wiped clean and inserted into the bell to contact the gasket. Then the pipe shall be forced all the way into the belt by crowbar, or by jack and choker slings. The location of the gasket shall be checked with a gauge or tool designed for that purpose to assure that the gasket is in the proper position.
- D. Installation of Polyethylene Encasement. The polyethylene encasement shall prevent contact between the pipe and the surrounding backfill and

bedding material, but is not intended to be a completely air and watertight enclosure. Overlaps shall be secured by the use of 2-inch wide, 10 mil thick, polyethylene pressure sensitive tape.

The polyethylene wrap tubing shall be cut to provide for a minimum of one foot of lap over both the adjoining pipes. The ends of the tubing shall be wrapped using three (3) circumvential turns of tape.

The loose wrap on the barrel is to be pulled snugly around the barrel of the pipe and the excess folded over at the top. This fold will be held in place by means of six inch (6") strips of the tape placed at intervals of three feet (3') along the pipe barrel.

Bends, reducers, and offsets shall be wrapped in the same manner as pipe.

Valves shall be wrapped by bringing the tube wrap on the adjacent pipe over the bells of the valve and sealing with tape. The valve bodies are then wrapped with flat sheets passed under the valve bottom and brought up around the body to the stem and fastened with the tape.

3-3 Installation of Thrust Restraint:

The movement of fittings shall be restrained by use of concrete thrust blocks or steel clamp and tie bolt assemblies as indicated on the drawings. The thrust blocks shall be poured between undisturbed solid ground and the fitting to be anchored; the area of bearing on the undisturbed trench wall shall be that shown on the thrust block detail or directed by the Project Manager. The concrete shall be placed so that the pipe or fitting joints will be accessible for repair. Thrust blocks or other thrust restraint where thrust blocks cannot be used shall be required at all the fitting unless otherwise shown on the Drawings. A bond breaker shall be placed over the fitting before placing concrete.

Thrust restraint clamps and tie bolts shall be assembled using clamps on each side of pipe bells with tie rods extending full pipe length for the dimensions shown on the detail drawings each direction from the restrained fitting. Clamps shall be installed tight enough to prevent twisting around the pipe. Two tie bolts per clamp with washer at the clamp shall be located on the side of pipe. Tighten tie bolt nut to "hand tight" with 12-inch wrench (approximately 50-100 foot-pounds torque). Threaded tie rods shall extend two full threads past nut in final position.

3-4 Installation of Casing Pipe:

Not required for this project. Install water pipeline carrier pipe inside a casing pipe in accordance with details on the Drawings. Insulator skids shall be installed according to manufacturer's recommendations. A minimum of 3 skids/casing chocks shall be provided per individual pipe length.

Carrier pipe shall be jointed outside the casing and moved into place by placing a brace across the bell furthest from the casing and moving the pipe with a jack behind the brace or winch and cable from the opposite end of the casing pipe. Pulling the pipe through the casing from the leading bell shall not be permitted. As each length of pipe enters into the casing, a new length shall be laid adjacent, jointed and moved into place in the same manner. The pipe bells shall not be permitted to contact the casing pipe.

After the carrier pipe is entirely in place, the ends of the casing pipe shall be sealed water tight with grout or approved casing end seals.

3-5 Connections to Existing System:

Operation of existing system must at all times remain under the control of the Owner. The Contractor shall operate no valves or hydrants on the system without permission of the Owner.

All points at which the existing water systems are to be disconnected and connected to the new mains are shown on the Drawings. Connections to the existing system shall be completed after new pipeline, valves, thrust blocks and other appurtenances are installed and tested. Contractor shall provide all necessary temporary restraints on existing pipelines. At each point of connecting new pipes to existing pipes, the Contractor shall expose the existing pipe and locate a good sound point at which to cut the existing pipe off square. He shall then provide and install a transition coupling that has been designed and manufactured explicitly for the purpose of joining together two types and sizes of pipe which he must connect.

The Contractor shall take precautions as necessary to minimize interruption of all utility services and will be responsible for restoration of service. The Contractor shall schedule existing valve locates with the Owner at least three days before scheduling a shutoff.

Unless otherwise specified, at any time that a customer on the existing system will be deprived of a supply of water, the Contractor shall advise such customer 48 hours in advance when the supply will be disconnected and when the supply will again be available.

3-6 Testing:

Testing of ductile iron pipe shall be as specified in Section 02601.

3-7 Backfill and Restoration of Surface Conditions:

Backfill and restoration of surface conditions shall be as specified in Section 02200.

3-8 Disinfection of Potable Pipelines:

Ductile iron pipe shall be disinfected as specified Section 02675.

END OF SECTION

SECTION 02615

STEEL PIPE

PART 1: GENERAL

1-1 Description:

This section covers steel pipe 6 inches in diameter and larger, together with fittings, specials, and appurtenances.

Steel pipe smaller than 6 inches in diameter, miscellaneous small piping, pipe supports, cathodic protection, pressure and leakage tests, and cleaning and disinfection are covered in other sections.

Pipe trenching, bedding, and backfill shall be done in accordance with Section 02200.

Steel piping shall be furnished and installed complete with all fittings, specials, jointing materials, appurtenances, and accessories indicated on the drawings or otherwise required for proper installation and functioning of the piping.

1-2 Reference Standards:

Except as modified or supplemented herein, all steel pipe, fittings, and specials shall conform to the applicable requirements of the following standards:

American Water Works Association (AWWA)
American National Standards Institute (ANSI)
American Society for Testing and Materials (ASTM)
American Society of Mechanical Engineers (ASME)

1-3 Submittals:

Submit certificates of compliance and manufacturer's literature on all materials used in the work in accordance with Section 01300.

PART 2: MATERIALS

2-1 Pipe Design:

Steel pipe, fittings, and specials may be either fabricated or mill type. In either case, all items shall be fabricated to the sizes, dimensions, and shapes indicated on the drawings or specified herein.

The specified size of fabricated pipe, fittings, and specials shall be the nominal inside diameter, in inches, where 12 inches and smaller in size, and the actual inside diameter of pipe lining, where 14 inches and larger in size. Where stab joint pipe is permitted and two or more pipe wall thicknesses are required for the same size pipe, pipe size may be adjusted slightly to allow the different classes of pipe to be stabbed together.

The specified size of mill pipe, fittings, and specials shall be the nominal pipe size as set forth in ANSI/ASME B36.10.

- A. Pipe Wall Thickness. The pipe wall thickness shall be determined by the pipe fabricator using the following formula, except that all pipe shall have a wall thickness of at least 1/4 inch:

$$t = \frac{PD}{s}$$

where:

t = The pipe wall thickness in inches.

s = The allowable fiber stress in psi which shall not exceed 50 percent of the yield strength of the steel plate at working pressure or 75 percent of the yield strength at shop test pressure.

P = The pipe working pressure or shop test pressure in psi.

D = The pipe outside diameter, in inches, of straight pipe sections or the larger outside diameter of tapered sections.

- B. Fitting Dimensions. Unless otherwise permitted by the Engineer, the dimensions of steel pipe fittings shall be as indicated on the drawings.
- C. Reinforcement of Fittings and Specials. All bends, fittings, branch connections, reducers, and special sections shall be reinforced, or the wall thickness shall be increased, so that the combined stresses due to internal pressure (circumferential and longitudinal) and bending will not exceed 67 percent of the yield strength of the pipe material.

Whether or not indicated on the drawings, reinforcements or additional wall thickness shall be provided as required to ensure that the combined stresses do not exceed the specified maximum. Unless otherwise indicated or directed, the internal pressure shall be the specified shop test pressure for the piping adjacent to the item in question, and the dead load

shall be equal to the pipe full of water.

Wall thicknesses of reducing sections shall be not less than the required thicknesses for the larger ends.

- D. Joints. Acceptable joints of the type indicated on the drawings and as specified herein shall be provided for all pipe installations in the locations indicated or approved by the Project Manager. To facilitate installation, additional field-welded or mechanically coupled joints may be provided. Additional field joints shall be kept to a minimum, and their location shall be acceptable to the Project Manager. Field-welded joints shall not be used in pipe smaller than 27 inches, except in locations where the interior coating can be satisfactorily repaired and inspected.

2-2 Pipe Materials:

shall a fine	A. All Pipe, Fittings, and Specials	ANSI/AWWA C200. All steel be fully killed and made to austenitic grain size practice.
	B. Flanged Joints	
	All Flanges:	ANSI/AWWA C207, and be the slip-on type, except where otherwise permitted or required.
	All dimensions and drilling:	ANSI/AWWA C207, Class F, where indicated on the drawings, specified, or required to match existing or equipment flanges.
	All Blind Flanges	ANSI/AWWA C207, unless otherwise indicated on the drawings or specified.
	All Gaskets:	ANSI/AWWA C207, full-face type, John Crane "Style 999" neoprene, 1/8 inch thick, for field test pressures up to 250 psi; ring type, John Crane "Style 4160" compressed aramid fiber sheet, 1/16 inch thick, for field test

pressures above 250 psi.

The products of other manufacturers and other products of the manufacturer named herein will not be acceptable unless a certificate of product suitability is submitted as set forth in the Drawings and Data paragraph herein.

	All Insulated Flanges:	As specified herein, except bolt holes shall be enlarged as required to accept bolt insulating sleeves.
	Insulation Kits:	As manufactured by Central Plastics or PSI Industries,
reinforced Buna-N	Insulating Gaskets:	Type E, pyrox 1E glass epoxy, 1/8 inch thick, with sealing element,
	Bolt Insulating Sleeves:	Mylar, 1/32 inch thick.
	Insulating Washers:	Phenolic laminate, 1/8 inch thick, one for each flange bolt, and
	Backing Washers:	Steel, 1/8 inch thick, two for each flange bolt.
	Flange Bolting:	ANSI/AWWA C207 and be bolt and nut type; bolt-stud and two nuts permitted for 1 inch and larger.
	Bolts and Bolt-studs:	
	Length:	Such that ends project 1/4 inch to 1/2 inch beyond surface of nuts and
	Ends:	Chamfered or rounded.

	Threading:	ANSI/ASME B1.1, coarse thread series, Class 2A fit. Bolt-studs may be threaded full length.
	Bolt Head Dimensions:	ANSI B18.2.1; regular pattern for square, heavy pattern for hexagonal, and
	Nuts:	Hexagonal conforming to ANSI/ASME B18.2.2, heavy, semi-finished pattern.
	Threading:	ANSI/ASME B1.1, coarse thread series, Class 2B fit.
C. Stab Joints		Bell-and-spigot with rubber gasket as sole element depended upon for watertightness.
	Bells and Spigots:	Rolled groove, Carnegie shape, or fabricated type, as required or permitted.
	Rubber Gaskets:	Continuous O-ring; ANSI/AWWA C200, Section 3.6, except basic polymer shall be synthetic rubber. Natural rubber will not be acceptable.
D. Mechanical Couplings		
	Insulating Couplings:	Baker "Series 216", Dresser "Style 39", or Smith Blair "416"; without pipe stop.
	Reducing Couplings:	Baker "Series 220", Dresser "Style 62", or Smith Blair "413" and "415"; without pipe stop.
	All Others:	Baker "Series 200", Dresser "Style 38", or Smith Blair "411 Flexible Coupling"; without pipe stop.

E. Restrained Joints

Of the type indicated on the drawings or specified.

Lugs or Collars:

ASTM A283, Grade B or C; or ASTM A36.

Tie Bolts:

ASTM A193, Grade B7.

Threading:

ANSI/ASME B1.1, Class 2A fit, coarse thread series for 7/8 inch and smaller, and 8-thread series for 1 inch and larger, and

Ends:

Chamfered or rounded.

Nuts:

Hexagonal, ASTM A194, Grade 2H or better.

Threading:

As specified for tie bolts except Class 2B fit.

Dimensions:

ANSI/ASME B18.2.2, heavy semi finished pattern.

Flat Washers:

ASTM A325. Hardened steel,

F. Small Branch Connections

Pipe Nipples:
ASTM
weight(Schedule 40).

Seamless black steel pipe,
A53, standard

Welding Fittings:

Threaded Outlets:

Bonney "Thredolets", Porter "W-S Teelets", or Vogt "Weld Couplets", or

Welded Outlets:

Bonney "Weldolets", Porter "W-S Teelets", or Vogt "Weld Couplets".

G. Coatings and Linings

Rust-inhibitive Primer:	Ameron "Amercoat 3153A Universal Primer", Cook "391-N-167 Barrier Primer", Kop-Coat "340 Gold Primer", Tnemec "37-77 Chem-Prime", or Valspar "13-R-28 Chromox Primer".
Rust-preventive Compound:	Houghton "Rust Veto 344".
Coal Tar Enamel:	ANSI/AWWA C203.
Liquid Epoxy:	ANSI/AWWA C210.
Tape Coating:	ANSI/AWWA C209 and C214.
Cement Mortar:	ANSI/AWWA C205 and C602.
Cement:	ASTM C150, Type II.
Sand:	ANSI/AWWA C205, Section 2.3, except sand for field-applied lining shall pass a 16 mesh sieve.
Epoxy Bonding Agent:	ASTM C881, Type II, moisture-insensitive and suitable for conditions.
Latex Admixture:	Protex Industries "Probond Vinyl".
Thixotropic Coal Tar:	MIL-C-18480; Kop-Coat "Bitumastic No.50" or Tnemec "46-450 Heavy Tnemecol".

H. Bituminous Filler for Wall

Fittings:	Plastic asphalt roof cement, free; ASTM D4586, Type II.
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I. Watertight Pipe Sleeves

Thunderline Corporation
"Link-Seal", insulating type with
modular rubber sealing elements,
nonmetallic pressure plates, and
galvanized bolts and nuts.

J. Anchor Bolts

ASTM A307.

2-3 Shop Inspection and Testing:

Except as otherwise indicated or acceptable to the Project Manager, all materials furnished and work performed shall be inspected and tested by the pipe manufacturer in accordance with ANSI/AWWA C200. All costs in connection with such inspection and testing shall be borne by the Contractor.

Copies of all test reports shall be submitted as set forth in the submittals section.

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.

- A. City's Inspection at the Shop. If the City elects to inspect any work performed or materials furnished, as permitted under Section 1.4 of ANSI/AWWA C200, all costs in connection with the City's inspector will be paid for by the City. Additional weld test specimens shall be furnished to the City's inspector for an independent testing laboratory whenever, in the judgment of the City's inspector, a satisfactory weld is not being made. Test specimens shall also be furnished when the City's inspector desires. The entire cost of obtaining, inspecting, and testing of such additional specimen plates, welds, or materials will be borne by the City. If any specimen is found not to conform to the specified requirements, materials represented by the specimen will be rejected. The expense of all subsequent tests, due to failure of original specimens to comply with the specifications, shall be the responsibility of the Contractor.

Work to be performed by the City's inspector at the fabricating shop will include checking of flange alignment after welding to the pipe and tolerances of stab joints.

In addition to making or witnessing all specified tests and submitting reports to the Project Manager as may be required, the City's inspector will make written reports to the Contractor concerning all materials rejected, noting the reason for each rejection.

Inspection by the City's inspector, or failure to provide inspections, shall not relieve the Contractor of his responsibility to provide materials and perform the work in accordance with the Contract Documents.

- B. Welding Procedures, Welder Qualifications, and Testing. All welding procedures, welders, welding operators, and tackers shall be qualified in accordance with AWS D1.1 and as defined in ANSI/AWWA C200. All qualifications shall be in accordance with all-position pipe tests as defined in Section 5 of AWS D1.1.

All shop welds on steel pipe and fittings shall be ultrasonically tested by the fabricator, by qualified and certified operators. Shop ultrasonic weld tests shall be in accordance with Section 9 of API 5L, 37th Edition. All costs for shop ultrasonic testing shall be paid for by the Contractor. One copy of all ultrasonic test reports shall be furnished to the Contractor and the Project Manager.

Personnel performing visual inspection of welds shall be qualified and currently certified as Certified Welding Inspectors (CWI) in accordance with AWS QC1, Standard for Qualification and Certification of Welding Inspectors. Personnel performing ultrasonic and radiographic tests shall be qualified and certified to the requirements of SNT-TC-1A.

Nondestructive examination procedures shall be submitted in accordance with the requirements of the submittals section at the time welding procedures are submitted. Records of inspection, nondestructive examination, and material certification shall be furnished to the Project Manager.

All costs for shop weld inspection shall be paid for by the Contractor.

2-4 Ends of Sections:

- A. For Field Welding. Ends of pipe, fittings, and specials for joints butt-welded in the field shall have the ends beveled for butt welding in accordance with the governing standards.

Ends of pipe, fittings, and specials for field-welded lap joints shall have both the bell and the spigot expanded by pressing (not rolling) to obtain the required shape and the required welding tolerances.

- B. For Fitting with Flanges. Ends to be fitted with slip-on flanges shall be prepared to accommodate the flanges in accordance with the governing

standards.

- C. For Stab Joints. Stab joints shall be designed so that the gasket will maintain a watertight joint under all conditions of service, including expansion, contraction, and earth settlement. The gasket shall not support the entire weight of the pipe. Spigot ends shall have a groove to retain the gasket. Pipe ends shall be self-centering without the aid of the gasket.
- D. For Mechanical Couplings. Ends to be joined by mechanical couplings shall be plain end type in accordance with the governing standard. In addition, the welds on ends to be joined by couplings without pipe stops shall be ground flush to permit slipping the coupling in at least one direction to clear the pipe joint.
- E. For Connection to Dissimilar Pipe Materials. Steel pipe connections to buried or submerged concrete pipe or cast iron pipe shall be made with insulated flanges.

2-5 Seams:

Except for seamless mill-type pipe, all piping shall be made from steel plates rolled into cylinders or sections thereof with the longitudinal seams butt-welded, or shall be spirally formed and butt-welded. There shall be not more than two longitudinal seams. Girth seams shall be butt-welded and shall be spaced not closer than 10 feet apart except in specials and fittings.

2-6 Pipe Lengths:

Straight pipe sections shall be 40 foot lengths unless otherwise indicated on the drawings.

All pipe to be connected with mechanical couplings shall be fabricated so that the space between pipe ends within the couplings will not exceed the allowable as recommended by the coupling manufacturer but will be at least 1/2 inch.

2-7 Small Branch Connections:

Branch connections 2-1/2 inches and smaller shall be made with welding fittings with threaded outlets. Where there is some doubt as to the exact outlet size desired, but it is known that the size will be less than 1 inch, a 1 inch outlet shall be provided and reducing bushings used as required.

Branch connections 3 inches through 12 inches in size shall be made with pipe

nipples or with welding fittings with welded outlets. Pipe nipples and welding fittings shall be welded to the pipe shell and reinforced as required to meet design and test requirements.

Small branch connections shall be located so as not to interfere with joints, supports, or other details and shall be provided with caps or plugs to protect threads during shipping and handling.

2-8 Drains and Vents:

In interior locations, drains and vents shall be provided at the locations and in the sizes indicated on the drawings. Pipe used for drain and vent piping shall be ASTM A53 standard weight, black steel pipe. Drain valves shall be hose valves.

Vent valves shall be resilient seat globe valves. Drain and vent valves shall comply with the requirements of the miscellaneous valves section.

2-9 Flanged Joints:

Flange faces shall be normal to the pipe axis. Angular deflection (layback) of the flange faces shall not exceed the allowable set forth in Section 4.3 of ANSI/AWWA C207. All flanges, after welding to the pipe, shall be refaced, if necessary, to prevent distortion of connecting valve bodies from excessive flange bolt tightening and to prevent leakage at the joint.

Pipe lengths and dimensions and drillings of flanges shall be coordinated with the lengths and flanges for valves, pumps, and other equipment to be installed in the piping. All mating flanges shall have the same diameter and drilling and shall be suitable for the pressures to which they will be subjected.

Flanges shall be of the slip-on type, except that welding-neck or slip-on flanges welded to short lengths of pipe shall be used where installation of flanges in the field is permitted or required.

Insulated flanged joints shall be installed where indicated on the drawings. In addition to one full-faced insulating gasket, the flange insulating assembly for each insulated flanged joint shall consist of one full-length sleeve, one insulating washer, and two backing washers for each flange bolt. The insulating gasket ID shall be 1/8 inch less than the ID of the flange in which it is installed. The insulated flanged joint accessories shall be installed in accordance with the instructions and recommendations of the manufacturer.

2-10 Stab Joints:

Rubber-gasketed bell-and-spigot (stab type) steel pipe shall be furnished where

indicated or specified. The design of the rubber-gasketed bell-and-spigot joints shall be subject to review and acceptance by the Project Manager.

The difference in circumferential measurements between the outside of the spigot end and the inside of the bell shall be not more than 0.12 inch. Bends in the pipe wall forming each bell shall have a radius of at least 15 times the pipe wall thickness.

The Contractor shall obtain from the fabricator and shall submit certification indicating that the pipe joints will successfully withstand working pressures and test pressures equal to those specified, and documentation that joints of the type proposed have performed satisfactorily under similar conditions.

Gasket installation and other jointing operations shall conform to the instructions and recommendations of the pipe manufacturer. All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean. Measurements shall be taken at the joints after installation to ensure that the specified clearances have not been exceeded at any point.

2-11 Mechanical Couplings:

The middle ring of each mechanical coupling shall have a thickness at least equal to the wall thickness specified herein for the size of pipe on which the coupling is to be used. The length of each middle ring shall be not less than 10 inches for 36 inch and larger pipe and not less than 7 inches for pipe smaller than 36 inch size.

The interior surfaces of the middle rings of all mechanical couplings and the remaining surfaces of all components of submerged or buried mechanical couplings, including bolts, nuts, and washers, shall be prepared for painting in accordance with instructions of the paint manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The remaining components of mechanical couplings which are to be installed in exposed or interior locations shall be cleaned and shop primed with the manufacturer's standard rust-inhibitive primer.

2-12 Restrained Joints:

Restrained joints shall be flanged, welded, or harnessed, as specified or indicated on the drawings.

Where indicated on the drawings, mechanically coupled or stab-type joints shall be restrained with harness bolts and lugs or collars. Joint harnesses shall

conform to the details indicated on the drawings. Lugs or collars shall be shop welded to the pipe and coated as specified for the adjacent pipe.

2-13 Welded Joints:

All welds shall be sound and free from embedded scale or slag, shall have tensile strength across the weld not less than that of the thinner of the connected sections, and shall be watertight.

Butt welds shall be used for all welded joints in pipe assemblies and in the fabrication of bends and other specials. Field-welded joints, where permitted, shall be either butt-welded or lap-welded.

Field welding of joints shall conform to ANSI/AWWA C206. Single field-welded butt joints with outside backing rings may be used for pipe larger than 27 inches in diameter. Backing rings will not be permitted for 27 inch and smaller pipe. Butt straps shall be welded on both the inside and outside of the pipe and at each end of the pipe and strap to avoid stress multiplication.

Field-welded lap joints shall have fillet welds both inside and outside to avoid stress multiplication. The outside weld may be a seal weld.

- A. Welding Procedures, Welder Qualifications, and Testing. Shop inspection and testing shall be in accordance with the shop inspection and testing provisions herein. Field welding procedures, welders, welding operators, and tackers shall be qualified in accordance with AWS D1.1 and as defined in Section 3 of ANSI/AWWA C206 or ANSI/AWWA C200, as applicable. All qualifications shall be in accordance with all-position pipe tests as defined in Section 5 of AWS D1.1.

For field welding, the welder qualification testing shall be performed at the project site. Previous qualifications will not be accepted. The Contractor shall provide the services of an independent testing laboratory to perform the welder qualification onsite. Copies of all test data and certifications shall be provided to the Project Manager. All costs for welder qualification testing shall be paid for by the Contractor.

Upon completion of each field-welded joint, the welding operator shall mark his regularly assigned identification number and the last two numbers of the year in which the work was completed, or the Contractor may have a records system that traces a welder's work completion to a specific joint. Steel stamping directly on piping will not be permitted unless "low stress" die stamps, such as interrupted dot or round nose types, are used.

Field welds will be randomly inspected and tested by an independent testing laboratory as directed by the Project Manager. Field lap welds will be inspected by magnetic particle or dye penetration methods. Field butt welds will be inspected in accordance with the requirements of API 1104 by the radiographic method and the acceptance criteria of API 1104. The Contractor shall inform the Project Manager before completed weld joints are to be backfilled so that the joint may be inspected. The Contractor shall assume all costs of exposing backfilled joints for inspection when backfilling preceded the inspection.

Personnel performing visual inspection of welds shall be qualified and currently certified as Certified Welding Inspectors (CWI) in accordance with AWS QC1, Standard for Qualification and Certification of Welding Inspectors. Personnel performing nondestructive tests shall be qualified and certified to the requirements of SNT-TC-1A.

The Project Manager may also order nondestructive testing by an independent testing laboratory in addition to any testing specified herein.

Except as otherwise specified herein, all costs for the independent testing laboratory to inspect and test field welds will be paid for by the City. If the weld is defective, the inspection costs shall be paid for by the Contractor. Defective welds shall be repaired and retested at the Contractor's expense.

Test reports of all laboratory tests shall be submitted as provided in the quality control section.

2-14 Pipe Anchors, Blocking, Encasement, Hangers and Supports:

Pipe anchors, blocking, hangers, and supports shall be fabricated in accordance with the requirements of the pipe supports section and the details indicated on the drawings and shall be furnished and installed complete with all concrete bases, anchor bolts and nuts, plates, rods, and other accessories required for proper support of the piping. All piping shall be rigidly supported and anchored so that there is no movement or visible sagging between supports. Where the details must be modified to fit the piping and structures, all such modifications shall be subject to acceptance by the Project Manager. Unless otherwise permitted, lugs required for lateral or longitudinal anchorage shall be shop welded to the pipe.

Concrete reaction anchorage, blocking, encasements, and supports shall be provided as indicated on the drawings or as otherwise permitted by the Project

Manager. Concrete for anchorages, blocking, encasements, and supports shall conform to the requirements of the cast-in-place concrete section.

2-15 Protective Coatings and Linings:

All steel pipe, fittings, specials, wall fittings, and accessories shall be lined, coated, or wrapped as specified herein.

- A. Type of Coating and Lining. Surface preparation shall be in accordance with the coating or lining manufacturer's instructions. Types of protective coating and lining shall be as follows:

Exterior Surfaces Underground, ANSI/AWWA C214, Including Those Encased in Concrete:	Tape coating, as modified herein.
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Interior Surfaces:	Cement mortar, ANSI/AWWA C205.
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Pipe Joints

Couplings:	Shop coating as specified for each type of coupling. Field coating as specified for ends of sections.
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Ends of Sections:	As specified herein.
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Machined Surfaces:	Rust-preventive compound.
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- B. Field Coating and Repair of Coatings and Linings. Entry into the pipe pipeline for application of interior linings to unlined ends shall be from open ends or through access manholes, except as otherwise permitted by the Project Manager.

Field repair of shop-applied exterior coatings and interior linings shall conform to the following:

For Field-welded Joints

Cement Mortar:	Hold back coating and lining 4 inches from joint. Field repair in accordance with Appendix A of
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ANSI/AWWA C205 as modified herein.

Tape Coating:

Hold back at least 4 inches from joint. Field repair in accordance with ANSI/AWWA C209, except the total applied tape thickness shall be not less than 80 mils.

For Flanged Joints

Extend lining to ends of pipe. The coating of exterior surfaces is covered in the painting section.

For Stab Joints

Cement Mortar:

Hold back the coating on spigots and the lining in bells from joints as specified for coal tar enamel coatings in ANSI/AWWA C203. Field repair in accordance with Appendix A of ANSI/AWWA C205 as modified herein.

Tape Coating:

Hold back the coating on spigots as specified for coal tar enamel in ANSI/AWWA C203. Field repair in accordance with ANSI/AWWA C209.

For Mechanically Coupled Joints

Cement Mortar:

Hold back coating 16 inches from joints; paint exposed surfaces with 2.5 mil dry-film thickness of Type B primer in accordance with ANSI/ AWWA C203. Lining shall extend to end of pipe. Field coat exterior surfaces with 35 mil dry-film thickness of thixotropic coal tar. Repair of lining at joints not required.

Tape Coating:

Hold back coating 16 inches from joints; paint exposed surfaces with 2.5 mil dry-film thickness of Type B primer in accordance with ANSI/AWWA C203. Field coat exterior surfaces with 35 mil dry-film thickness of thixotropic coal tar. Repair of lining at joints not required.

C. Modifications to the Governing Standards.

1. Shop-applied Cement Mortar Lining. Unless otherwise acceptable to the Project Manager, cement mortar lining for all 36 inch and smaller steel pipe shall be shop applied. Except as modified herein, shop-applied mortar linings shall comply with ANSI/AWWA C205.
 - a. Specials. Wire fabric reinforcement shall be used in lining of fittings and specials in accordance with Section 4.5 of ANSI/AWWA C205.
 - b. Field Repair. Field repair of inside joint surfaces shall be performed in accordance with Appendix A, Paragraph A2 of ANSI/AWWA C205, except that an epoxy bonding agent and latex admixture shall be used in conjunction with the sand and cement mortar. The addition of lime or pozzolan will not be permitted.

The exposed steel shall be thoroughly cleaned and all grease shall be removed. A coat of epoxy bonding agent shall be applied over the area to be lined in accordance with the manufacturer's recommendations. A coat of soupy mixture of cement and water shall be applied over the epoxy after it becomes tacky. Cement mortar to which the latex admixture has been added shall then be packed into the area to be patched and screeded off level with the adjacent cement mortar lining. The patched area shall be given an initial floating with a wood float, followed by a steel trowel finish.

Defective or damaged shop-applied cement mortar linings

shall be removed, surfaces cleaned, and the lining repaired as specified above for joint repair.

- c. Adjacent to Valves. Steel pipe installed adjacent to butterfly valves shall be provided with tapered cement mortar lining so that the valve disc will not interfere with the lining material during valve operation.
- 2. Shop-applied Tape Coat. Except as modified or supplemented herein, shop-applied tape coating shall comply with ANSI/AWWA C214. The tape coating system shall be composed of four layers consisting of a primer layer, one inner layer of tape for corrosion protection, and two outer layers of tape for mechanical protection. The total thickness of the tape coating system shall be not less than 80 mils. The outer layer of tape shall be white.
- D. Field Inspection. All shop-applied exterior tape coatings on pipe, fittings, or specials shall be electrically inspected for holidays and other defects, and repaired if necessary. All electrical inspection shall be made in accordance with Section 2.14.12 of ANSI/AWWA C203.

Inspection and repair of exterior coatings shall be performed by and at the expense of the Contractor, after receipt of the pipe, fittings, or specials on the job and before installation. Electrical inspection of exterior tape coatings after installation of the pipe, fitting, or special in the trench shall be made where, in the opinion of the Project Manager, the coating may have been damaged by handling during installation.

2-16 Provisions for Future Cathodic Protection:

Provisions shall be made for the future cathodic protection of underground steel pipelines. An insulated type joint shall be provided at each branch connection to an existing or future water line, each connection between concrete pipe or ductile iron pipe, and where indicated on the drawings. An electrical bond shall be provided across all other gasketed pipeline joints. Test lead stations, for monitoring the activity of electrical currents on the pipeline, shall be provided at each insulated joint, at each end of a casing pipe, at 1,000 foot intervals, and where indicated on the drawings.

- A. Insulated Joints. Insulated joints shall be of the insulated flange type and shall be provided where indicated on the drawings or specified. After installation is completed, protective coatings shall be provided around the joint as specified herein.

- B. Electrical Bond Across Rubber-gasketed Joints. Two electrical bonding cables shall be provided to and across each mechanical coupling and across each rubber-gasketed stab joint. Before the field joint coating is applied to mechanical couplings, two small areas of metal surface shall be exposed on the pipe on each side of the coupling, on the middle ring, and on each follower ring. Before the field joint coating is applied to stab joints, two small areas of metal surface shall be exposed on each side of the joint. Each area shall be thoroughly cleaned, and two cathodic protection cables shall be bonded to the pipe on either side of the joint and also to the middle ring and follower rings for mechanically coupled joints. Each cable shall be bonded by the thermite process. The completed connections and exposed metal surface shall be coated as specified for field repair of coatings.
- C. Electrical Bond Across Valves and Flanges. Two electrical bonding cables shall be provided across valves and flanged connections other than insulated flanges. The electrical bond shall be provided as specified for bond across rubber-gasketed joints.
- D. Bonding Cables. Bonding cable and test lead wires shall be not less than No. 6 AWG, Type CP copper cathodic protection cable provided with low density, high molecular weight polyethylene insulation.
- E. Test Lead Stations. Test lead stations shall be provided where specified or indicated. Test lead stations shall be in accordance with the details indicated on Figure 2-02615 included at the end of this section, and as specified herein. The test lead wires shall be terminated at the ground surface in a standard connection box in a protected location acceptable to the Project Manager. Standard connection boxes for test lead stations shall be C.P. Test Services "NM-7" plastic terminal boxes, 18 inches long, 5 inch inside diameter, with a cast iron locking lid and a terminal block with seven terminals. Each connection box shall have the inscription "CP TEST" cast into its cover.

2-17 Handling:

Pipe, fittings, specials, and appurtenances shall at all times be handled and stored in a manner that will ensure installation in sound, undamaged condition.

2-18 Cleaning:

The interior of all pipe and fittings shall be thoroughly cleaned of all foreign matter before being installed and shall be kept clean until the work has been accepted.

Precautions shall be taken to ensure that foreign matter does not enter the pipe during jointing, lining repair, or inspection operations.

PART 3: EXECUTION

3-1 Alignment and Grade:

Pipe shall be laid to the lines and grades indicated on the drawings. Pipelines or runs intended to be straight shall be laid straight. Curves in stab joint pipe may be formed by opening the joint. Maximum joint openings and deflections shall be 1-1/2 degrees. In welded pipe, deflections up to 4-1/2 degrees may be made by shop-mitering one end of one pipe. Deflections up to 22-1/2 degrees may be made by shop-mitering the ends of two adjacent sections of pipe by equal amounts. Deflections greater than 22-1/2 degrees shall be made by use of fabricated bends.

High points which allow air to collect in pipelines will not be permitted unless an air release valve is indicated on the drawings at that location.

For pipelines in areas where the terrain is relatively flat and grade must be closely controlled, laser beam equipment, surveying instruments, or other suitable methods shall be used to maintain alignment and grade. At least one elevation reading shall be taken on each length of pipe. If laser beam equipment is used, periodic elevation measurements shall be made with surveying instruments to verify accuracy of grades. If such measurements indicate thermal deflection of the laser beam due to differences between ground temperature and the air temperature within the pipe, precautions shall be taken to prevent or minimize further thermal deflections.

3-2 Installation:

- A. Buried Piping. All trenching, embedment, and backfilling for buried piping shall conform to the requirements of Section 02200 and the details indicated on the drawings.

Whenever pipe laying is stopped, the open end of the line shall be sealed with a watertight plug. All water in the trench shall be removed prior to removing the plug.

Pipe embedment and backfilling shall closely follow the installation and jointing of steel pipe in the trench to prevent flotation of the pipe by water which may enter the trench and to prevent longitudinal movement caused by thermal expansion or contraction of the pipe. Not more than 160 feet of

restrained joint pipe shall be exposed at any time ahead of the backfilling in any section of trench. The backfill adjacent to each field joint may be temporarily omitted to provide adequate space for field coating the joints. Closure welds on restrained joint pipe shall be made during the cool part of the day.

- B. Out-of-round Pipe. Pipe which deviates from a true circle by more than 1 percent shall be laid with its larger diameter vertical, or struts or jacks on continuous head and sill timbers may be used to correct the vertical diameter where permitted by the Project Manager. Struts or jacks shall be left in place until the joints at each end have been completed and until the pipe embedment and backfilling for the section have been completed to at least 12 inches above the top of the pipe. Final inspection, repair, and checking of interior lining shall be performed after the struts or jacks have been removed.
- C. Flanged Joints. Care shall be taken in bolting flanged joints so that there is no restraint on the opposite end of the piece which would prevent pressure from being evenly and uniformly applied upon the gasket. The pipe or fitting must be free to move in any direction while bolting. Bolts shall be gradually tightened in a crisscross pattern, to ensure a uniform rate of gasket compression around the entire flange.

Special care shall be taken when connecting to pumping equipment to ensure that piping stresses are not transmitted to the pump flanges. All connecting piping shall be permanently supported so that accurate matching of bolt holes and uniform contact over the entire surface of flanges are obtained before any bolts are installed in the flanges. In addition, pump connection piping shall be free to move parallel to its longitudinal center line while the bolts are being tightened. Each pump shall be leveled, aligned, and wedged into position which will fit the connecting piping, but shall not be grouted until the initial fitting and alignment of the pipe so that the pump may be shifted on its foundation if necessary to properly install the connecting piping. Each pump shall, however, be grouted before final bolting of the connecting piping. After final alignment and bolting, the pump connections shall be tested for applied piping stresses by loosening the flange bolts which, if the piping is properly installed, should result in no movement of the piping relative to the pump or opening of the pump connection joints.

- D. Couplings. Surfaces of pipe ends and couplings which contact the sealing gasket shall be clean and free from foreign material when the coupling is installed on the pipe. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer. All bolts shall be tightened approximately the same amount, with all parts of the coupling

square and symmetrical with the pipe. Following installation, the exterior coating of each coupling shall be touched up or re-primed.

3-3 Connections with Existing Piping:

Connections between new work and existing piping shall be made using fittings suitable for the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with service to customers, and as authorized by the City.

Facilities shall be provided for proper dewatering and for disposal of all water removed from the dewatered lines and excavations without damage to adjacent property.

Special care shall be taken to prevent contamination when dewatering, cutting into, and making connections with existing potable water piping. Trench water, mud, or other contaminating substances shall not be permitted to enter the lines. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and then swabbed with, or dipped in, chlorine solution having a chlorine content of 200 milligrams per liter.

3-4 Concrete Encasement:

Concrete encasement shall be installed as indicated on the drawings. Concrete and reinforcing steel shall be as specified in Section 03300. All pipe to be encased shall be suitably supported and blocked in proper position, and shall be anchored to prevent flotation.

3-5 Hydrostatic Tests:

After installation, steel piping shall be tested for defective workmanship and materials by being subjected to a hydrostatic test as specified in Section 02601.

3-6 Leakage:

All steel piping shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of the Contractor.

3-7 Disinfection:

After installation, steel piping shall be disinfected as specified in Section 02675 - Disinfection of Water Pipe.

3-8 Drawings and Data:

Drawings, specifications, installation schedules, welding procedures and welder qualifications, and other data showing complete details of the fabrication, construction, weld locations, joint details and certification, and installation of pipe, fittings, specials, and connections, together with complete data covering all materials proposed for use, shall be submitted in accordance with Section 01300.

Submittals shall indicate the ASTM designation for the material from which each class of pipe is fabricated.

In addition to the markings, as specified under the governing standard, the Contractor's drawings shall include a complete laying schedule with piece description to show where each numbered pipe, fitting, or special is to be installed. The numbers indicated on the drawings shall correspond with those painted on the pipe.

If the flange gasket materials to be provided are other than the materials set forth herein, the Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket material or materials are compatible with the flanged joints specified herein and are recommended for the specified field test pressure.

END OF SECTION

SECTION 02619

BURIED POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

PART 1: GENERAL

1-1 Description:

The work of this section consists of providing and installing buried polyvinyl chloride (PVC) pressure pipe and fittings.

1-2 Reference Standards:

American Society for Testing and Materials (ASTM)
American National Standards Institute (ANSI),
American Water Works Association (AWWA),
Federal Specifications (FS),
National Sanitation Foundation (NSF)

1-3 Submittals:

In accordance with Section 01300 submit certificates of compliance and manufacturer's literature.

1-4 Product Handling:

Handle pipe carefully to ensure delivery in a sound, undamaged condition. Inspect pipe for cracks, dents, abrasions or other flaws. Project Manager will reject damaged pipe on site. Contractor shall replace damaged pipe at no additional expense to the City. Do not store materials directly on ground.

PART 2: MATERIALS

2-1 Buried Polyvinyl Chloride Pipeline:

Unless revised on the Drawings the polyvinyl chloride (PVC) pipe shall be similar and equal to Class 200, and shall conform to AWWA C900, "Polyvinyl Chloride (PVC) Pressure Pipe, 4-inch through 12-inch, for Water" or similar and equal to Class 200 and conform to AWWA C905, "Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 in. Through 36 in.". All Class 200 pipe shall meet the dimension requirements of DR14 for 12-in. pipe and smaller and DR 18 for 14-in. pipe and larger and shall have an equivalent cast-iron pipe

outside diameter.

Unless otherwise specified the pipe joint shall be the "push-on" type, made from clean, virgin, NSF Approved Class 12454-A or 12454-B PVC conforming to requirements of ASTM D1784 (latest revision).

Provisions must be made for contraction and expansion at each joint with a rubber ring and integral thickened bell as part of each joint. Pipe shall be supplied in laying lengths of 20 feet. All pipe and fittings shall be assembled with a non-toxic lubricant. Each length of pipe shall have marked on the exterior the following:

- Nominal size and OD base
- Material Code Designation
- Dimension Ratio number "DR 14" or "DR 18"
- AWWA Pressure Class "PC 200"
- AWWA Designation, AWWA C900 or C905
- Name or Trademark of Manufacturer
- National Sanitation Foundation Seal for Potable Water

The fittings shall be ductile-iron or cast-iron conforming to the requirements set forth in ANSI A21.10, AWWA C110 or ANSI 21.53, AWWA C153. Cast-iron fittings 12-inch size and smaller shall be Class 250, and fittings larger than 12 inches shall be Class 150. The interior of the fittings shall be cement-mortar lined, as is required for the pipe with a 1 mil bituminous exterior coating. The fittings shall have mechanical joints in accordance with ANSI A21.11. The gaskets for the joints shall be suitable for potable water service.

2-2 Polyethylene Encasement:

All pipeline fittings and appurtenances shall be encased in polyethylene film in accordance with the requirements of ANSI A21.5, AWWA C105.

2-3 Thrust Restraint:

Where designated on the Drawings or where existing conditions do not permit the use of concrete thrust blocks, fitting restraints shall be made with tie rods and pipe clamps or special fitting bolts. Tie rod restraint systems shall have a minimum of 2 bolts or rods per joint or clamp. Minimum tie bolt/rod sizes are as follows:

<u>Pipe Size</u>	<u>Bolt Diameter</u>
4"-8"	5/8"
10"-14"	3/4"
16"	1"
18"-20"	1-1/4"
24"	1-1/2"

All materials shall be fabricated from "Cor-Ten" steel or equal according to the requirements of ASTM A-242 with a minimum yield stress of 46,000 psi.

2-4 Water Services:

Water services shall be installed as indicated on the Drawings (see Section 02620). Each corporation stop shall be inserted in a double-strap bronze service saddle, similar and equal to "Rockwell" No. 323 or brass service saddle similar and equal to "Ford" No. S90. The general locations of the service lines are shown on the Drawings.

PART 3: EXECUTION

3-1 General:

Sizes as shown. Lay to the grades and lines shown in accordance with pipe manufacturer's specifications. Rest each section upon the pipe bed for full length of the barrel with recesses excavated to accommodate joints. Take up and re-lay any length that has had its line, grade, or joint disturbed after laying. Thoroughly clean pipe interiors of foreign matter before lowering into trench. Replace with new pipe any section of pipe found damaged or defective.

3-2 Installation of PVC Pipelines:

Except as specified herein or unless specifically authorized by the Project Manager, all pipe shall be laid as follows:

- A. Pipe Laying. Pipe shall be laid with bell ends facing in the direction of laying. No deflection in the joints shall be allowed. Whenever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or to plumb valve operators, the pipe itself may be uniformly curved as shown in the table below.

<u>Approximate Pipe Size</u>	<u>Offset in 20-Foot Length</u>	<u>Radius of Curve</u>
4"	15"	120'
6"	15"	160'
8"	15"	250'
10"	15"	300'
12"	15"	400'

Pipe deflection for curvature shall not be permitted at temperatures less than 32°F ambient temperature.

When pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Project Manager.

The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. The flame cutting of pipe by means of an oxyacetylene torch will not be allowed. Bevel the end of the pipe with a beveling tool after the pipe is field cut. Place a clearly visible position mark at the correct distance from the end of the field cut pipe.

Tracer wire shall be attached to the pipe as shown in the Drawings.

- B. Jointing of Mechanical Joints. The outside of the spigot and the inside of the bell shall be wiped thoroughly clean. Set the rubber ring in the bell with the marked edge facing toward the end of the bell. Lubricate the spigot end using a thin film of the manufacturer-supplied lubricant. Push the pipe spigot into the bell manually, with blocking and bar, or with special jacks. Position the completed joint so that the mark on the pipe end is in line with the end of the bell. Pipe joint shall not be assembled using power or trenching equipment.

3-3 Installation of Thrust Restraint:

The movement of fittings shall be restrained by use of concrete thrust blocks or steel clamp and tie bolt assemblies as indicated on the drawings. The thrust blocks shall be poured between undisturbed solid ground and the fitting to be anchored; the area of bearing on the undisturbed trench wall shall be that shown on the thrust block detail or directed by the Project Manager. The concrete shall be placed so that the pipe or fitting joints will be accessible for repair. Thrust blocks or other thrust restraint where thrust blocks cannot be used shall be

required at all the fittings unless otherwise shown on the Drawings. A bond breaker shall be placed over the fitting before placing concrete.

Thrust restraint clamps and tie bolts shall be assembled using clamps on each side of pipe bells with tie rods extending full pipe length for the dimensions shown on the detail drawings each direction from the restrained fitting. Clamps shall be installed tight enough to prevent twisting around the pipe. Two tie bolts per clamp with washer at clamp shall be located on side of pipe. Tighten tie bolt nut to "hand tight" with 12-inch wrench (approximately 50-100 foot-pounds torque). Threaded tie rods shall extend two full threads past nut in final position.

3-4 Installation of Tracer Cable:

Tracer cable shall be laid directly above or alongside the pipe in the trench. The cable shall be 10 gauge, single conductor, solid, copper, rated for 600 volts and suitably insulated for direct bury. The cable shall be thermally, cad welded to a connecting metallic pipe or extended and attached to an above grade flange bolt of a fire hydrant. No splices are allowed during the initial installation of the tracer cable. If the tracer wire is inadvertently broken, then the splice shall be made using a lug type connection.

3-4 Testing:

Testing of PVC pressure pipe shall be as specified in Section 02601.

3-5 Backfill and Restoration of Surface Conditions:

Backfill and restoration of surface conditions shall be as specified in Section 02200.

3-6 Disinfection of Potable Pipelines:

PVC pressure pipe shall be disinfected as specified Section 02675.

END OF SECTION

SECTION 02620

WATER SERVICES

PART 1: GENERAL

1-1 Description:

The work of this section consists of providing and installing copper pipe and fittings, water meters, corporation stops, and other required materials for water service connections for potable water supply. All material and procedures used in the installation of water service lines shall be lead free.

1-2 Reference Standards:

American Water Works Association (AWWA), American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), and manufacturers' printed recommendations.

1-3 Submittals:

In accordance with Section 01300 submit certificates of compliance and manufacturers' literature on all materials used in the work.

1-4 Product Handling:

Handle pipe carefully to ensure delivery in a sound, undamaged condition. Contractor shall replace damaged pipe at no additional expense to the City. Do not store material directly on the ground. Adequately support piping.

PART 2: MATERIALS

2-1 Pipe:

Seamless Type K copper, soft drawn. In accordance with ASTM B88.

2-2 Fittings:

Use flared fittings to match pipe such as "Mueller" H-15400, "Ford" C22, or approved equal. Use bends such as "Mueller" H-15525, "Ford" L22, or approved equal.

2-3 Corporation Stops:

Corporation stops shall be "Mueller" H-01500, "Ford" F600, or approved equal.

2-4 Water Meters:

Water meters shall be purchased from the City of Lakewood.

2-5 Service Saddles:

Corporation stops require the installation of a double strap bronze service saddle, similar and equal to "Rockwell" No. 323 with PVC pipe or brass service saddle similar and equal to "Ford" No. S90. No direct taps to PVC pipe shall be allowed.

2-6 Insulators (DIP Only):

Insulators shall be installed at the inlet end of the corporation stop and shall be "Ford Service Insulators" or an approved equal for service lines.

PART 3: EXECUTION

3-1 General:

Size as shown, lay to grades and lines in accordance with pipe manufacturer's specifications. Thoroughly clean pipe interiors of foreign matter before placing into trench. Replace with new pipe any laid section of pipe found damaged or defective. All pipe fittings, valves, and appurtenances shall be installed according to manufacturer's instructions. Corporation stops shall be installed with the appropriate tapping machine in the presence of the Project Manager after the waterline has been pressure tested.

All bedding, pipe zone backfill, compaction, polyethylene sheathing and other details of the water pipeline construction shall be returned to original condition after service connections are completed.

Service connections to all ferrous mains shall be electrically insulated by means of a City approved insulating fitting.

3-2 Pipe Cutting:

Cutting shall be done neatly by methods which will not damage pipe.

3-3 Water Meters:

Water meters shall be installed as indicated on the drawings for all water services. Actual location of water meters shall be determined by the Project Manager before installation.

3-4 Testing:

Testing of water service pipe shall be as specified in Section 02601.

3-5 Backfill and Restoration of Surface Conditions:

Backfill and restoration of surface conditions shall be as specified in Section 02200.

3-6 Disinfection of Potable Pipelines:

Water service pipe shall be disinfected as specified Section 02675.

END OF SECTION

SECTION 02641

GATE VALVES

PART 1: GENERAL

1-1 Description:

The work of this section consists of installing buried gate valves equipped with valve boxes.

1-2 Reference Standards:

American Water Works Association (AWWA).

1-3 Submittals:

In accordance with Section 01300, supply certificates of compliance and manufacturer's literature.

PART 2: MATERIALS

2-1 Gate Valves:

Iron-bodied, fully bronze mounted, resilient seat, non-rising stem. Valves shall open clockwise and shall conform to AWWA C500. All buried valves shall have one (1) 2-inch square operating nut. Provide MJ or push-on joints as appropriate for buried installations. Extension stems with a 2-inch square operating nut and a support for the upper end of the extension shall be provided for all valves installed more than 5 feet deep. The operating nut shall be located within 5 feet of the finished grade. Extension stems shall be mechanically connected to the operating nut.

2-2 Extension Stems and Guides:

Fabricated from solid steel shafting not smaller in diameter than the stem of the valve or from galvanized steel pipe having an ID not smaller than the OD of the valve stem. Extension stems shall be connected to the valve by a flexible socket type coupling. All connections shall be pinned, keyed, or socket type. Pipe couplings are not acceptable. Extension stems and stem guides shall be provided where shown, specified, or required for proper operation.

2-3 Valve Boxes:

Valve boxes shall be of cast iron of the three piece screw type. Extensions shall be the screw type and bases shall be No. 6 round or oval. Shafts shall be 5 1/4 inches diameter. They shall be Tyler 6860 series with stayput cover, or approved equal, bearing the word "Water" on top. Valve boxes shall be considered integral units, and shall have at least six inches adjustment above and below specified depth of cover over pipe.

2-4 Special Wrenches and Keys:

All tools needed to operate valve and to open valve box lid. A minimum of one of each type as required for each style and size of box and lid shall be furnished by the Contractor. Provide one key for each valve. Key lengths shall be approved by the Project Manager.

PART 3: EXECUTION

3-1 Gate Valves:

Install in the lines as indicated on the drawings, unless otherwise directed, and set plumb on a firm base. All foreign matter shall be removed from the interior prior to installation.

3-2 Valve Boxes:

Install over the gate valves unless otherwise directed, with base section centered over valve and resting on well-compacted backfill. Top section shall be so set as to allow equal movement above and below finished grade, final elevation to be 1/4-inch below finished grade in roadways and 1/10-inch above grade outside of roadways, unless otherwise directed. Top of base section shall be approximately on line with nut at top of valve stem, and the entire assembly shall be plumb.

3-3 Tests:

Gate valve tests shall be with and part of the tests on the companion water lines.

3-4 Disinfection:

Gate valve disinfection shall be with and part of the disinfection to the companion water line.

END OF SECTION

SECTION 02642

BUTTERFLY VALVES

PART 1: GENERAL

1-1 Description:

The work of this section consists of furnishing and installing butterfly valves, valve operators and valve boxes as shown on the drawings.

1-2 Reference Standards:

American Water Works Association (AWWA)
American Society for Testing and Materials (ASTM)
American National Standards Institute (ANSI)

1-3 Submittals:

In accordance with Section 01300 supply certificates of compliance and manufacturer's literature.

PART 2: MATERIALS

2-1 General:

At locations designated on the Drawings, butterfly valves shall be installed on the buried pipelines. The valves shall be designed for buried service and shall conform to the AWWA C504. The valves shall be designed to operate as open or closed with a design velocity of 8 feet per second. The valves shall have a cast-iron body with mechanical joint ends conforming to ANSI 21.11, designed for a maximum 150 psi pressure. Discs shall be cast or ductile iron with stainless steel, type 304, either stub or one piece shafts. Seats shall be rubber vulcanized to the body and designed to provide bubble tight shutoff with mating surface of stainless steel mounted on the discs. Shaft bearings shall be the bushing type of nylon or teflon. Shaft seals may be rubber ring or chevron packing. The valve operator shall be the traveling nut type designed for previous stated conditions, in an enclosed body, sealed to prevent the entrance of groundwater up to the depth of five feet above the valve. The operator shall have travel stop limiting devices to prevent over closing or opening damage to the valve. Valves shall open counterclockwise with the use of a valve key on a 2-inch square operating nut. A 5-1/4-inch shaft diameter 1/4-inch thickness, adjustable valve box with cover and

base suitable for side operator shall be provided for each valve. Valve shall be installed with the shaft horizontal.

Extension stems with a 2-inch square operating nut and a support for the upper end of the extension shall be provided for all valves installed more than 5 feet deep. The operating nut shall be located within 5 feet of the finished grade.

PART 3: EXECUTION

3-1 Handling:

All valves and actuators shall be transported and stored in a manner which will protect them from damage.

3-2 Installation:

Install valve with the shaft horizontal. The manufacturer's recommended procedures for installation will be allowed. Operate all valves from full open to full close before installation. Check all seats, seat rings, shaft sleeves, disc connections, etc. prior to installation.

END OF SECTION

SECTION 02643

TAPPING SLEEVE AND VALVE

PART 1: GENERAL

1-1 Description:

The work of this section consists of installing tapping sleeves and tapping valves equipped with valve boxes.

1-2 Reference Standards:

American Water Works Association (AWWA).

1-3 Submittals:

In accordance with Section 01300, supply certificates of compliance and manufacturer's literature.

1-4 Qualifications:

The manufacturer of the tapping sleeves and tapping valves shall be experienced in their design and construction, shall be regularly engaged in their manufacture, and shall have produced tapping sleeves and valves of the sizes specified herein which have given successful service for a period of at least 5 years.

PART 2: MATERIALS

2-1 General:

Materials used in the manufacture of tapping sleeves and tapping valves and accessories shall be new and shall conform to the latest applicable standards of the American Society for Testing and Material.

All steel plate used in fabrication of the tapping sleeves shall conform to ASTM Designation A 36 or A 285, Grade C.

2-2 Flanges:

Flanges shall be fabricated from steel plate, and all dimensions shall conform to AWWA Standard C207, Class D. Flanges shall be machined to a flat rate with finish of 250 micro inches or machined to a flat surface with a serrated finish in accordance with AWWA Standard C207. In addition, the machined face shall

also be recessed for tapping valves in accordance with the MSS Standard SP-60.

2-3 Gaskets:

Gaskets shall be compounded from new materials, and the shape of cross-section of gasket shall provide adequate seal for the design pressure. Gaskets shall be shop glued to the groove provided in the body section.

2-4 Fasteners:

Bolts and hex nuts shall be Stainless Steel, "Usalloy", "Dresserloy", "Cor-Ten" or an approved equal for corrosion control.

2-5 Testing Outlet:

A 3/4 inch NPT by welded coupling shall be attached to the outlet nozzle of each tapping sleeve assembly complete with a 3/4 inch square head pipe plug.

2-6 Tapping Valves:

Tapping valves shall conform to AWWA C500 as modified herein. All tapping valves shall be resilient seat, modified wedge disc type. Tapping valves shall be non-rising stem type with O-ring stem seals.

All valves shall be provided with manual operators. Unless otherwise required by the Project Manager, the direction of rotation of the wheel, wrench nut, or lever to open the valve shall be to the left (counterclockwise).

2-7 Extension Stems:

Extension stems and stem guides shall be provided where shown, specified, or required for proper operation. Extension stems shall be fabricated from solid steel shafting not smaller in diameter than the stem of the valve or from galvanized steel pipe having an ID not smaller than the OD of the valve stem. Extension stems shall be connected to the valve by a flexible socket type coupling. All connections shall be pinned, keyed, or socket type. Pipe couplings will not be acceptable.

Extension stems shall be provided for buried valves when the operating nut is 5 feet or more below finished grade. Each extension stem for a buried valve shall extend to within 6 inches of the ground surface, shall be provided with spacers which will center the stem in the valve box, and shall be equipped with a wrench nut.

2-8 Valve Boxes:

All buried valves shall be provided with valve boxes. Valve boxes shall be of cast iron, three-piece screw type, suitable for the depth of cover required by the drawings. Valve boxes shall be 5½ inches in diameter, shall have a minimum thickness at any point of 1/16 inch, and shall be provided with suitable cast iron bases and stay-put covers. Covers shall have cast thereon "water" on the top. They shall be Tyler 6860 series.

The valve box shall have at least 6 inches adjustment above and below specified depth of cover over pipe.

All parts of valve boxes, bases, and covers shall be coated by dipping in bituminous varnish.

Valves and valve boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves, with the top of the box brought flush with the finished grade. After being placed in proper position, earth shall be filled in around each valve box and thoroughly tamped on each side of the box.

2-9 Painting:

All ferrous metal surfaces of tapping sleeves, valves and accessories, both interior and exterior, shall be shop painted for corrosion protection. The valve manufacturer's standard paint will be acceptable provided it is functionally equivalent to the specified paint and is compatible with the specified field painting.

A. Materials

Asphalt Varnish:	Fed. Spec TT-V-51
Coal Tar:	Koppers "Bitumastic Super Tank Solution".
Epoxy:	Mobil "78-D-7 Tank Lining Epoxy".
Rust Preventative:	Houghton "Rust Veto 344" or Rustoleum Compound "R-9"

B. Surfaces to be Painted

Unfinished Surfaces:

Interior: Asphalt varnish (2 coats), coal tar or epoxy.

Exterior to be Buried or Located in Manholes: Asphalt varnish or coal tar

Polished or Machined Surfaces: Rust preventative compound

Operators and Accessories Rust inhibitive primer

PART 3: EXECUTION

3-1 Tapping Valves:

Install in the lines as indicated on the drawings, unless otherwise directed, and set plumb on a firm base. All foreign matter shall be removed from the interior prior to installation. Gate valve shall be securely bolted to the tapping sleeve in accordance with the manufacturers instructions using the fasteners specified in 2.0 (C) above.

3-2 Extension Stems:

Shall be provided for buried valves when the operating nut is 5 feet or more below finished grade. Each extension stem for a buried valve shall extend to within 6 inches of the ground surface, shall be provided with spacers which will center the stem in the valve box, and shall be equipped with a wrench nut.

3-3 Valve Boxes:

Install over the gate valves unless otherwise directed, with base section centered over valve and resting on well-compacted backfill. Top section shall be so set as to allow equal movement above and below finished grade, final elevation to be 1/4-inch below finished grade in roadways and 1/10-inch above grade outside of roadways, unless otherwise directed. Top of base section shall be approximately on line with nut at top of valve stem, and the entire assembly shall be plumb.

3-4 Tests:

Gate valve tests shall be with and part of the tests on the companion waterlines.

3-5 Disinfection:

Gate valve disinfection shall be with and part of the disinfection to the companion waterline.

END OF SECTION

SECTION 02645

FIRE HYDRANTS

PART 1: GENERAL

1-1 Description:

The work of this section consists of providing and installing fire hydrants at locations indicated on the Drawings.

1-2 Certification:

Furnish an affidavit from the manufacture that the hydrant conforms to AWWA Standard C502.

1-3 Submittals:

In accordance with Section 01300, furnish catalog cuts, complete maintenance data and assembly drawings.

PART 2: MATERIALS

2-1 General:

Fire hydrants shall be from those manufacturers approved by the Denver Water Department, with mechanical joint bottom connection and shall comply with AWWA C502 having the following requirements:

- Inlet Pipe: 6-inch, mechanical joint inlet shoe and accessories
- Trench Depth: 4.5-feet cover, minimum
- Operating Nut: 1-5/8-inch pentagon
- Open: Right (CW)
- Connection: Two 2-1/2-inch hose nozzles and one 4-1/2 inch pumper nozzle
- Threads: National Standard Hose Threads
- Pressure: 150 psi working pressure, 300 psi test pressure
- Hydrants shall be provided with traffic break-off flange
- Color shall be Federal Color No. 13538 yellow
- Set of spare break-off parts shall be furnished

PART 3: EXECUTION

3-1 Excavation and Backfill:

Perform in accordance with the applicable provisions of Section 02200.

3-2 Hydrants:

Where applicable, hydrants shall be installed with pumper outlet facing the adjacent roadway or parking area. Set hydrants at such elevations that the connecting pipe shall drain to the main with a grade of not less than 1 percent, and upon a concrete foundation not less than 6 inches thick and 18 inches square. The centerline of nozzles shall be at least 18 inches above finished grade. Firmly block the back of the hydrant opposite the pipe connection with a concrete thrust block braced against the vertical face of the trench to prevent the hydrant from blowing off the line.

3-3 Drainage Aggregate and Backfill:

Place not less than 1/3 cubic-yard of approved clean gravel or crushed rock around the base of each hydrant and 12" over the top of the supply pipe to insure drainage. A layer of 30-pound asphalt-saturated felt paper or heavy vinyl sheet shall be placed over gravel to keep backfill material from sifting into gravel. Thoroughly compact the backfill around hydrants, to the grade line, in an approved manner.

3-4 Operations Check:

Clean hydrant interiors of all foreign matter before installation. Stuffing boxes shall be tightened and the hydrant inspected in opened and closed positions to see that all parts are in working condition.

3-5 General:

Hydrants shall be tagged "out of service" until the water system is operational. It is the responsibility of the Contractor to notify West Metro Fire Department regarding the location of the tagged hydrants.

END OF SECTION

SECTION 02646

COMBINATION AIR VALVE

PART 1: GENERAL

1-1 Description:

The work of this section consists of providing and installing a combination air valve.

1-2 Submittals:

Submit shop drawings for manholes and manufacturer's literature for the combination air valve.

PART 2: MATERIALS

2-1 Manholes:

Refer to Section 02515 for manhole specifications.

2-2 Combination Air Valve:

The valve shall be a 2 inch combination air release vacuum valve, "Clow" No. 5403-B, 250 psi, or approved equal.

The combination air valve shall be provided with a 2 inch diameter hand wheel operated gate valve.

2-3 Hose Gate Valve:

The 3/4 inch hose gate valve to be installed in the air release valve manhole shall be bronze body, threaded end, solid wedge, union bonnet, inside screw rising stem gate valves. The valves shall be "Powell" 375 HS. Each hose gate valve shall be equipped with a brass cap and chain.

2-4 Ball Valve:

Ball valves shall be of bronze or brass construction with two-piece end entry body, bronze or brass ball, teflon or Viton stem seal, reinforced teflon seats and thrust washer, a removable operating lever, and threaded ends. Valves shall be rated not less than 500 psi non-shock cold WOG and shall be drip-tight in both

directions. Valves shall be "Conbraco Industries" Apollo 70-100 Series, "Powell" Fig 4210T, or "Stockham" S-216.

2-5 Corporation Stop:

Corporation stop shall be "Mueller" H-01500, "Ford" F600, or approved equal.

2-6 Insulators:

Insulators shall be installed at the inlet end of the corporation stop and shall be Ford Service Insulators or an approved equal for service lines.

PART 3: EXECUTION

3-1 Installation:

Install valve, manhole, and appurtenances as indicated on the "Standard Combination Air Valve Manhole" drawing and in accordance with applicable provisions of the related sections. Location and sizes are indicated on the drawings.

3-2 Disinfection:

Valve testing and disinfection shall be concurrent with the companion waterline.

END OF SECTION

SECTION 02675

DISINFECTION OF WATERLINES

PART 1: GENERAL

1-1 Description:

The work of this section consists of the disinfection of all portions of the potable water system, including buried piping, valves, hydrants, and stops, and any portion of the existing connecting system that might have become contaminated during construction activities, and also any temporary water service piping used during construction.

Care shall be taken to prevent contaminating materials from entering the water mains during construction or repair. Such materials that may accidentally enter the main shall be removed by flushing. This flushing shall be done prior to disinfection unless the tablet method of disinfection is used. If, in the opinion of the Engineer, the contaminated material that has entered cannot be removed by flushing, the interior of the pipe shall be cleaned by mechanical means and then swabbed with a 1% hypochlorite solution.

1-2 Reference Standards:

American Water Works Association (AWWA C651)

1-3 Submittals:

In accordance with Section 01300, submit plan for gathering, transport and disposal of chlorine solutions and surplus materials after use.

PART 2: MATERIALS

2-1 Chlorinating Material:

The chlorinating material shall either be a hypochlorite solution, tablets or granules.

2-2 Tablet Attachment:

The hypochlorite tablets shall be fastened to the top of the pipe using Permatex No. 1.

PART 3: EXECUTION

3-1 Disinfection:

Upon completion of the water pipelines, all new pipe, valves, hydrants, etc. shall be thoroughly flushed and disinfected, using a continuous-feed method of hypochlorite and water mixture or hypochlorite tablets or granules in accordance with AWWA Standard C-651, latest revision.

The chlorinating material shall be introduced into the water lines and distribution systems in a manner approved by the Project Manager. After a contact period of not less than 24 hours, the treated water in the lines shall contain not less than 10 mg/liter chlorine using the continuous-feed method or 25 mg/l chlorine using the tablet or granular method throughout the length of the line. The system shall be flushed after successful completion of disinfection with clean water until the residual chlorine content is not greater than 1.0 mg/liter. All valves in lines being disinfected, except those being used as bulkheads, shall be opened and closed several times during the contact period. During flushing and disinfection the Contractor shall make sure that none of the disinfection solution enters any existing water main.

Flushing shall be done with a flushing velocity of at least 2.5 feet per second. The Contractor shall provide all fittings required to flush the line. Flushing will be accomplished in such a manner that no erosion will occur and there will be no damage to street, fish, animals, plants or other property.

3-2 Bacteriological Examination:

After the system has been thoroughly flushed, take samples from representative points in the system, in sterile bottles, and submit to proper authorities as directed for bacteriological examination. If the report is unsatisfactory, repeat the disinfection procedure until satisfactory results are obtained.

3-3 Disposal of Solution:

This shall be the Contractor's responsibility. He shall notify and obtain the approval of the Project Manager. The solution and flushing water shall be disposed of into the nearest sanitary sewer line. The solution and flushing water shall not be dumped into any lakes, streams, waterways, irrigation ditches or stormwater drainage systems. If wasted water cannot be safely discharged into a sanitary sewer system, then a reducing agent shall be applied to the wasted water to thoroughly neutralize the chlorine residual remaining in the water.

END OF SECTION

APPENDIX B
SANITARY SEWER SYSTEM CONSTRUCTION SPECIFICATIONS

Title
Section

Excavation and Embankment.....	02315
Trench Excavation and Backfill	02320
Manholes and Inlets	02515
Reinforced Concrete Pipe	02527
PVC Sewer Pipe	02616
Buried Polyvinyl Chloride (PVC) Pressure Pipe	02619
Testing of Sewer Pipelines and Manholes	02701
Concrete Reinforcement	03201
Cast-In-Place Concrete	03300

SECTION 02315

EXCAVATION AND EMBANKMENT

PART 1: GENERAL

1-1 Description:

This Work shall consist of excavation; embankment fill; removal and disposal of all debris; stripping and stockpiling topsoil; the handling, storage, transportation, and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property; backfilling; construction of fills and embankments; surfacing and grading; compaction of all material encountered within the limits of work, including excavation and fill for structures; and other appurtenant work. The excavation shall include, but is not limited to, the native soils which must be excavated for the Project Work. All Work shall be completed in accordance with these Specifications and the lines, grades and typical cross-sections shown on the Drawings.

All excavation will be classified, "unclassified excavation," or "muck excavation" or "rock excavation," as hereafter described. All embankment will be classified "embankment material" as hereafter described.

1-2 Definitions:

- A. Unclassified Excavation shall consist of the excavation of all materials of whatever character required of the Work, obtained within the Project limits.
- B. Muck Excavation shall consist of the removal of mixtures of soils and organic matter not suitable for foundation material and replacement with approved material.
- C. Rock Excavation shall consist of igneous, metamorphic and sedimentary rock which cannot be excavated without the use of rippers, and all boulders or other detached stones each having a volume of one-half ($\frac{1}{2}$) cubic yard or more, as determined by physical or visual measurement. It shall also include replacement with approved material as required.
- D. Embankment Material shall consist of approved material acquired from

excavation or from outside sources, hauled and placed in embankments.

1-3 Submittals:

Samples of all materials specified in this section shall be submitted to the Engineer in accordance with Section 01300. The quantity of material samples required will be specified by the Engineer. Where gradations or other material properties are specified, information certifying these properties shall also be submitted. All gradation and samples of materials submitted must be approved by the Engineer before incorporated into the work.

1-4 Reference Standards:

American Association of State Highway and Transportation Officials (AASHTO), American Society for Testing and Materials (ASTM), Colorado Department of Transportation (CDOT) Standard Specifications for Road and Bridge Construction.

1-5 Safety:

With reference to the terms and conditions of the construction standards for excavations set forth in the OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, the Contractor shall employ a competent person and, when necessary, a registered professional engineer, to act upon all pertinent matters of the work of this section.

1-6 Quality Assurance:

All tests required for preliminary review of materials shall be made by an acceptable independent testing laboratory at the expense of the Contractor. Two initial gradation tests shall be made for each type of pipe bedding, fill, or backfill material, and one additional gradation test shall be made for each additional 500 tons of each material. Initial moisture-density (Proctor) tests and relative density tests on the materials, and all in-place field density tests, shall be made at the expense of the Owner. Retests of samples failing initial tests shall be at the expense of the Contractor.

Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.

Final topography and/or cross-sections will be surveyed of areas that are to finished grade and compared to the design section for accuracy. Final grade shall match design grades within the tolerances discussed in PART 3 EXECUTION.

1-7 Related Sections:

- A. Section 02230 – Clearing and Grubbing
- B. Section 02240 – Water Control and Dewatering
- C. Section 02320 – Trench Excavation and Backfill

PART 2: MATERIALS

2-1 General:

- A. Embankment material may consist of approved material acquired from excavations or material hauled from outside the Project limits. Suitable material identified on-site shall be used first for embankments and backfill. Excess excavated native soils which are not used as embankment or backfill shall become the property of Contractor and shall be disposed of off-site by Contractor, in a location acceptable to Engineer.
- C. Muck excavation shall also include the replacement of excavated muck with uniformly graded rock, riprap, on-site or imported soils, or other material, whichever is most suitable for the specific situation encountered. Engineer will determine which type of aggregate or other material which shall be used after observing the specific site conditions.
- C. Gradation for structural backfill shall conform to the following:

<u>Sieve Size</u>	<u>By Weight Passing Square Mesh Sieves</u>
2 inch	100
No. 4	30 – 100
No. 50	10 – 60
No. 200	5 – 20

Structural backfill shall have a liquid limit not exceeding 35 and a plastic limit not exceeding 6 when determined in conformance with AASHTO T 89 and T 90, respectively. Refer to Section 2-7 for additional requirements.

PART 3: EXECUTION

3-1 General Excavation/Embankment:

- A. **General.** The excavation and embankment should be finished to reasonably smooth and uniform surfaces. Variation from the subgrade plane shall not be more than 0.08 foot in soil or more than 0.08 foot above or 0.50 foot below in rock. Where bituminous or concrete surfacing materials are to be placed directly on the subgrade, the subgrade plane shall not vary more than 0.04 foot. Materials shall not be wasted without permission of Engineer. Excavation operations shall be conducted so that material outside of the limits of slopes will not be disturbed. Prior to beginning grading operations in any area, all necessary clearing and grubbing in that area shall have been performed in accordance with Section 02230 of these Specifications.

Contractor shall notify Engineer in sufficient time before beginning excavation or embankment such that the necessary topography and/or cross-sections may be taken. Contractor shall not excavate beyond the dimensions and elevations established, and material shall not be removed prior to surveying the site.

When Contractor's excavating operations encounter remains of pre-historic people's dwelling sites or artifacts of historical or archaeological significance, the operations shall be temporarily discontinued. Engineer will contact archaeological authorities to determine the disposition thereof. When directed, Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and shall remove them for delivery to the custody of the proper state authorities. Such excavation will be considered and paid for as extra Work.

All sites that will be occupied by permanent construction, embankments, or as called out on the construction drawings, shall be cleared of all logs, trees, roots, brush, tree trimmings, and other objectionable materials and debris. All stumps, roots, foundations, and debris shall be removed to a minimum of 24 inches below final grades (grubbed). Backfill foundations, stumps and root holes with approved materials and compact per this specification. Subgrades for fills and embankments shall be cleaned and stripped of all surface vegetation, sod, and organic topsoil. All waste materials shall be removed from the site and disposed of by and at the expense of the Contractor.

In natural areas where excavation will occur, strip all topsoil, or in the absence of topsoil, strip the top 6 inches of surface material and store separately from other excavated materials.

For concrete walks, roadways, parking areas and road crossings, cut existing pavement full depth to a true line before excavation.

B. Excavation

1. **Unclassified:** All excess suitable material excavated from the Project site and not used for embankment shall be removed from the Project site and become the property of Contractor. Where material encountered within the limits of the Work is considered unsuitable for embankment (fills) on any portion of this Project Work, such material shall be excavated as directed by Engineer and replaced with suitable fill material. All unsuitable excavated material from excavation consisting of any type of debris (surface or buried), excavated rock, bedrock or rocks larger than six (6) inches in diameter, and boulders shall be hauled from the Project site and disposed of by Contractor at Contractor's expense. Debris is defined as "anything that is not earth which exists at the job site."
2. **Muck:** Where excavation to the finished grade section results in a subgrade or slopes of unsuitable soil, Engineer may require Contractor to remove the unsuitable materials and backfill to the finished graded section with approved material. Disposal of the unsuitable material and replacement with suitable material shall be at Contractor's expense.

Good surface drainage shall be provided around all permanent cuts to direct surface runoff away from the cut face.

3. **Rock:** Unless otherwise specified, rock shall be excavated to a minimum depth of 0.5 foot below subgrade within the limits of the channel area, and the excavation shall be backfilled with material shown on the DRAWINGS or as designated by Engineer. Disposal of material and replacement with suitable approved material shall be at Contractor's expense.

Blasting or other use of explosives for excavation will not be permitted.

4. **Shoring:** As needed, all excavations shall be properly sheeted and braced to meet Federal, State and local laws in regard to safe working conditions. The shoring shall be arranged so as not to place any stress on portions of the completed work until the general construction thereof has proceeded far enough to provide ample strength. Any damage to pipes or structures resulting from settlements, heaving, water or earth pressures, slides, caving, or other causes, due to lack

of shoring, sheeting, or bracing, or due to failure of shoring, or due to improper shoring, or due to any other negligence on the part of the Contractor, shall be repaired by the Contractor at his own expense.

Shoring shall be removed as the work progresses, unless left in place by written order of the Project Manager. The Contractor will be paid for shoring so ordered left in place on the basis of invoice material cost only. Trench sheeting shall not be pulled before backfilling unless the pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting, nor shall sheeting be pulled after backfilling. Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.

5. Water Control and Dewatering: Dewatering equipment shall be provided to remove and dispose of all surface water and groundwater entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

All excavations for concrete structures or trenches which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level beneath such excavations 12 inches or more below the bottom of the excavation.

Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

- C. **Storage of Excavated Materials.** Excavated material shall be stockpiled near the immediate construction area in a confined configuration. For storage of excess excavated material suitable for backfill, Contractor shall obtain and pay for a storage site. All transportation to and from (including loading) storage site and temporary land/site acquisition is included in the work.

All excess excavated material at the completion of the work and all debris, stones, logs, stumps, roots, and other unsuitable materials shall be

removed from the site and disposed of by, and at the expense of, the Contractor.

- D. **Embankment Construction.** Embankment construction shall consist of constructing all fill areas, including preparation of the areas upon which they are to be placed, the placing and compacting of approved material within areas where unsuitable materials have been removed, and the placing and compacting of embankment material in holes, pits and other depressions within the Project area. Only approved materials shall be used in the construction of embankments and backfills.

Approved materials shall consist of clean on-site cohesive soils or approved imported soils. Additional material shall be provided as required. After preparation of the fill or embankment site, the subgrade shall be leveled and rolled so that surface materials of the subgrade will be compact and well bonded with the first layer of the fill or embankment.

All material deposited in fills and embankments shall be free from rocks or stones, brush, stumps, logs, roots, debris, and organic or other objectionable materials, and shall be wetted or dried as required and thoroughly mixed to ensure uniform moisture content. On-site cohesive soils or imported soils should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift and embankment height. On-site or imported cohesive soils should be compacted within a moisture content range of two percent (2%) below, to two percent (2%) above optimum moisture content and compacted to ninety-five percent (95%) of the Maximum Standard Proctor Density (ASTM D698).

When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is built one-half ($\frac{1}{2}$) width at a time, the slopes that are steeper than four-to-one (4.1) when measured longitudinally or at right angles to the adjacent ground shall be continuously benched over those areas where it is required as the Work is brought up in layers. Benching shall be well "keyed" and where practical a minimum of eight (8) feet. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus cut out shall be recompacted along with the new embankment material at Contractor's expense.

The ground surface underlying all fills shall be carefully prepared by removing all organic matter, scarification to a depth of eight (8) inches and

recompacting to ninety-five percent (95%) of the Maximum Standard Proctor Density (ASTM D698) at optimum moisture content + or - two percent (2%) prior to fill placement.

Embankment material shall be placed in horizontal layers not exceeding 8 inches (loose measurement) and shall be compacted to ninety five percent (95%) of the Maximum Standard Proctor Density (ASTM D698) at optimum moisture content + or - two percent (2%). Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting. As the compaction of each layer progresses, continuous leveling and manipulating will be required to assure uniform density.

For embankments which serve as berms, the downstream portion shall be keyed into the subsurface soils a minimum of three (3) feet to enhance the stability of the slope.

Materials which are removed from excavations beneath the water table may be over the optimum moisture content and will require that they be dried out prior to reusing them.

Cross hauling or other action as appropriate will be ordered when necessary to insure that the best available material is placed in critical areas of embankments, including the top two (2) feet of all embankments. No additional payment will be made for cross hauling ordered by Engineer.

Frozen materials shall not be used in construction of embankments. Backfilling and construction of fills and embankments during freezing weather shall not be done except by permission of the Engineer. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.

During the construction of the channels, the channel bottom shall be maintained in such condition that it will be well drained at all times.

Excavation or embankment (fill), and structural backfill Work either completed or in a stage of completion that is either eroded or washed away or becomes unstable due to either rains, snow, snow melt, channel flows, or lack of proper water control shall be either removed and replaced, recompacted, or reshaped as directed by Engineer and in accordance with the Drawings and Specifications at Contractor's sole expense. Removed unsuitable materials shall be hauled away and disposed of at Contractor's expense. Placing of replacement materials for

removed unsuitable materials shall be purchased, placed, and compacted at Contractor's expense.

- E. **Proof Rolling.** Proof rolling with a heavy rubber tired roller will be required, if designated on the Drawings or when ordered by Engineer. Proof rolling shall be done after specified compaction has been obtained. Areas found to be weak and those areas which failed shall be ripped, scarified, wetted if necessary, and recompacted to the requirements for density and moisture at Contractor's expense.

Proof rolling shall be done with equipment and in a manner acceptable to Engineer. Proof rolling as shown on the Drawings or as ordered by Engineer shall not be measured and paid for separately, but shall be included in the unit prices bid for the work.

3-2 Excavation and Backfill for Structures:

Excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.

Conform to elevations and dimensions shown within a tolerance of 0.10 feet. In excavating for footings and foundations, take care not to disturb the bottom of the excavation. Excavate by hand tools to final grade just before concrete is placed. Trim bottoms to required lines and grades to leave a solid base to receive concrete.

Protect excavation bottoms against freezing when atmospheric temperature is less than 35° F.

The quality and moisture content of materials for backfill around and outside of structures shall conform to the requirements for materials used for backfills and structural backfill. Backfill materials shall be deposited in layers not to exceed 8 inches in uncompacted thickness and compacted to at least 95 percent of maximum density at optimum moisture content as determined by ASTM D698. Compaction of structure backfill by rolling will be permitted, provided the desired compaction is obtained and damage to the structure is prevented. Compaction of structure backfill by inundation with water will not be permitted.

No backfill shall be deposited or compacted in water.

Particular care shall be taken to compact structure backfill which will be beneath pipes, drives, roads, parking areas, walks, curbs, gutters, or other surface construction or structures. Place backfill evenly, adjacent to structures, to required elevations. Carry material uniformly around the structure to approximately the same elevation in each lift. In addition, wherever a trench is to

pass through structure backfill, the structure backfill shall be placed and compacted to an elevation not less than 12 inches above the top of pipe elevation before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.

Poor foundation material for any of the Work shall be removed, by Contractor as directed by Engineer. Contractor will be compensated for removal and replacement of such materials in accordance with Muck Excavation.

Contractor is cautioned that construction equipment may cause the natural soils to pump or deform while performing excavation Work inside and on footings, structural floor slabs, or other structure foundation areas.

Contractor shall remove and replace at Contractor's expense any foundation materials which are: a) saturated by either surface or subsurface flows due to the lack of adequate water control or dewatering work by Contractor; b) frozen for any reason; or c) disturbed by Contractor's Work or caused to become unacceptable for foundation material purposes by means of Contractor's equipment, manpower, or methods of Work.

Dewatering should not be conducted by pumping from inside footings, structural floor slabs, or other structure foundation limits. This may decrease the supporting capacity of the soils.

Care should be taken when excavating the foundations to avoid disturbing the supporting materials. Excavation by either hand or careful backhoe soil removal, may be required in excavating the last few inches of material to obtain the subgrade of any item of the concrete Work.

Subgrades for concrete structures and trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workmen.

Subgrades for concrete structures or trench bottoms which are otherwise solid, but which become mucky on top due to construction operations, shall be reinforced with crushed rock or gravel. The stabilizing material shall be spread and compacted to a depth of not more than four inches; if the required depth exceeds four inches, the material shall be furnished and installed as specified for stabilization material. The finished elevation of stabilized subgrades shall not be above subgrade elevations indicated on the drawings.

Any over-excavated subgrades that are due to Contractor's actions, shall be brought back to subgrade elevations by Contractor and at Contractor's expense

in the following manner:

- A. For over-excavations of two (2) inches or less, either backfill and compact with approved granular materials; backfill with one-half (½) inch crushed rock; or fill within concrete at the time of the appurtenant structure concrete pour.
- B. For over-excavations greater than two (2) inches, backfill and compact with an approved granular material.

All granular footings, structural floor slabs, or other structure areas shall be compacted with a vibratory plate compactor prior to placement of concrete, reinforcing, or bedding materials.

Backfill, and fill within three (3) feet adjacent to all structures and for the full height of walls, shall be selected non-swelling material. It shall be granular, well graded, and free from stones larger than two (2) inches. Material may be job excavated, but selectivity will be required as determined by Engineer. Stockpiled material, other than topsoil from the excavation, shall be used for backfilling unless an impervious structural backfill is specified. The backfill material shall consist of either clean on-site granular material free of stones larger than two (2) inches in diameter with no more than twenty percent (20%) passing the No. 200 sieve, or equivalent imported materials. All backfill around the structures shall be consolidated by mechanical tamping. The material shall be placed in six-inch (6") loose lifts within a range of two percent (2%) above to two percent (2%) below the optimum moisture content and compacted to ninety-five percent (95%) of Maximum Standard Proctor Density (ASTM D698) for cohesive soils, or to seventy-five percent (75%) relative density for pervious material as determined by the relative density of cohesionless soils test, ASTM D4253.

When specified on the Drawings or as required by Engineer, Class I structural backfill shall meet the following gradation requirements.:

<u>Sieve Size</u>	<u>% By Weight Passing Square Mesh Sieves</u>
2-inch	100
No. 4	30 - 100
No. 50	10 - 60
No. 200	5 - 20

In addition, this material shall have a liquid limit not exceeding thirty five (35) and a plasticity index of not over six (6).

Impervious structural backfill, where shown or specified, shall consist of material having one hundred percent (100%) finer than two (2) inches in diameter and a minimum of thirty five percent (35%) passing a No. 200 U.S. Standard Sieve. The material shall be placed in six-inch (6") loose lifts within a range of two percent (2%) above to two percent (2%) below the optimum moisture content and compacted to ninety five percent (95%) of Maximum Standard Proctor Density for cohesive soils as determined by ASTM D698.

3-6 Restoration:

- A. Streets and Roadways. Any pavements disturbed during construction shall be repaired in accordance with Detail Drawings and Specifications Sections 02511, 02512 and 02513 for Aggregate Base Course, Bituminous Prime Coat and Hot Bituminous Pavement.

All streets and paved surfaces shall be restored within two (2) weeks of their excavation. All dirt and debris, including dust shall be removed from streets and paved surfaces within three (3) days of the restoration of streets and paved surfaces. Initial removal of dirt and debris shall be made using a vacuum sweeper, after which the paved surfaces shall be cleaned using water hoses.

- B. Concrete Walks, Curb and Gutter, Fencing and Culverts. Restore all existing structures to conditions equal to or exceeding existing structures and according to local requirements.

- C. Landscape. After other outside work has been finished, and backfilling and embankments completed and settled, all areas which are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas which have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least 4 inches. Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth.

Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to hand work. All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least one percent shall be provided.

Final grading and surfacing shall be smooth, even, and free from clods and stones larger than one inch in greatest dimension, weeds, brush, and other

debris.

The top portion of backfill beneath established lawn areas shall be finished with at least 12 inches of topsoil corresponding to, or better than, that underlying adjoining lawn areas.

- D. Other Items. The Project Manager will clarify restoration of other minor items as construction proceeds. Such items must be restored to equal or exceed existing conditions.

3-7 Cleanup:

Prior to final inspection and acceptance, the Contractor shall remove all rubbish and excess materials and leave area in a neat, satisfactory condition.

3-8 Maintenance of Backfill:

All backfill shall be maintained in a satisfactory condition and all places showing signs of settlement shall be filled and maintained during the life of the Contract and for a period of one year following the date of final acceptance of all work performed under the Contract. When the Contractor discovers or is notified by the City that any backfill is not in compliance with the provision of this Contract, the Contractor shall correct such conditions. Any utilities and road surfacing damaged by such settlement shall be repaired by the Contractor to the satisfaction of the City. In addition, the Contractor shall be responsible for the cost to the Owner of all claims for damages due to settlement of backfilled areas.

END OF SECTION

SECTION 02320

TRENCH EXCAVATION AND BACKFILL

PART 1: GENERAL

1-1 Description:

This Work shall consist of all labor, equipment and materials necessary for excavation; trenching; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property; pipe embedment; construction of fills and embankments; surfacing and grading; and backfilling for utility lines and other related Work.

1-2 Submittals:

Samples of all materials specified in this section shall be submitted to the Engineer in accordance with Section 01300. The quantity of material samples required will be specified by the Engineer. Where gradations or other material properties are specified, information certifying these properties shall also be submitted. All gradation and samples of materials submitted must be approved by the Engineer before incorporated into the work.

1-3 Reference Standards:

American Association of State Highway and Transportation Officials (AASHTO), American Society for Testing and Materials (ASTM), Colorado Department of Transportation (CDOT) Standard Specifications for Road and Bridge Construction.

1-4 Safety:

With reference to the terms and conditions of the construction standards for excavations set forth in the OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, the Contractor shall employ a competent person and, when necessary, a registered professional engineer, to act upon all pertinent matters of the work of this section.

1-5 Quality Assurance:

In-place moisture density tests will be performed to ensure trench backfill complies with specified requirements. The following minimum tests should be expected to be performed.

1. Trench bedding – one per two hundred (1 per 200) feet
3. Backfill - 1 per 200 feet

Two initial gradation tests shall be made for each type of pipe bedding, fill, or backfill material, and one additional gradation test shall be made for each additional 500 tons of each material.

Backfill compaction tests will be performed until compaction meets or exceeds requirements. The cost of "passing" tests shall be paid by Owner. Costs associated with "failing" tests shall be paid by Contractor.

Pipe bedding shall be tested prior to placement of backfill.

Testing of all bedding and backfill material shall be done in compliance with Occupational Safety & Health Administration (OSHA) - Excavations.

1-6 Protection:

- A. **Sheeting and Shoring.** Contractor shall protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent any excessive widening or sloughing of the trench which may be detrimental to human safety, to the pipe or appurtenances being installed, or to existing facilities or structures. The latest requirements of OSHA shall be complied with at all times including trenching and confined space entry requirements.

Contractor shall be responsible for underpinning adjacent structures which may be damaged by excavation Work, including service utilities and pipe chases.

- B. **Weather and Frost.** Contractor shall protect bottom of excavations and soil adjacent to and beneath foundations from frost.

1. Do not place backfill, fill, or embankment on frozen surfaces.
2. Do not place frozen materials, snow, or ice in backfill, fill, or embankments.
3. Do not deposit, tamp, roll, or otherwise mechanically compact backfill in water.

- C. **Drainage and Groundwater.** The excavation shall be graded to prevent surface water runoff into trench or excavation.

1. Maintain excavations and trenches free from water during construction.
2. Remove water encountered in trenches to the extent necessary to provide a firm subgrade, to permit joints to be made in the dry, and to prevent the entrance of water into the pipeline.
3. Divert surface runoff and use sumps, gravel blankets, well points, drain lines, or other means necessary to accomplish the above.

4. Maintain the excavation or trench free from water until the structure, or pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.
5. Prevent water from entering into previously constructed pipe.
6. Do not use the pipe under construction for dewatering.

1-7 Related Work:

- A. Section 02240 – Water Control and Dewatering
- B. Section 02315 – Excavation and Embankment

PART 2: MATERIALS

2-1 General:

All bedding and backfill material shall have the approval of the Engineer and shall be included in the unit price for the pipe unless otherwise specified and indicated in the Proposal. All bedding and backfill material shall be free of frozen material, organic material and debris.

- 2-2 Muck Excavation.** Muck excavation shall also include the replacement of excavated muck with uniformly graded rock ranging from three-quarter ($\frac{3}{4}$) inch to one-and-one-half ($1\frac{1}{2}$) inches or as required by Engineer. Engineer shall determine which type of aggregate or other material shall be used after observing the specific site conditions.

2-2 Pipe Bedding:

Bedding materials both below and above the bottom of the pipe, classes of bedding to be used, and placement and compaction of bedding materials shall conform to the following requirements:

Bedding materials shall contain no cinders or other material which may cause pipe corrosion.

- A. Concrete Arch Encasement. Concrete arch encasement is not required unless improper trenching or unexpected trench conditions require its use as determined by the Engineer.
- B. Granular Bedding Material for Ductile Iron Pipe and PVC Pressure Pipe. Granular bedding material shall consist of washed chips, nominal size 3/8" meeting the following gradation:

Sieve Size	Percent Passing by Weight
1/2-inch	100
3/8-inch	85-100
No. 4	10-30
No. 8	0-10
No. 16	0-5

If approved by the Engineer, squeegee sand conforming to the gradation in D. below may be used for ductile iron pipe only. All granular bedding material shall be placed in not more than 6" layers and compacted by slicing with a shovel or vibrating.

- C. Granular Bedding Material for PVC and HDPE Sewer Pipe. This material shall be imported, crushed, angular quarry rock and meet the following gradation (ASTM D448, No. 67):

Sieve Size or Designation	Total Passing (% by Weight)
1- inch	100
¾ - inch	90-100
3/8 - inch	20-55
No. 4	0-10
No. 8	0-5

- D. Granular Bedding Material for RCP Sewer Pipe. This material shall be squeegee sand meeting the following gradation:

Sieve Size	Percent Passing by Weight
3/8-inch	100
No. 200	0-5

Note: It shall be the responsibility of Contractor to locate material meeting the Specifications, to test its ability to consolidate to at least seventy five percent (75%) relative density, and to secure approval of Engineer before such material is delivered

to the Project. Relative density shall be determined as stipulated in ASTM D4253.

2-4 Trench Backfill:

Trench backfill refers to material placed above the pipe bedding. Trench backfill shall be finely divided job excavated material free from debris, rubbish, clods, roots, brush, frozen lumps of earth, organic material and large stones unless otherwise specified, and shall be moistened as required. Flowable fill, as specified in Section 2-6, or granular backfill material, as specified in Section 2-7, may be used if approved by the Engineer.

If the job excavated material proves to be unsuitable for backfill, the contractor may, at his option and if approved by the Engineer, use a pit-run material consisting of rocks less than 3" in diameter and a maximum of 20 percent passing a No. 200 sieve.

2-5 Stabilization Material:

Stabilization material shall be placed on suitably prepared subgrades and compacted by vibration. Stabilization material shall be crushed rock or gravel; shall be free from dust, clay, or trash; and shall be graded 1-1/2 inch to No. 4 as defined in ASTM C33 and shall be compacted to not less than 70 percent relative density as determined by ASTM D4253 and D4254.

2-5 Groundwater Barrier Material:

Groundwater barrier material shall meet AASHTO soil classification SC or CL, free from stones, organic material or debris, or flowable fill may be used as specified in Section 2-6.

2-8 Flowable Fill:

Flowable fill shall meet the following requirements and shall be used for trench backfill when specified in the contract or by the Engineer, or as a groundwater barrier.

<u>Ingredients</u>	<u>Lbs/CY</u>
Cement	50
Coarse Aggregate (AASHTO No. 57 or 67)	1700
Fine Aggregate (AASHTO M 6)	1845
Water	325 (or as needed)

The amount of water shall be such that the flowable fill flows into place properly without excessive segregation. Approximately 39 gallons of water per cubic yard of flowable fill is normally needed.

The Contractor may use aggregate which does not meet the above specifications if the cement is increased to 100 pounds per cubic yard and the aggregate conforms to the

following gradation:

<u>Sieve Size</u>	<u>% Passing</u>
1 inch	100
No. 200	0 – 10

The Contractor may substitute 30 lbs/cy of cement and 30 lbs/cy of fly ash for 50 lbs/cy of cement or may substitute 60 lbs/cy of cement and 60 lbs/cy of fly ash for 100 lbs/cy of cement.

The Owner reserves the right to review the use of recycled broken glass (glass cullet) as part or all of the aggregate. Proposed mix design must be submitted in accordance with Section 01300, Submittals.

Compaction of flowable fill shall be done by means of vibration. The flowable fill shall be vibrated until the fill has lost sufficient moisture to be walked on without indenting more than 2 inches.

The maximum depth of trench in which flowable fill may be used shall be 3 feet. With trench depths greater than 3 feet, a combination of backfill materials may be used. An aggregate base course material, compacted by traditional methods and equipment, may be used for depths exceeding the flowable fill limits, and topped off with a flowable fill cap of 3 feet in depth. The flowable fill shall be placed so that it heaps over the top edge of the trench. This is required so that, when the fill is vibrated, the excess water can rise to the surface and flow away from the trench. Any damage resulting from the placing of the flowable fill, or from not providing sufficient consolidation shall be repaired at the contractor's expense.

2-9 Granular Backfill Material:

Granular backfill material shall be an imported graded material meeting the 57/67 size requirements of ASTM C33 or the requirements for stabilization material as specified in Section 2-4.

If approved by the Engineer, granular backfill material may be finely divided job excavated material free from debris, rubbish, clods, roots, brush, frozen lumps of earth, organic material and stones larger than 6 inches and with no more than 50 percent by weight passing the No. 200 sieve.

2-9 Cut-Off Walls

1. Clay Cut-Off Walls: More than fifty percent (50%) shall pass a No. 200 Sieve. The plasticity index shall be greater than twelve (12).
2. Controlled Low Strength Material Backfill: (Flo-Fill - See Section 02321).

PART 3: EXECUTION

3-1 General:

The following procedures shall be followed by Contractor in sequencing the Work:

- A. No more than one hundred fifty (150) feet of trench shall be left open at any time. The entire trench shall be backfilled to within fifty (50) feet of the open trench upon conclusion of each day's Work. The trench shall not be backfilled until the pipe installation is reviewed by Engineer.
- B. Trench shall be backfilled within one hundred (100) feet of the pipe installation at all times.
- C. Clean-up shall be maintained within four hundred (400) feet of the trench excavation.

Prior to placement in the trench, all pipes, fittings, and appurtenances shall be cleaned and examined for defects by Contractor. If found defective, Contractor shall reject the defective pipe, fitting, or appurtenance. Contractor shall advise Engineer of all defective materials.

All surplus excavation shall be placed, in an orderly manner. If material is stockpiled on private property, written permission must be obtained from the property owner and provided to Engineer.

All muck excavation, bedding, and pipe zone material shall be imported unless otherwise designated by Owner's geotechnical engineer.

Upon completion of the Work, all plants, rubbish, unused materials, concrete forms, and other like material shall be removed from the job site. The site shall be left in a state of order and cleanliness.

3-2 Maintenance and Correction:

- A. Scarify surface, reshape, and compact to required density completed or partially completed areas of Work disturbed by subsequent construction operations or by adverse weather.
- B. Maintain and correct backfill, fill, and embankment settlement and make necessary repairs to pavement structures, seeding, and sodding which may be damaged as a result of settlement for the guarantee period.
- C. Such maintenance and correction may be performed by subcontract.

3-3 Obstructions and Disposal of Waste Material:

Contractor shall remove obstructions that do not require replacement from within the trench or adjacent areas such as tree roots, stumps, abandoned piling, buildings and concrete structures, frozen material, logs, and debris of all types without additional compensation. Engineer may, if requested, make changes in the trench alignment

to avoid major obstructions, if such alignment changes can be made within the Work limits without adversely affecting the intended function of the facility. Excavated materials unsuitable for backfill or not required for backfill shall be disposed of in accordance with local regulations.

3-4 Shoring:

As needed, all excavations shall be properly sheeted and braced to meet Federal, State and local laws in regard to safe working conditions. The shoring shall be arranged so as not to place any stress on portions of the completed work until the general construction thereof has proceeded far enough to provide ample strength. Any damage to pipes or structures resulting from settlements, heaving, water or earth pressures, slides, caving, or other causes, due to lack of shoring, sheeting, or bracing, or due to failure of shoring, or due to improper shoring, or due to any other negligence on the part of the Contractor, shall be repaired by the Contractor at his own expense.

Shoring shall be removed as the work progresses, unless left in place by written order of the Project Manager. The Contractor will be paid for shoring so ordered left in place on the basis of invoice material cost only. Trench sheeting shall not be pulled before backfilling unless the pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting, nor shall sheeting be pulled after backfilling. Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.

3-6 Water Control and Dewatering:

Dewatering equipment shall be provided to remove and dispose of all surface water and groundwater entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

All excavations for concrete structures or trenches which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level beneath such excavations 12 inches or more below the bottom of the excavation.

Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

The Contractor shall be responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipe or conduit shall be left clean and free of sediment.

3-6 Trench Excavation:

Trenches shall be excavated so that pipes can be laid in accordance with the profiles, grades, elevations and minimum cover as shown on the drawings or specified herein. No trenches or excavation shall be left open after working hours.

- A. Excavation in Streets and Other Paved Surfaces. The excavation in streets with asphalt paving must be confined to a minimum width as required to maintain a safe trench condition. The pavement shall be cut vertical and on a straight line.

Regardless of the amount of pavement damaged or removed during installation of the pipelines, except for pipe 36" diameter and greater, the maximum width of pavement replacement that will be paid for will be up to 30 inches on either side of the pipe centerline and a maximum total width of 60 inches if pavement is excavated on both sides of the pipe centerline and shall include all base course, cleaning, prime coats and asphalt pavement.

- B. Minimum Cover. Where pipe grades or elevations are not definitely fixed by the contract drawings, trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill cover over the top of the pipe of 54 inches. Sanitary sewer mains require a minimum of 42 inches of cover; storm sewers require a minimum of 12 inches of cover.

- C. Trench Widths. The minimum clear trench width measured at the top of the pipe barrel shall not be less than the outside pipe diameter, plus 16-inches.

For all pipe, the maximum clear trench width measured at a point 12-inches above the top of the pipe barrel shall be not greater than the trench width shown on the following table:

Pipe Diameter Inches	Maximum Trench Inches	Pipe Diameter Inches	Maximum Trench Inches
4	24	24	48
6	26	27	52
8	28	30	56
10	30	33	60
12	34	36	68
14	36	39	72
15	37	42	76
16	38	48	82
18	40	54	90
20	42	72	110
21	44		

If the stated maximum trench widths are exceeded, either through accident or otherwise, and if the Project Manager determines that the combined dead and live loads will exceed the design loadings on the pipe, the Contractor shall either cradle the pipe in concrete, or use a pipe of a stronger class, as required by the Project Manager. The cost of such remedial measures shall be entirely at the Contractor's expense.

Cutting trench banks on slopes to reduce earth load to prevent sliding and caving shall be done only in areas where the increased trench width will not interfere with surface features.

- D. Trench Walls. The Contractor may slope or bench the trench sidewalls in areas where an increased trench width will not interfere with surfaces features or other utilities. Such sloping or benching shall terminate at a depth not lower than one foot above the top of the pipe barrel, and from that point down, the trench wall shall be vertical. The trenching operation, including the spoil bank and sloping of the trench sidewalls shall be confined to the width of the permanent and temporary rights-of-way, if any.

A clear area shall be maintained a sufficient distance back from the top edge of the excavation to avoid overloading which may cause slides or caving of the trench walls. The excavated material shall be kept trimmed in such a manner as to be of as little inconvenience as possible to the public and adjoining property owners. Unless otherwise authorized by the Project Manager, all public thoroughfares and crossroads shall be kept open to traffic. Bridging shall be

used when authorized by the Project Manager at street crossings, sidewalks and other points where necessary, to prevent serious interruption of travel and to provide access to fire hydrants and public and private premises.

- E. Trench Depth. The trenches shall be excavated to such depths that the pipeline can be laid at the elevation of the grade lines shown on the Drawings, or at the depths or covers specified herein. If unauthorized over-excavation occurs, the Contractor shall place and compact stabilization material at no additional cost to the City.

The pipe trench shall be excavated to a depth as shown on the drawings below the bottom of the pipe and backfilled with the specified granular bedding material and compacted to the requirements of Section 3-10.

- F. Trench Preparation. The trench shall be excavated only so far in advance of pipe laying as permitted by the Project Manager. The trench wall shall be so braced that the workmen may work safely and efficiently. All trenches shall be drained so that pipe laying may take place in unwatered conditions. Trench preparation shall also conform to the details shown on the Drawings.

Trenches above a point 12-inches above the top of the pipe shall be of such extra width, when required, as will permit the convenient placing of timber supports, sheeting and bracing, and the handling of special units as necessary.

Bell holes in the trench bottom shall be provided at each joint to permit the jointing to be made properly and to prevent the pipe from bearing on the pipe bells.

After excavation, the trench bottom shall be uniformly graded and hand-shaped so that the pipe barrel (exclusive of the joint) will have uniform and continuous bearing on thoroughly compacted pipe bedding material throughout the length of the pipe. The trench grade shall permit the pipe spigot to be accurately centered in the preceding laid pipe joint, without lifting the pipe above the grade and without exceeding the permissible joint deflection. If it is necessary to raise the pipe subgrade, approved, compacted bedding material shall be used at the Contractor's expense.

- G. Excavation Material. Excess excavated material suitable for backfill shall not be disposed of until all backfill operations are complete. If excavated material unsuitable for backfill is encountered, the excess material from other locations in the project shall be used for backfill at no additional cost to the City.
- H. Rock Excavation. In the event of rock excavation, the bottom of the trench shall be lowered so that the bottom of the trench is 6 inches below the outside surface of the pipe. The space between the rock and the pipe shall be filled with granular bedding material. The bedding material shall be compacted to a density equal to or greater than 90% of the maximum laboratory density. During compaction, the bedding material shall be shaped to provide support along the full length of pipe.

3-7 Storage of Excavated Material:

Excavated material shall be stockpiled near the immediate construction area in a confined configuration. For storage of excess excavated material suitable for backfill, Contractor shall obtain and pay for a storage site. All transportation to and from (including loading) storage site and temporary land/site acquisition is included in the work.

All excess excavated material at the completion of the work and all debris, stones, logs, stumps, roots, and other unsuitable materials shall be removed from the site and disposed of by, and at the expense of, the Contractor.

3-8 Foundations on Unstable Soils:

If the bottom of the excavation is soft or unstable, and in the opinion of Engineer, cannot satisfactorily support the pipe or structure, a further depth and width shall be excavated and refilled to six (6) inches below grade with rock uniformly graded between three-quarter ($\frac{3}{4}$) inch and one and one-half ($1\frac{1}{2}$) inches or other approved material to provide a firm foundation for the pipe or structure. From six (6) inches below grade to grade, the appropriate bedding material shall be placed to provide support for the pipe or structure.

3-9 Installation of Pipe Bedding:

Pipe Bedding material shall consist of the material on which the pipe is placed (refer to 2-2 above). Bedding material shall be placed to a minimum of 4-inches below the pipe invert. Tamping equipment shall be used to thoroughly tamp the bedding material. The moisture content of the material shall be within 2 percent of optimum.

After bedding material has been placed and has been approved and after the pipe has been installed and approved, the granular bedding material shall be installed to an elevation 12-inches above the top of the pipe. For RCP sewer pipe, granular bedding material shall be installed to the springline of the pipe. The granular bedding material shall be placed and compacted in distinct, separate lifts not to exceed 6-inches of loose depth; except that the first loose lift shall not be higher than the pipe centerline (springline). Compaction shall meet the above requirements utilizing T-bars or mechanical tamping equipment.

3-10 Installation of Trench Backfill:

Unless accurate results cannot be obtained, the compaction requirements shall conform to maximum dry density according to ASTM D698, Moisture-Density Relations of Soils (Standard Proctor). When the ASTM D698 test is not applicable, the percentage compaction requirements shall conform to ASTM D2049 Test for Relative Density of Cohesionless Soils.

When required by the Engineer the Contractor shall excavate backfilled trenches for purposes to perform compaction tests at locations and depths determined by the

Project Manager. The Contractor shall be responsible for reinstalling and compacting the test excavations at no additional cost to the City.

All backfill above the bedding installation shall be carefully placed and compacted. Compaction shall be by mechanical tamping in 8-inch maximum horizontal, loose lifts using mechanical or hand tampers, suitable for material being compacted, or vibratory rollers. All other means must be approved in writing by the Project Manager. All backfill shall be compacted to 95% of maximum laboratory dry density or 70 percent relative density. The material shall be within 2.0 percent of optimum moisture content.

The Contractor may request approval of alternate means of compaction. Such request must be submitted to the Project Manager in writing. Approval of the compaction method will be made by the Project Manager only in writing. Use of specified or approved compaction methods does not relieve the Contractor from providing a complete project meeting the intent of this Specification.

A layer of backfill material not more than 8 inches deep may be placed over concrete arch encasement or concrete reaction blocking after the concrete has reached its initial set, to aid curing. No additional backfill shall be placed over arch encasement or blocking until the concrete has been in place for at least three days.

3-14 Restoration:

- A. Streets and Roadways. Any pavements disturbed during construction shall be repaired in accordance with Detail Drawings and Specifications Sections 02511, 02512 and 02513 for Aggregate Base Course, Bituminous Prime Coat and Hot Bituminous Pavement.

All streets and paved surfaces shall be restored within two (2) weeks of their excavation. All dirt and debris, including dust shall be removed from streets and paved surfaces within three (3) days of the restoration of streets and paved surfaces. Initial removal of dirt and debris shall be made using a vacuum sweeper, after which the paved surfaces shall be cleaned using water hoses.

- B. Concrete Walks, Curb and Gutter, Fencing and Culverts. Restore all existing structures to conditions equal to or exceeding existing structures and according to local requirements.

- C. Landscape. After other outside work has been finished, and backfilling and embankments completed and settled, all areas which are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas which have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least 4 inches. Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth.

Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to hand work.

All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least one percent shall be provided.

Final grading and surfacing shall be smooth, even, and free from clods and stones larger than one inch in greatest dimension, weeds, brush, and other debris.

The top portion of backfill beneath established lawn areas shall be finished with at least 12 inches of topsoil corresponding to, or better than, that underlying adjoining lawn areas.

- D. Other Items. The Engineer will clarify restoration of other minor items as construction proceeds. Such items must be restored to equal or exceed existing conditions.

3-15 Cleanup:

Prior to final inspection and acceptance, the Contractor shall remove all rubbish and excess materials and leave area in a neat, satisfactory condition.

3-16 Maintenance of Backfill:

All backfill shall be maintained in a satisfactory condition and all places showing signs of settlement shall be filled and maintained during the life of the Contract and for a period of one year following the date of final acceptance of all work performed under the Contract. When the Contractor discovers or is notified by the Owner that any backfill is not in compliance with the provision of this Contract, the Contractor shall correct such conditions. Any utilities and road surfacing damaged by such settlement shall be repaired by the Contractor to the satisfaction of the Owner. In addition, the Contractor shall be responsible for the cost to the Owner of all claims for damages due to settlement of backfilled areas.

END OF SECTION

SECTION 02515

MANHOLES AND INLETS

PART 1: GENERAL

1-1 Description:

The work of this section consists of furnishing and installing precast concrete manholes, frames and covers, and installation materials and the construction of storm sewer inlets.

1-2 Reference Standards:

American Society for Testing and Materials (ASTM) and American Association of State Highway and Transportation Officials (AASHTO).

1-3 Submittals:

In accordance with Section 01300, furnish manufacturer's literature on manholes, joint material, frame and cover, and steps.

PART 2: MATERIALS

2-1 General:

Manholes shall be constructed of pre-cast concrete riser sections, in accordance with the detail drawing in the construction plans. The concrete sections shall conform to ASTM C478. The top section required for change of diameter shall be eccentric cone or flat slab. Invert channel shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. The minimum internal diameter of the manhole barrel shall be as follows for all manhole installations.

<u>Pipe Size</u>	<u>M.H. Inner Dia.</u>
24" and smaller	4' - 0'
27" - 36"	5' - 0"
42" - 48"	6' - 0" (or special detail)
54" and larger	Special Detail

To bring the manhole cover to the correct elevation, the adjustment section of each manhole shall be constructed of brick which is sound and true in shape and size and shall be Grade S-W from clay or shale.

Pre-cast concrete grade adjustment rings may be substituted for the brick. These rings shall be not less than 6 inches wide and furnished in heights to allow for 1-inch adjustment. Total adjustment height, with grade rings or bricks, shall not exceed 12 inches.

2-2 Joints:

Precast manhole and inlet joints shall be made watertight with Ram-Nek material or approved equal. Diameter of gasket shall be as recommended by the manufacturer.

2-3 Frame and Cover:

Manhole frames and covers shall be of heavy duty traffic lids, round base, 24 inch opening lids, 1-1/16 inch thick, non-lockings type with an 8 inch frame and cover. Cover and frame seat shall be machine finished to prevent any rocking of cover in its associated frame. Cover shall have the word "SEWER" for sanitary sewer manholes and "STORM SEWER" for storm sewer manholes clearly cast on its surface. Frames and covers shall be Denver Standard J – 1161 available from C and C Supply, or approved equal.

2-4 Manhole Steps:

Manhole steps shall be built into and thoroughly anchored to the walls at time of fabrication and shall be positioned as shown on the drawings. The material for extruded aluminum steps shall conform to Federal Specifications QQ-A-200/8 for aluminum alloy 6061 T6510 or T6511. The material for cast aluminum steps shall conform to ASTM B26 for aluminum alloy 535.0-F and be equal to ALCOA No. 12653B. Aluminum steps shall have plastic inserts or be coated with bituminous paint to protect against corrosion with cement. Copolymer polypropylene coated steel steps Model PS-2-PF, as manufactured by M.A. Industries, are also approved.

2-5 Grout:

Grout shall be non-shrink type with aluminum filings; grout with iron filings is not acceptable. Grout shall be "Five Star Grout," "Embeco Grout" or equal.

2-6 Concrete:

Concrete for cast-in-place manhole bases shall have a 28-day compressive strength of not less than 3,000 psi. The maximum water content shall be 0.5 pounds of water per pound of cement. Entrained and entrapped air shall be between 4 and 9 percent. All reinforcement shall be standard deformed

reinforcement conforming to the requirements set forth in ASTM, A615, Grade 60.

2-7 Inlets:

Inlets shall be constructed of reinforced concrete and shall conform to the dimensions and specifications as set forth in the Colorado Department of Transportation, Division of Highways, M Standards as shown on the drawings. Inlet steps shall be built into and thoroughly anchored to the walls at the time of inlet construction. These steps shall conform to the requirements for Manhole steps, and shall be positioned as shown on the drawings.

PART 3: EXECUTION

3-1 Construction of Manholes:

Concrete construction shall conform to the requirements for reinforced concrete. Concrete bases shall be poured on undisturbed ground. Pipe sections shall be flush on the inside of the structural wall (except as noted below) and project outside sufficiently for proper connection to the next pipe section. All pipelines into a manhole or an inlet shall have a joint located no more than 12-inches from the exterior wall. Where incoming pipes enter a storm drain manhole or inlet at a elevation 3.0 feet or greater above the base, the incoming pipe shall project 2.0 inches inside the inlet or manhole. Grout all annular spaces around the pipe opening.

The ground surface below precast concrete bases shall be excavated six inches below the elevation of the bottom of the base and backfilled with gravel or other approved material. The gravel shall be carefully leveled and smoothed as to give uniform support to the precast base over its entire area. The precast base shall be set at the proper location to center the manhole.

The invert channels of manholes shall be smooth and semicircular in shape, conforming to the inside of the incoming and outgoing sewer pipelines. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Where differences of 24 inches or less in invert elevations are called for, sloped flow channels shall be formed so the water does not undergo a vertical drop. A drop manhole shall be installed where the specified distance in the manhole inverts exceeds 24 inches. The inlet channels may be formed directly in the concrete of the manhole base. The floor of the manhole outside of the channel shall be smooth and shall slope towards the channel not less than 1.0 inch per foot nor more than 2.0 inches per foot. The top of the manhole bench shall be at the same level as the crown of the highest sewer pipe entering the manhole (except for the upper connection of outside

drop structures). The manhole covers shall be set with their tops at the grade line, as set forth on the drawings. When a manhole is located in the pavement area, it shall not be constructed to final grade until the pavement has been completed, unless directed otherwise by the Project Manager.

Joints between manhole sections shall be sealed by RUB'R-NEK, Kent Seal No. 2 or LO-MOD GEL Joint Material. Diameter of the gasket shall be as recommended by the manufacturer. Grout all joints inside and outside after manhole is completed.

Gaskets for connecting PVC pipe to manhole sections shall be specifically manufactured for that purpose. The gasket shall provide for at least 5 bearing points on the pipe surface. The interior circumference of the gasket shall be approximately 5% less than the exterior circumference of the pipe. The gasket shall be as manufactured by Hamilton Kent Mfg. Co. of Kent, Ohio, or approved equal. Grout all annular spaces around pipe openings.

Stubs shall be provided at manholes when so shown on the drawings. Such stubs shall be sealed with a removable plug. Plugs shall be specifically manufactured for the pipelines in which they are to be installed. The plug shall be constructed of a material approved by the Project Manager and shall provide a permanent water-tight installation.

3-2 Adjusting Manhole Tops:

When grade adjustment of an existing structure is specified, remove frames and covers and reconstruct as required. Reset cleaned frames at the indicated elevation. Prior to final acceptance, clean structures of accumulations of silt, debris, or foreign matter.

3-3 Testing Manholes:

Refer to Section 02701.

END OF SECTION

SECTION 02527

REINFORCED CONCRETE PIPE

PART 1: GENERAL

1-1 Reference Standards:

All piping and fittings shall be of the type and materials specified herein or shown on the drawings and all materials shall be new and unused. All pipe sizes and all references to pipe diameter on the drawings or in the specifications are intended to be nominal diameter, and shall be interpreted as such.

Work covered by this section will not be accepted until specified tests and backfilling connected with the work have been completed satisfactorily. Any section of storm sewer line that is found defective in tests, materials, alignment, grade, or joints before acceptance shall be corrected to the satisfaction of the Project Manager without additional cost to the City.

A copy of the manufacturer's installation recommendations for each kind of pipe must be provided to each foreman and inspector prior to construction and must be followed during construction unless otherwise instructed.

1-2 Submittals:

Submittals shall be required for all reinforced concrete pipe, end sections, joint material, and any other materials used for the installation of reinforced concrete pipe. Submittals shall be approved by the Project Manager prior to delivery to the job site. The Contractor shall be required to submit drawings, specifications, and other data showing complete details of the design, fabrication and construction of the reinforced concrete pipe to the Project Manager for review before manufacture of the pipe begins. These submittals shall include data on all materials proposed to be used in the pipe, the size and location of each cage of the reinforcement, joint details including reinforcement, gasket details, and test results on materials, joints and pipe.

PART 2: MATERIALS

2-1 Reinforced Concrete Pipe:

The reinforced concrete pipe shall comply with the requirements of ASTM C76. The pipe shall be Class III unless noted otherwise on the drawing. The cement for the pipe shall conform to the requirements set forth in ASTM 150 and shall be type II and shall have a minimum compressive strength of 4,000 psi. All wall thicknesses shall be those established in "Wall B" in table 3, of said C76

specification, and the reinforcement shall be shown in the same "Wall B". Each joint of pipe shall be 7'-6" or greater in length.

No elliptical reinforcement will be permitted except for any elliptical reinforced concrete pipe designated on the construction plans.

Lifting holes will not be permitted in any of the pipe.

The following shall be clearly marked on the interior surface of the pipe:

- ASTM Specification
- Date of manufacture
- Class and size
- Name or trademark of Manufacturer

The joint design shall be tongue and groove, or bell and spigot. Joints for the circular reinforced concrete pipe shall be all rubber gasket conforming to ASTM C-443, latest revision. The gasket shall be attached to the spigot of the pipe and shall make the joint flexible and watertight. The Contractor may use butyl mastic joint sealant in rope or trowel applied form in lieu of rubber gaskets for circular pipe if approved in writing by the Project Manager. For all non-circular pipe and culverts, butyl mastic joint sealant may be used. The Contractor shall submit test results and material specifications on the sealant to the Project Manager before the Project Manager gives written approval of its use. This sealant must be made specifically for permanently sealing joints in tongue and groove concrete sewer pipe, must adhere tightly to the pipe surface, and form a tight flexible joint.

The gaskets or sealants shall be installed as directed by the manufacturer of the pipe.

Flared end sections, bends and tees shall comply with the requirements of ASTM C76 and shall be the same class and shall have the same joint design as the pipe described above.

The pipe will be tested by the manufacturer based on the 3-edge bearing test for both the 0.01-inch crack and the ultimate strength as set forth in ASTM C-497 and at the Contractors own cost. Said cost shall include the pipe, testing, and report to the engineer, the pipe shall be tested at the manufacturer's plant. Not more than one percent of the number of pipe lengths, but no fewer than 2 pipes, for each size of pipe, will be tested. The Engineer may select the pieces to be tested.

In addition, visual testing will be made at the job site, and pipe will be rejected on account of any deficiencies covered by ASTM Specification Designation C76 or

on account of the following:

- Porous spots, inside or outside, having a greater area than 10 square inches and a depth of more than 1/4 inch.
- Patched or repair of porous spots or other defects that are not approved by the Engineer.
- Exposure of reinforcement that indicates the reinforcement has been replaced.

PART 3: EXECUTION

3-1 Laying Pipe:

All materials shall be carefully lowered into the trench piece-by-piece by means of a derrick, ropes or other suitable tools or equipment, in such a manner as to prevent damage. Under no circumstances shall materials be dropped or dumped into the trench. All pipe shall be inspected for defects prior to installation. Any defective, damaged or unsound pipe shall be rejected.

All foreign matter or dirt shall be removed from the inside of the pipe and fittings before it is lowered into its position in the trench.

Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the trench. If the pipe-laying crew cannot put the pipe into the trench and in place without getting dirt into it, the Project Manager may require that before lowering the pipe into the trench a heavy, tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipes.

An approved snug-fitting stopper or plug shall be installed in each pipe immediately after it is laid and prior to any further excavating, or backfilling. All openings along the line of the main shall be securely closed as directed and in the suspension of work at any time, stoppers shall be placed to prevent dirt or other substances from entering the main. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe.

In the event of rock excavation, the bottom of the trench shall be lowered so that the bottom of the trench is 6 inches below the outside surface of the pipe. The space between the rock and the pipe shall be filled with granular bedding material as designated in Section 02200, 2-2D. The bedding material shall be compacted to a density equal to or greater than 90% of the maximum laboratory

density. During compaction, the bedding material shall be shaped to provide support along the full length of the pipe.

Pipes shall be laid to a true line and at uniform rates of grade between manholes as shown on the drawings. Fine grading to the bottom of the barrel shall proceed ahead of the pipe laying. The grade shall be accurately established for each joint by laser beam. The laser beam shall be checked with a level each time it is moved and each day before construction proceeds, and thereafter as required to assure that it is set at the correct alignment. If any errors of grade are observed, pipe laying shall stop until the grade is corrected.

Holes shall be dug for the pipe bells and coupling bands and the material placed along the preceding pipe laid. The pipe shall be supported for the bottom 90 degrees and throughout its length (except for the minimum distance necessary at the bell holes) as shown on the drawings. Bell holes shall be adequate to make the joint, but no larger than necessary so that maximum support on undisturbed ground will be provided for the pipe. In no event shall the weight of the pipe be resting on the bell. The remainder of the pipe shall be surrounded to at least the mid-point of the pipe with granular bedding material, shovel placed and hand tamped, to fill completely all spaces under and adjacent to the pipe.

Pipe laying should proceed upgrade with the spigot ends pointed in the direction of flow. No pipe shall be laid in water or when the trench conditions are unsuitable for such work, except by written permission of the Project Manager. The Contractor shall make all connections of pipe to the manholes which have previously been constructed. When connecting to existing sewers, the Contractor shall take every precaution necessary to prevent dirt or debris from entering the existing lines.

Bedding shall be placed under and on both sides of the pipe as each length of sewer pipe is installed.

3-2 Joining Pipe:

Use method of joining conduit sections that ensures that ends are fully entered and inner surfaces are flush and even. The equipment used to force the joints together must be adequate enough to overcome the gasket pressure involved.

Just prior to joining the pipes, the ends of the pipe shall be thoroughly cleaned with a wire brush to remove all foreign substances which may have adhered to the pipe surface. All dust and dirt shall be removed with a clean rag. A lubricating solution that is not injurious to the gasket or concrete, such as flax soap or water glass, shall be liberally applied to the gasket groove and to the entire surface of the bell ring. Following this operation, a thin film of lubricant

shall be applied to the gasket which shall then be snapped into place in the groove, after which a small diameter smooth steel rod shall be inserted between the gasket and groove and run completely around the gasket to equalize the gasket tension.

In the event that any foreign matter becomes imbedded in the lubricant, or the lubricant becomes contaminated by water or other substances before the joint is started, the area affected shall be re-cleaned and new lubricant shall be applied.

The pipe being jointed shall be carefully moved into position, line and grade checked, and, as the spigot end is started into the bell of the section previously laid the gasket position shall be checked to ensure uniform entry in to the bell at all points.

3-3 Testing and Flushing Pipe:

Prior to acceptance of each section of storm sewer line, the Contractor shall jet clean all sewers up through 18 inches in diameter. Larger storm sewers shall be cleaned by other appropriate methods approved by the City. All dirt and debris shall be prevented from entering the existing storm sewer system by means of watertight plugs or other suitable methods.

When the City cleans the mains by rodding, jetting, or both, the City shall assess the Contractor for the cleaning at a set per foot charge with a minimum dollar amount.

The City will televise all mains, and the City will bill the Contractor for the televising at a set per foot charge with a minimum dollar amount. Any defects found during the televising will be repaired, in a manner approved by the City.

Any visible infiltration, which the City's authorized representative considers to be the result of poor installation of the specified materials, shall be repaired in a manner approved by the City before the work will be accepted.

Before acceptance of the work, the City's authorized representative will survey the manhole invert and surface elevations. Any inverts of surface elevations not meeting the design plans shall not be approved and shall be redone to the satisfaction of the City.

Upon completion of the contract, the City will carefully inspect all sewers and appurtenances. Any unsatisfactory work shall be removed and replaced in a proper manner. The invert of sewer and manholes shall be left smooth, clean, and free from any obstructions throughout the entire line. Manhole rings and covers must be raised to finished grade before the acceptance of the sewer.

END OF SECTION

SECTION 02616

PVC SEWER PIPE

PART 1: GENERAL

1-1 Description:

The work of this section consists of providing and installing buried PVC sewer pipe and appurtenances.

1-2 Reference Standards:

References, American Society for Testing and Materials (ASTM).

1-3 Submittals:

In accordance with Section 01300, submit certificates of compliance and manufacturer's installation instruction or guides, and literature.

1-4 Product Handling:

Handle pipe and fittings to insure delivery in a sound, undamaged condition. Do not store materials on the ground. Use covers to protect materials from direct sunlight.

PART 2: MATERIALS

2-1 Polyvinyl Chloride Pipe:

The 4 to 15-inch diameter pipe shall be type PSM polyvinyl chloride pipe (PVC) and shall be suitable for gravity sewer service. The pipe material shall be PVC plastic having a cell classification of 12454-B or 12454-C or 13364-B (with a minimum tensile modulus of 500,000 psi) as defined ASTM D1784. All PVC pipe and fittings shall meet or exceed all of the material requirements of ASTM D3034 and thickness requirements of SDR 35.

Provisions must be made for contraction and expansion at each joint with a rubber ring and integral thickened bell as part of each joint. Gaskets shall conform to ASTM F477. Pipe shall be supplied in laying lengths of 13 feet. All pipe and fittings shall be assembled with a non-toxic lubricant. Each length of pipe and all fittings shall have marked on the exterior the following:

- Manufacturer's Name or Trademark
- Nominal Pipe Size
- PVC Cell Classification (e.f. 12454-B)
- Legend - Type PSM SDR-35 Sewer Pipe
- ASTM - D3034

All fittings and plugs to be used with the PVC pipe shall be those manufactured by the manufacturer of the pipe. Each special fitting shall be a completely manufactured unit with either bells or spigots on each connection that are an exact duplication of the bells and spigots on the pipeline. Fittings with any other type of connections will not be accepted.

2-2 Plugs:

Plugs shall be specifically manufactured for the pipelines in which they are to be installed. The plug shall be constructed of a material approved by the Project Manager and shall provide a permanent water-tight installation without permanently sealing the joint.

2-3 Couplings:

Couplings on main line installations shall be used only where shown on the drawings or where approved in writing by the Project Manager. The Contractor shall provide a description of an exact location of any couplings used.

Couplings shall consist of a rubber gasket or boot and a stainless steel tightening band. The coupling shall conform to requirements of ASTM C425 and shall be "Mission" ARC or approved equal. Adapters manufactured by Onset Pipe Products, Inc. may be substituted as approved by the Project Manager.

2-4 Grout:

Grout shall be a non-shrink type with aluminum filings; grouts with iron filings are not acceptable. Grout shall be "Five Star Grout," "Embeco Grout" or equal. The Contractor may substitute a 2-component, 100% solids epoxy resin (Sikadur Hi-Mod LV) for the specified grout.

Grout used for sealing service connections shall be a 2-component, waterproof epoxy grout specifically manufactured for this application. The grout shall adhere to any of the dissimilar materials.

2-5 Sealants:

Sealants used on manholes or pipe connections shall be equal to SIKAFLEX-la, a one component polyurethane base, elastomeric sealant. When required due to moisture or immersion, provide SIKAFLEX 429 primer for application onto the substrate according to manufacturer's recommendation.

PART 3: EXECUTION

3-1 Site Conditions:

Do not lay pipe when trenches or weather conditions are unsuitable for such work.

3-2 General Installation Requirements:

Each pipe length and fitting interior, interior surface of bells, and exterior surface of spigots shall be cleaned of all foreign material before placing it in the trench and shall be kept clean all times thereafter. Each item must also be examined for cracks and other defects before installation.

Pipe shall be cut, only whenever necessary, to conform to location of manholes or connections. All cuts shall be straight, true, and at right angles to the axis of the pipe unless otherwise noted or directed by the Project Manager. The cutting process shall leave a smooth end without damaging the pipe. All burrs shall be removed from the ends of cut pipe, and the end lightly rasped or filed. All tools used in cutting pipe shall be subject to the Project Manager's approval.

Pipe laying shall proceed with the spigot ends of pipe pointing in the direction of the flow, unless otherwise approved by the Project Manager. Each pipe length shall be laid true to line and grade in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets to the flow line. Pipe shall be laid in an unwatered trench and shall not be used for draining water from the trench.

Whenever the pipe is left unattended or pipe laying is not in progress, temporary plugs shall be installed at all openings. Temporary pugs shall be watertight and of such design as to prevent debris and animals from entering the pipe. All temporary plugs shall be subject to approval of the Project Manager.

The Contractor shall install the materials in accordance with the manufacturer's recommendations. If there is a conflict between the Contract Documents and the manufacturer's instructions, the Contractor shall obtain resolution from the Project Manager before proceeding with the work.

3-3 Installation of PVC Plastic Pipe:

- A. Pipe Laying. No deflection in the joints shall be allowed. All pipe shall be fully supported by the full length of pipe barrel without support by the bell mounding.

When curved sewers are indicated on the drawings, the alignment curve shall be accomplished by installing the pipes on uniform curves by deflecting the pipe barrel. The minimum curves are shown below:

<u>Pipe Diameter</u> <u>Inches</u>	<u>Minimum Radius</u> <u>Feet</u>	<u>Offset 20' length</u> <u>Inches</u>
4	150	16
6	200	12
8	250	10
10	300	8
12	350	7
15	400	6
18	450	5
24	500	4
27	550	4
30	600	3
33	650	3
36	700	2

- B. Joining the Pipe. The outside of the spigot and the inside of the bell shall be thoroughly wiped clean. Set the rubber ring in the bell with the marked edge facing toward the end of the bell. Lubricate the spigot end using a thin film of the manufacturer-supplied lubricant. Push the pipe spigot into the bell. Position the completed joint so that the mark on the pipe end is in line with the end of the bell.

Bevel the end of the pipe with a beveling tool after the pipe is field cut. Place a clearly visible position mark at the correct distance from the end of the field-cut pipe.

- C. Pipe Bedding. Installation of the pipe bedding shall be done in conformance to Section 02200.
- D. Tracer Wire. Tracer wire shall be attached directly to the pipe, from the main line to the structure's foundation, in order to permit surface detection of the service line after backfilling. The wire shall be AWG size #10, Type

UF or use cable, UL Listed, with single copper conductor. One end of the wire is to be inserted inside the upper part of a cleanout installed on the service line just outside the structure's foundation wall.

3-4 Connection of PVC to Concrete Manhole Base:

The PVC pipe shall be encased in the concrete for the manhole base as detailed on the Drawings and special provisions shall be made for water-tightness of the connection.

The exterior circumference of the PVC pipe where encased in concrete for water-tightness shall be uniformly roughened or scarified by sanding with coarse sandpaper or emery cloth for a minimum of 6-inches encased length.

Additionally, gasket as specified elsewhere shall be stretched onto the PVC pipe to form a weep ring where encased in concrete. Any alteration to the above specified methods for PVC pipe connection to concrete shall be submitted to the Project Manager for approval.

3-5 Grouting:

Any opening between manhole wall and pipe made by the Contractor, or designated elsewhere, shall be closed watertight with grout. The opening shall be of sufficient size to accommodate the pipe, "O" rings, and grout. Channels that have been cut into concrete bases shall be smoothed to the specified contour with grout. The grout shall extend no less than the full width of the manhole barrel.

3-6 Temporary Plugs:

Where required on drawings and at the end of each sewer service, the pipe shall be sealed with a removable plug. Plugs shall be specifically manufactured for the pipelines in which they are to be installed. The plug shall be constructed of a material approved by the Project Manager and shall provide a permanent watertight installation without permanently sealing the joint.

3-7 Sewer Service Pipelines:

Sewer service pipelines are to be installed in accordance with the details set forth on the Drawings and with appropriate installation requirements of this Specification.

The general location of the service lines is shown on the Drawings. Actual locations of these pipelines are to be determined in the field by the Project

Manager prior to main pipeline construction. It shall be the Contractor's responsibility to notify the Project Manager prior to constructing each main pipeline so that the Project Manager may have adequate time to determine the final location of each service tee or wye fitting to be installed in the main pipeline.

Failure of the Contractor to properly notify the Project Manager as noted above will result in the Contractor's removal of any portion of the main pipeline which is necessary to install the fittings in their proper location as determined by the Project Manager.

The Contractor will be allowed to tap and install a service saddle to new sewer pipelines only at those locations approved in writing by the Project Manager. Connections onto PVC pipelines shall be made only by boring or drilling with equipment designed for this purpose. Connections shall not be made by impact equipment. The Contractor shall request, in writing, Project Manager approval of methods and equipment he proposes to use for connections.

The Contractor shall remove from the pipeline all debris created by making connections before the service line is connected.

Service line saddle connections shall be attached to the main line with an epoxy bonding agent. The bonding agent shall be applied to a clean, dry surface. The connection shall remain dry until the bonding material has set, depending upon environmental conditions. Backfill around the connection shall not be attempted until the material has hardened and been accepted by the Project Manager.

At the end of all sewer services, the Contractor shall provide plugs and furnish and set 2 marker posts. One marker post shall be buried a minimum of 3 feet and shall extend a minimum of 2 feet above the ground surface and shall have a piece of green flagging at the top or be painted green. The second marker shall extend from the end of the service to 18" below the existing surface. The marker posts shall be wood 2 x 4's, 4 x 4's or #4 rebar.

3-8 Backfill and Restoration of Surface Conditions:

Backfill and restoration of surface conditions shall be as specified in Section 02200.

3-9 Testing:

Testing shall be as specified in Section 02701.

END OF SECTION

02616-6

SECTION 02619

BURIED POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

PART 1: GENERAL

1-1 Description:

The work of this section consists of providing and installing buried polyvinyl chloride (PVC) pressure pipe and fittings.

1-2 Reference Standards:

American Society for Testing and Materials (ASTM)
American National Standards Institute (ANSI),
American Water Works Association (AWWA),
Federal Specifications (FS),
National Sanitation Foundation (NSF)

1-3 Submittals:

In accordance with Section 01300 submit certificates of compliance and manufacturer's literature.

1-4 Product Handling:

Handle pipe carefully to ensure delivery in a sound, undamaged condition. Inspect pipe for cracks, dents, abrasions or other flaws. Project Manager will reject damaged pipe on site. Contractor shall replace damaged pipe at no additional expense to the City. Do not store materials directly on ground.

PART 2: MATERIALS

2-1 Buried Polyvinyl Chloride Pipeline:

Unless revised on the Drawings the polyvinyl chloride (PVC) pipe shall be similar and equal to Class 200, and shall conform to AWWA C900, "Polyvinyl Chloride (PVC) Pressure Pipe, 4-inch through 12-inch, for Water" or similar and equal to Class 200 and conform to AWWA C905, "Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 in. Through 36 in.". All Class 200 pipe shall meet the dimension requirements of DR14 for 12-in. pipe and smaller and DR 18 for 14-in. pipe and larger and shall have an equivalent cast-iron pipe outside diameter.

Unless otherwise specified the pipe joint shall be the "push-on" type, made from clean, virgin, NSF Approved Class 12454-A or 12454-B PVC conforming to

requirements of ASTM D1784 (latest revision).

Provisions must be made for contraction and expansion at each joint with a rubber ring and integral thickened bell as part of each joint. Pipe shall be supplied in laying lengths of 20 feet. All pipe and fittings shall be assembled with a non-toxic lubricant. Each length of pipe shall have marked on the exterior the following:

- Nominal size and OD base
- Material Code Designation
- Dimension Ratio number "DR 14" or "DR 18"
- AWWA Pressure Class "PC 200"
- AWWA Designation, AWWA C900 or C905
- Name or Trademark of Manufacturer
- National Sanitation Foundation Seal for Potable Water

The fittings shall be ductile-iron or cast-iron conforming to the requirements set forth in ANSI A21.10, AWWA C110 or ANSI 21.53, AWWA C153. Cast-iron fittings 12-inch size and smaller shall be Class 250, and fittings larger than 12 inches shall be Class 150. The interior of the fittings shall be cement-mortar lined, as is required for the pipe with a 1 mil bituminous exterior coating. The fittings shall have mechanical joints in accordance with ANSI A21.11. The gaskets for the joints shall be suitable for potable water service.

2-2 Polyethylene Encasement:

All pipeline fittings and appurtenances shall be encased in polyethylene film in accordance with the requirements of ANSI A21.5, AWWA C105.

2-3 Thrust Restraint:

Where designated on the Drawings or where existing conditions do not permit the use of concrete thrust blocks, fitting restraints shall be made with tie rods and pipe clamps or special fitting bolts. Tie rod restraint systems shall have a minimum of 2 bolts or rods per joint or clamp. Minimum tie bolt/rod sizes are as follows:

<u>Pipe Size</u>	<u>Bolt Diameter</u>
4"-8"	5/8"
10"-14"	3/4"
16"	1"
18"-20"	1-1/4"
24"	1-1/2"

All materials shall be fabricated from "Cor-Ten" steel or equal according to the requirements of ASTM A-242 with a minimum yield stress of 46,000 psi.

2-4 Water Services:

Water services shall be installed as indicated on the Drawings (see Section 02620). Each corporation stop shall be inserted in a double-strap bronze service saddle, similar and equal to "Rockwell" No. 323 or brass service saddle similar and equal to "Ford" No. S90. The general locations of the service lines are shown on the Drawings.

PART 3: EXECUTION

3-1 General:

Sizes as shown. Lay to the grades and lines shown in accordance with pipe manufacturer's specifications. Rest each section upon the pipe bed for full length of the barrel with recesses excavated to accommodate joints. Take up and re-lay any length that has had its line, grade, or joint disturbed after laying. Thoroughly clean pipe interiors of foreign matter before lowering into trench. Replace with new pipe any section of pipe found damaged or defective.

3-2 Installation of PVC Pipelines:

Except as specified herein or unless specifically authorized by the Project Manager, all pipe shall be laid as follows:

- A. Pipe Laying. Pipe shall be laid with bell ends facing in the direction of laying. No deflection in the joints shall be allowed. Whenever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or to plumb valve operators, the pipe itself may be uniformly curved as shown in the table below.

<u>Approximate Pipe Size</u>	<u>Offset in 20-Foot Length</u>	<u>Radius of Curve</u>
4"	15"	120'
6"	15"	160'
8"	15"	250'
10"	15"	300'
12"	15"	400'

Pipe deflection for curvature shall not be permitted at temperatures less than 32°F ambient temperature.

When pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Project Manager.

The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. The flame cutting of pipe by means of an oxyacetylene torch will not be allowed. Bevel the end of the pipe with a beveling tool after the pipe is field cut. Place a clearly visible position mark at the correct distance from the end of the field cut pipe.

Tracer wire shall be attached to the pipe as shown in the Drawings.

- B. Jointing of Mechanical Joints. The outside of the spigot and the inside of the bell shall be wiped thoroughly clean. Set the rubber ring in the bell with the marked edge facing toward the end of the bell. Lubricate the spigot end using a thin film of the manufacturer-supplied lubricant. Push the pipe spigot into the bell manually, with blocking and bar, or with special jacks. Position the completed joint so that the mark on the pipe end is in line with the end of the bell. Pipe joint shall not be assembled using power or trenching equipment.

3-3 Installation of Thrust Restraint:

The movement of fittings shall be restrained by use of concrete thrust blocks or steel clamp and tie bolt assemblies as indicated on the drawings. The thrust blocks shall be poured between undisturbed solid ground and the fitting to be anchored; the area of bearing on the undisturbed trench wall shall be that shown on the thrust block detail or directed by the Project Manager. The concrete shall be placed so that the pipe or fitting joints will be accessible for repair. Thrust blocks or other thrust restraint where thrust blocks cannot be used shall be required at all the fittings unless otherwise shown on the Drawings. A bond breaker shall be placed over the fitting before placing concrete.

Thrust restraint clamps and tie bolts shall be assembled using clamps on each side of pipe bells with tie rods extending full pipe length for the dimensions shown on the detail drawings each direction from the restrained fitting. Clamps shall be installed tight enough to prevent twisting around the pipe. Two tie bolts per clamp with washer at clamp shall be located on side of pipe. Tighten tie bolt nut to "hand tight" with 12-inch wrench (approximately 50-100 foot-pounds torque). Threaded tie rods shall extend two full threads past nut in final position.

3-4 Installation of Tracer Cable:

Tracer cable shall be laid directly above or alongside the pipe in the trench. The cable shall be 10 gauge, single conductor, solid, copper, rated for 600 volts and

suitably insulated for direct bury. The cable shall be thermally, cad welded to a connecting metallic pipe or extended and attached to an above grade flange bolt of a fire hydrant. No splices are allowed during the initial installation of the tracer cable. If the tracer wire is inadvertently broken, then the splice shall be made using a lug type connection.

3-4 Testing:

Testing of PVC pressure pipe shall be as specified in Section 02601.

3-5 Backfill and Restoration of Surface Conditions:

Backfill and restoration of surface conditions shall be as specified in Section 02200.

3-6 Disinfection of Potable Pipelines:

PVC pressure pipe shall be disinfected as specified Section 02675.

END OF SECTION

SECTION 02701

TESTING OF SEWER PIPELINES AND MANHOLES

PART 1: GENERAL

1-1 Description:

The work of this section consists of testing gravity sewer pipelines and manholes. The Contractor shall be responsible for all costs associated with, and the scheduling of, all required air testing and deflection testing. All costs and scheduling of required television inspections and vacuum testing shall be the responsibility of the Owner.

PART 2: MATERIALS

2-1 General:

The Contractor shall provide all labor, equipment, supplies and material specifically designed for air testing and deflection testing of sewers.

PART 3: EXECUTION

3-1 Notification and Witness:

The Contractor shall notify the Project Manager of all tests at least 48 hours prior to testing so that the Project Manager can witness the tests.

The Contractor shall submit records of all test results performed clearly identifying location, pipe characteristics, observations, procedures and results data.

The pipe may be tested for leakage at any convenient time after the trench has been partially backfilled, except at the joints, or backfilled as permitted by the Project Manager. Where any section is provided with concrete thrust blocks, the pressure test shall not be made until at least two days have elapsed after the concrete was installed.

3-2 Testing Procedures:

- A. General. The Contractor shall flush the pipelines, as the work progresses, by means that are in accordance with good practice, to insure that earth, sand, rocks, or other foreign materials are removed from the interior of the pipeline. Care shall be taken to insure that foreign material is not

transported downstream into the existing system.

- B. Alignment and Grade. Sewer pipelines will be checked by the Project Manager to determine whether any displacement of the pipe has occurred after the trench has been bedded to an elevation 6-inches above the pipe and tamped as specified. The test will be as follows:

A light will be flashed between manholes, or if the manholes have not as yet been constructed, between the locations of the manholes, by means of a flashlight or by reflecting sunlight with a mirror. If the illuminated interior of the pipeline shows poor alignment, displaced pipe, earth, or other debris in the pipe, or any other kinds of defects, the defects determined by the Project Manager shall be remedied by the Contractor at his own expense. Test will be repeated after completion of backfilling and any poor alignment, displaced pipe, or other defects determined by the Project Manager shall be corrected by the Contractor at his own expense.

For sewers on curved alignment, between manholes, or location of manholes if not constructed, after the pipe has been laid and the backfill has been placed above the pipe, a heavy rubber ball shall be passed through the pipe. The outside diameter of the ball shall be the same as the inside diameter of the sewer pipe. The ball shall be placed at the upper manhole of the sewer to be cleaned. A head of water shall be placed against the ball to force the ball through the sewer and debris flushed from the line shall be collected at the lower manhole, or its location. The ball shall be secured by a line to control the rate at which the ball is allowed to pass through the sewer.

- C. Air Tests.

1. Pipe Sections. Air testing of sewer pipes shall be done on all sections of pipe between manholes. The pipe shall be cleaned and may be wetted before air testing. The section of pipeline being tested shall be plugged at each manhole with pneumatic balls.

Low-pressure air shall be introduced into the plugged line until an internal pressure of 4 psig greater than the average back pressure of any ground water pressure that may submerge the pipe. At least two minutes shall pass to allow air temperature to stabilize before the test time is started.

No pipeline installation will be accepted if the pressure drops 0.5 psig or more during the time and for the length of pipe indicated below:

(1)	(2)	(3)	(4)
Pipe Diameter (in.)	Minimum Time for Lengths of Pipe Equal to or less than Col. 3 (min:sec)	Maximum Length of Pipe for Minimum Time in Column 2 (ft.)	Minimum Time for Lengths Greater Than Column 3, L=Length of Pipe (sec.)
4	1:53	597	0.190L
6	2:50	398	0.427L
8	3:47	298	0.760L
10	4:43	239	1.187L
12	5:40	199	1.709L
15	7:05	159	2.671L
18	8:50	133	3.847L
21	9:55	114	5.235L
24	11:20	99	6.837L
27	12:45	88	8.653L
30	14:10	80	10.683L
33	15:40	72	12.926L
36	17:00	66	15.384L

If the pipeline installation fails the air test, repairs shall be made and the pipe shall be retested until it passes the air test.

2. Pipe Joint Testing. Sewer line joint testing shall be performed before and after any joint sealing operation by applying a positive air pressure to each sewer joint and monitoring the pressure in the void. The intent of joint testing is to identify defective joints prior to any joint sealing process and determine the effectiveness of the joint seal.

The joint testing equipment used shall consist of a television camera, joint testing device (such as a packer), and test monitoring equipment. The equipment shall be constructed in such a way as to provide means for introducing air, under pressure, into the void area created by the expanded ends of the joint-testing device and a means for continuously measuring the actual static pressure of the air within the void areas only.

Void pressure data shall be transmitted electrically from the void to the monitoring equipment. All test monitoring shall be aboveground and in a location to allow for simultaneous and continuous observation of the television monitor and test monitoring equipment by the Contractor.

Prior to starting the pipe joint testing phase of the work, a two-part control test shall be performed as follows:

- a. To ensure the accuracy, integrity, and performance capabilities of the testing equipment, a demonstration test will be performed aboveground in a test cylinder constructed in such a manner that a minimum of two known leak sizes can be simulated. This technique will establish the test equipment performance capability in relationship to the test criteria and ensure that there is no leakage of the test medium from the system or other equipment defects that could affect the joint testing results.

If this test cannot be performed successfully, the Contractor shall be instructed to repair or otherwise modify his equipment and re-perform the test until the results are satisfactory to the Owner. This test may be required at any other time during the joint testing work if the Owner suspects the testing equipment is not functioning properly.

- b. After entering each manhole section with the test equipment, but prior to the commencement of joint testing, the test equipment shall be positioned on a section of sound sewer pipe between pipe joints, and a test performed as specified. This procedure will demonstrate the reality of the test requirement, as no joint will test in excess of the pipe capability. Should it be found that the barrel of the sewer pipe will not meet the joint test requirements (void pressure cannot be held for 60 seconds), the requirements will be modified as necessary.

Each sewer line joint which is not visibly leaking shall be individually air tested at a test pressure equal to 0.5 psi per vertical foot of pipe depth (not exceeding a pressure of 10 psi, but no less than a pressure of 3 psi) and in accordance with the following procedure:

- a. The packer or testing device shall be positioned within the line in such a manner as to straddle the joint to be tested.
- b. The packer or testing device and elements (sleeves) shall be expanded so as to isolate the joint from the remainder of the line and create a void area between the packer or testing

device and the pipe joint. The ends of the testing device shall be expanded against the pipe with sufficient inflation pressure to contain the air within the void without leaking past the expanded ends.

- c. Air shall then be introduced into the void area until a pressure equal to or greater than the required test pressure is observed by the void pressure monitoring equipment. If the required test pressure cannot be developed (due to joint leakage), the joint will have failed the test.
- d. After the void pressure is observed to be equal to or greater than the required test pressure, the air flow shall be stopped. If the void pressure drops by more than 2 psi within 15 seconds (due to joint leakage), the joint will have failed the test.

During the joint testing work, complete records shall be kept which include:

- a. Identification of the manhole-to-manhole section tested;
- b. The test pressure used;
- c. Location (footage) of each joint tested; and
- d. A statement indicating the test results for each joint tested.

Any alternate form of air testing by the Contractor must be approved in writing in advance by the Project Manager.

- D. Deflection. All PVC sewer pipelines shall be tested for vertical deflection after placement and compaction of backfill. The maximum deflection allowed is 5%.

Method of testing shall be by deflectometer of the rigid GO/NO-GO type device. Any and all pipe with vertical deflection greater than the allowable shall be excavated, and removed from the pipeline, replaced, backfilled and compacted as specified, and retested at the Contractor's expense.

- E. Television. All PVC sewer lines shall be televised by the Owner. Any defects found during televising shall be repaired by the Contractor at the Contractor's expense.

3-3 Gravity Sewer Manholes:

- A. General. During the construction of the manholes, the Contractor shall, in accordance with good practice, insure that no earth, sand, rocks or other foreign material exists on the joint surfaces during assembly of the sections. The Project Manager shall check each manhole to determine whether the manhole fulfills the requirements of the Drawings and Specifications.

The Project Manager shall visually check each manhole, both exterior and interior, for flaws, cracks, holes, or other inadequacies which might affect the operation or water-tight integrity of the manhole. Should any inadequacies be found, the Contractor, at his own expense, shall make any repairs deemed necessary by the Project Manager.

- B. Vacuum Testing. It is estimated that every other manhole will be vacuum tested. If deficiencies with new manhole construction are observed, additional manholes may be tested for quality control. When required by the project manager, manholes shall be vacuum tested with the following procedure:

1. Each manhole shall be tested immediately after assembly and prior to backfilling.
2. All lift holes shall be plugged with an approved non-shrink grout.
3. No grout will be placed in the horizontal joints before testing.
4. All pipes entering the manhole shall be plugged, taking care to securely brace the plugs from being drawn into the manhole.
5. The test head shall be placed at the inside of the top of the cone section and the seal inflated in accordance with the manufacturer's recommendation.
6. A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum drop to 9 inches. The manhole shall pass if the time is greater than 60 seconds for a 48" diameter manhole, 75 seconds for a 60", and 90 seconds for a 72".
7. If the manhole fails the initial test, necessary repairs shall be made by the Contractor, at the Contractor's expense, with a non-shrink grout while the vacuum is still being drawn. Retesting shall

proceed until a satisfactory test is obtained.

END OF SECTION

02701-7

SECTION 03201
CONCRETE REINFORCEMENT

PART 1: GENERAL

1-1 Description:

This section covers furnishing and installing steel bars and welded wire reinforcement for concrete reinforcement.

1-2 Reference Standards:

- A. American Concrete Institute Standards (ACI):
 - 1. ACI 301 Specifications for Structural Concrete.
 - 2. ACI 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures.
 - 3. ACI 318 Building Code Requirements for Reinforced Concrete.
 - 4. ACI 117 - Standard Tolerance for Concrete Construction and Materials

- B. American Society for Testing and Materials
 - 1. ASTM A 615, A 616 including supplementary requirement S1, A 617, A 706
 - 2. ASTM A 767, Zinc-coated (galvanized) reinforcing bars
 - 3. ASTM A 775, Epoxy-coated reinforcing bars

- C. Concrete Reinforcing Steel Institute (CRSI)
 - 1. Manual of Standard Practice
 - 2. Placing Reinforcing Bars

- D. American Welding Society (AWS). AWS D1.4 - Structural Welding Code - Reinforcing Steel

1-3 Submittals:

Before fabrication of reinforcing steel, the Contractor shall review and approve Shop Drawings, bar lists, fabrication and setting drawings and shall submit same to the Project Manager for review. All sizes, quantity and dimensions for fabrication and placing of reinforcing bars and bar supports shall be shown on the Shop Drawings. The bar schedules, stirrup spacing, and diagrams of bent bars shall be indicated on the drawings.

Mill test certificates identifying chemical and physical analysis of each load of reinforcing steel delivered shall be submitted to the Project Manager.

Submittals shall also include manufacturer's specifications and installation instructions for splice devices when these devices are called for on the Drawings.

1-4 Quality Assurance:

Allowable Tolerances:

A. Fabrication Tolerances:

1. Sheared length: ± 1 inch
2. Depth of truss: +0, $-\frac{1}{4}$ inch for concrete thickness 24 inches or less and +0, $-\frac{1}{2}$ inch for concrete thickness over 24 inches.
3. Overall dimensions of stirrups, ties and spirals: +0, $-\frac{1}{4}$ inch for concrete thickness 24 inches or less and +0, $-\frac{1}{2}$ inch for concrete thickness over 24 inches.
4. All other bends ± 1 inch.

Do not weld reinforcement except where indicated on the Drawings for welded splices. Tack welding of reinforcement is not permitted, except where specified by the Engineer.

1-5 Product Delivery, Storage and Handling:

All material shall be delivered to site in bundles marked with metal tags indicating bar size and length. The material shall be carefully handled and stored on supports which will keep the steel from coming in contact with the ground or standing water.

PART 2: MATERIALS

2-1 Reinforcement Bars:

- A. Deformed Bars. Steel reinforcement shall be new, deformed billet steel, meeting ASTM A 615; Grade 60 for rebars 4 and larger; Grade 40 for 3 bars and designated reinforcement.
- B. Spirals. Spirals, hot-rolled plain or deformed bars per ASTM A 615, Grade 60 or cold drawn wire per ASTM A 82 as specified in the Drawings. Spirals for columns shall have two (2) "spacers" with a section modulus > 0.00in³ in order to maintain the proper pitch and spacing.
- C. Epoxy-Coated Reinforcing Bars. Epoxy-coated reinforcing bars shall conform to ASTM A 775. When required, damaged epoxy coating shall be repaired with patching material conforming to ASTM A 775 in accordance with the material manufacturer's recommendations.
- D. Zinc-coated (Galvanized Reinforcing Bars). Zinc-coated reinforcing bars shall conform to ASTM A 767. When required, damaged zinc coating shall be repaired with a zinc-rich formulation conforming to ASTM A 767.

Tie wire shall be annealed steel, Fed. Spec. QQ-W-461, 16 gauge minimum. When epoxy coated reinforcing steel is shown in the Drawings, PVC coated wire ties shall be used. The minimum PVC coating is 0.7 mils.

Splice devices shall be Thermite welding process and only when called for on the Drawings.

Fabrication shall be in accordance with CRSI Manual of Standard Practice except for the allowable tolerances specified herein in Part1-2A.2.

2-2 Bar Supports:

- A. General. Bar supports shall conform to "Bar Support Specifications," CRSI Manual of Standard Practice. The portions of the supports or accessories within ½ inch of the concrete surface shall be noncorrosive or protected against corrosion (plastic covered).
- B. Floor Slabs. Uncoated steel or non-metallic composite chairs shall be used unless otherwise shown in the Drawings. If required by Engineer, the chair shall be stapled on a bearing pad to prevent chair displacement. The bearing pad shall be made of exterior grade plywood and be

approximately five (5) inches square.

- C. Columns. Plastic "space wheels" manufactured by Aztec (Model DO 12/40), or equal, are required.
- D. Epoxy-Coated and Zinc-Coated Bar Supports. Epoxy-coated reinforcing bars supported from formwork shall rest on coated wire bar supports made of dielectric or other acceptable materials. Wire supports shall be fully coated with dielectric material, compatible with concrete. Reinforcing bars used as support bars shall be epoxy-coated. In walls reinforced with epoxy-coated bars, spreader bars shall be epoxy coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing shall be made of corrosion-resistant material or coated with dielectric material.

2-3 Welded Wire Reinforcement:

Welded Wire Reinforcement shall be electrically welded wire reinforcement of cold-drawn wire (70,000 psi yield point) of gauge and mesh size shown on the drawings, and shall conform to "Specification for Welded Steel Wire Reinforcement for Concrete Reinforcement" (ASTM A 185).

2-4 Identification:

Bundles of reinforcing bars and wire spirals shall be tagged, with a metal tag, showing specification, grade, size, quantity, and suitable identification to permit checking, sorting, and placing. When bar marks are used to identify reinforcing bars in the DRAWINGS, the bar mark shall be shown on the tag. Tags shall be removed prior to concrete placement.

Bundles of flat sheets and rolls of welded wire fabric shall be tagged similar to reinforcing bars.

2-5 Storage and Protection:

Reinforcing steel shall be stored off of the ground and protected from oil or other materials detrimental to the steel or bonding capability of the reinforcing bar. Epoxy-coated reinforcing bars shall be stored on protective cribbing.

Rust, seams, surface irregularities, or mill scale, shall not be cause for rejection provided that the weight and height of deformations of a hand-wire-brushed test specimen are not less than the applicable ASTM Specification.

When placed in the Work, the reinforcing bars shall be free from dirt, loose mill scale, paint, oil, loose rust, or other foreign substance.

PART 3: EXECUTION

3-1 Preparation:

All mud, oil, loose rust or mill scale or other foreign materials that may reduce the bond shall be removed. Rust or mill scale which is "tight" will be permissible without cleaning or brushing provided weights, dimensions, cross-sectional area, and tensile properties meet requirements of ASTM A 615.

3-2 Installation:

Bar placement shall conform to CRSI-WCRSI "Placing Reinforcing Steel". Reinforcement shall be supported and wired together to prevent displacement by construction loads or the placing of concrete.

The minimum number of bar supports, as required by ACI 315, should be provided. Do not use pebbles, pieces of broken stone, common or face brick, metal pipe or wood blocks to support reinforcement. On the ground, and where necessary, solid concrete blocks may be used to support the reinforcing steel in the slabs-on-grade. Maximum spacing of supports shall be 3'-0" o.c. each way. The blocks shall be made with the same cement content and w/c ratio as the surrounding concrete.

Staples used to attach bar supports to wall and roof forms shall have the staple "tails" clipped after form removal. For columns, three (3) wheels, spaced one hundred twenty degrees (120°) apart, shall be placed every four (4) feet of column height. Contractor may increase the column spiral pitch if a conflict occurs with the wheel. Pre-tied column reinforcing steel lowered into column forms shall be lowered vertically to prevent damage to the space wheels.

Bars shall be securely tied at fifty percent (50%) of all intersections except where spacing is less than one (1) foot in each direction, when alternate intersections shall be tied unless otherwise called out in the Drawings or in applicable specifications. Tying of steel by spot welding shall not be permitted unless specifically authorized by Engineer. The placing and securing of the reinforcement in any unit or section shall be accepted by Engineer before any concrete is placed in any such unit or section.

Bundle bars shall be tied together at not more than six-foot (6') centers.

The placement tolerances shall be as follows:

- Clear Distance to Formed Surface: See 3-2D Concrete Cover (1) and (2).
- Minimum Spacing Between Bars: $\frac{1}{4}$ inch
- Top Bars in Slabs and Beams: See 3-2D Concrete Cover (1) and (2).
- Spacing Crosswise of Members: spaced evenly within 2 inches.
- Lengthwise of Members: ± 2 inches.
- Maximum bar movement to avoid interference with other reinforcing steel, conduits or embedded items: one bar diameter.

If the reinforcement bars are moved more than one bar diameter, or enough to exceed the above tolerances, the resulting arrangement of bars may be rejected by the Engineer.

Except as otherwise indicated on the Drawings, provide the following minimum concrete cover for reinforcement:

A. Unformed surfaces adjacent to excavation:

Non-prestressed Concrete	3 inches
Prestressed Concrete	2 inches

B. Formed or top surfaces exposed to weather or saturated air, submerged or in contact with earth:

Non-prestressed Concrete	2 inches
Prestressed Concrete	1½ inches

C. Other locations:

Bars in beams or columns, including stirrups and ties	1½ inches
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Cover for reinforcing steel shall not be less than the minimum given above (no minus tolerance), and shall not exceed the minimum by more than $\frac{1}{4}$ inch where concrete thickness is 24 inches or less, or more than $\frac{1}{2}$ inch where the concrete thickness is more than 24 inches.

Any reinforcement adjustment shall be as stated under 3-2 C (6). All reinforcing bars shall be bent cold. Do not heat, bend or cut bars without Engineer's acceptance. Grade 60 bars shall not be bent after being partially embedded in hardened concrete. Bars shall not be bent or straightened in a manner that will injure the material.

Bar steel reinforcement shall be furnished in the full lengths indicated on the Drawings. Splicing of bars, except where shown on the Drawings, shall not be permitted without the written acceptance of Engineer. Splices shall be staggered. In cases where permission is granted to splice bars, other than those shown on the Drawings, the additional material required for the lap shall be furnished by Contractor at Contractor's own expense. The minimum distance between staggered splices for reinforcing bars shall be the length required for a lapped splice in the bar. All splices shall be full contact splices.

Splices shall not be permitted at points where the section is not sufficient to provide a minimum distance of two (2) inches between the splice and the nearest adjacent bar or the surface of the concrete.

Welding of reinforcement shall be done only if detailed on the Drawings or if authorized by Engineer in writing. Welding shall be done by a certified welder. The welding shall conform to AWS D 12.1, Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction, with the modifications and additions specified hereinafter. Where AWS D 2.0 Specifications for Welded Highway and Railway Bridges is referenced, the reference shall be construed to be for AWS D 1.1. Where the term AWS D1.1 is used it shall mean the American Welding Society Structural Welding Code, D 1.1 as modified and amended by the AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges. After completion of welding, coating damage to coated reinforcing steel bars shall be repaired.

When required or permitted, a mechanical connection may be used to splice reinforcing steel bars or as substitution for dowel bars. The mechanical connection shall be capable of developing a minimum of one hundred twenty five percent (125%) of the yield strength of the reinforcing bar in both tension and compression. All parts of mechanical connections used on coated bars, including steel splice sleeves, bolts, and nuts shall be coated with the same material used for repair of coating damage.

When coated reinforcing bars are cut in the field, the ends of the bars shall be coated with the same material used for repair of coating damage.

Welded wire reinforcement shall be installed in longest practicable length. Lap adjoining pieces $1\frac{1}{2}$ meshes plus end extension of wires, but not less than 12 inches in structural slabs. Do not make laps midway between, or directly over, support members of continuous structures. Offset laps in adjacent widths to prevent continuous laps. Extend welded wire reinforcement through contraction joints and construction joints unless otherwise indicated on the Drawings.

END OF SECTION

SECTION 03300

CAST IN PLACE CONCRETE

PART 1: GENERAL

1-1 Description:

This section covers all cast-in-place concrete, including reinforcing steel, forms, finishing, curing, expansion and contraction joint devices, and other appurtenant work. All concrete furnished hereunder shall be air-entraining.

1-2 Quality Standards:

- A. American Society for Testing Materials (ASTM)
 - 1. ASTM C 33 - Concrete Aggregates
 - 2. ASTM C 94 - Ready Mixed Concrete
 - 3. ASTM C 150 - Portland Cement
 - 4. ASTM C 260 - Air-entraining Admixtures for Concrete
 - 5. ASTM C 494 - Chemical Admixtures for Concrete
 - 6. ASTM C 618 - Fly Ash in Portland Cement Concrete
 - 7. ASTM C 979 - Pigments for Colored Concrete
 - 8. ANSI/ASTM D 994 - Preformed Expansion Joint Fillers
- B. American Concrete Institute (ACI)
 - 1. ACI 211 - Standard Practice for Selecting Proportions for Concrete
 - 2. ACI 212 - Guide for Use of Concrete Admixtures
 - 3. ACI 221 - Guide for Use of Normal Weight Aggregates
 - 4. ACI 301 - Structural Concrete for Buildings
 - 5. ACI 304 - Guide for Measuring, Mixing, Transporting and Placing Concrete

6. ACI 305 - Hot Weather Concreting
7. ACI 306 - Cold Weather Concreting
8. ACI 309 - Standard Practice for Consolidating Concrete
9. ACI 318 - Building Code Requirements for Structural Concrete
10. ACI 503 - Use of Epoxy Compounds
11. ACI 504 - Guide to Joint Sealants

1-3 Submittals:

Provide product data on the followings:

1. Ready Mixed Concrete Mix Designs
2. Fly Ash
3. Admixtures (such as air-entraining and water-reducing admixtures)
4. Form Release Agents
5. Bonding Agents
6. Grout

1-4 Quality Assurance:

- A. Acquire cement and aggregate from the same source for all work.
- B. Conform to ACI 305 for hot weather concrete placement.
- C. Conform to ACI 306 for cold weather concrete placement.
- D. Conform to ACI 309 for concrete consolidation.

1-5 Contractor Assistance:

Contractor shall assist Owner or the concrete testing consultant as requested during the performance of quality control testing. When concrete is placed using a concrete pumper, concrete for testing will be taken from the pumper discharge hose.

1-6 Delivery, Storage and Handling:

The ready-mixed concrete truck driver shall provide the batch ticket to Engineer at the time of concrete delivery. The ticket shall summarize the following information legibly in an easily discernible table:

- A. Weight in pounds of all materials, excepting the water reducing and air-entraining agents which shall be in ounces.
- B. Cubic yards batched.
- C. The ratio of water to cementitious (W/C) materials ratio.
- D. Temperature of the concrete at the time it was batched.
- E. Time of batching.
- F. Free moisture in the fine and coarse aggregates in percent of weight of aggregate.
- G. Gallons of water that may be added at the site without exceeding the permissible W/C ratio.
- H. Concrete Mix Design Number.

1-7 Related Sections:

- A. Section 03100 - Concrete Formwork
- B. Section 03151 - Hydrophilic Rubber Waterstop
- C. Section 03201 – Concrete Reinforcement
- D. Section 03320 - Construction Joints
- E. Section 03350 - Concrete Finishing
- F. Section 03390 - Concrete Curing
- G. Section 07900 - Sealants

PART 2: MATERIALS

2-1 Materials Incorporated into Work:

Cement:	ASTM C150, Type 1.
Fine Aggregate:	Clean natural sand, ASTM C33.
Coarse Aggregate:	Crushed rock, washed gravel, or other inert granular material conforming to ASTM C33.
Water:	Clean and free from deleterious substances.
Air-Entraining Agent:	ASTM C260
Reinforcing Steel:	
Bars:	ASTM A615, Grade 60.
Welded Wire Fabric:	ASTM A185 or A497.
Bar Supports:	CRSI Class C, plastic protected, or Class E, stainless steel protected.
Forms:	
Plywood:	PS1, waterproof, resin-bonded, exterior type, Douglas fir.
Lumber:	Straight, uniform width and thickness, and free from knots, offsets, holes, dents, and other surface defects.
Form Oil:	Light colored paraffin oil or other acceptable nonstaining material.
Polyethylene Film:	PS17; 6 mil.
Membrane Curing Compound:	Fed Spec TT-C-800, Type I, Class 1; min 18 percent solids; non-yellowing; unit moisture loss 0.039 gm/cm ² max; Gifford-Hill"

Sealco 800", ProSoCo "Kure and Seal", Protex "Acrychlor", or Sonneborn "Kure-N-Seal".

2-2 Preliminary Review:

The source and quality of concrete materials and the concrete proportions for the work shall be submitted to the Engineer before any concrete is placed.

2-3 Limiting Requirements:

Unless otherwise specified, concrete shall be controlled within the following limiting requirements.

- A. Minimum Cement Factors: The quantity of portland cement, expressed in pounds per cubic yard, shall be not less than that shown in the following table:

<u>Concrete Slump</u>	<u>Coarse Aggregate Size</u> <u>From No. 4 Sieve to</u>		
	<u>1/2"</u>	<u>3/4"</u>	<u>1"</u>
2 inches	639	602	573
3 inches	658	620	592
4 inches	677	639	611
5 inches	696	658	630
6 inches	714	677	649

- B. Aggregates: The maximum total combined aggregate weight and the maximum fine aggregate weight per hundred pounds of cement shall be as follows:

<u>Concrete Slump</u>	<u>Coarse Aggregate Size</u> <u>From No. 4 Sieve to</u>			<u>Maximum Fine Aggregate</u>
	<u>1/2"</u>	<u>3/4"</u>	<u>1"</u>	
2 inches	457	500	537	229
3 inches	436	479	511	218
4 inches	415	457	489	207
5 inches	394	436	468	202
6 inches	372	415	447	191

NOTE: The weights stipulated above are maximum and not authorized weights. Actual weights used shall be those necessary to produce concrete of the proper consistency.

- C. Total Water Content: Total water content of concrete shall not exceed 6.5 gallons of water per hundred pounds of cement in the mix.
- D. Slump: Concrete slump shall be kept as low as possible consistent with proper handling and thorough compaction. Concrete for blocking or encasement may be placed at a slump of up to 5 inches; slump for all other concrete shall not exceed 4 inches.
- E. Total Air Content: Unless otherwise shown in the Drawings, the amount of air entraining agent used in each concrete mix shall be such as will affect the entrainment of the percentage of air shown in the following tabulation in the concrete as discharged from the mixer or pumper discharge hose if applicable. This table is applicable for concrete strengths less than five thousand (5000) psi.

Table 1

Nominal Max. Aggregate Size, Inch	Average Air Content Percent	
	<u>Severe Exposure</u>	<u>Moderate Exposure</u>
$\frac{3}{8}$	$7 \frac{1}{2} \pm 1 \frac{1}{2}$	$6 \pm 1 \frac{1}{2}$
$\frac{3}{4}$	$6 \pm 1 \frac{1}{2}$	$5 \pm 1 \frac{1}{2}$
$1 \frac{1}{2}$	$5 \frac{1}{2} \pm 1 \frac{1}{2}$	$4 \frac{1}{2} \pm 1 \frac{1}{2}$

The level of exposure shall be determined by Engineer.

When a batch of concrete delivered to the Project does not conform to the minimum specified air content, an air-entraining admixture may be added, one (1) time only for the batch, at Contractor's option prior to consideration for rejection. After the mixture is added, the concrete shall be remixed for a minimum of twenty (20) revolutions of the mixer drum at mixing speed. The concrete shall then be retested and if found acceptable, may be placed in accordance with the Specifications.

- F. Water Reducing, Set-Controlling Admixture. Contractor shall use a "mid-range" water reducing, set controlling admixture, Polyheed 997, or equal. The water-reducing admixture shall be used in all concrete and shall conform to ASTM C 494, specifically Types A, B, C, D and E.
- G. Finely Divided Mineral Admixtures (Fly Ash). Mineral admixtures shall be limited to fly ash conforming to ASTM C 618, Class C or Class F. Class C fly ash is not permitted where sulfate resistant cement is required.

2-4 Storage of Materials:

Cement shall be stored in suitable moisture-proof enclosures. Cement which has become caked or lumpy shall not be used.

Aggregates shall be stored so that segregation and the inclusion of foreign materials are prevented. The bottom 6 inches of aggregate piles in contact with the ground shall not be used.

Reinforcing steel shall be carefully handled and shall be stored on supports which will keep the steel from contact with the ground.

PART 3: EXECUTION

3-1 Batching and Mixing:

Concrete shall be furnished by an acceptable ready-mixed concrete supplier and shall conform to ASTM C94.

- A. Consistency: The consistency of concrete shall be suitable for the placement conditions. Aggregates shall float uniformly throughout the mass and the concrete shall flow sluggishly when vibrated or spaded. The slump shall be kept uniform.
- B. Portland Cement. Either sacked or bulk cement may be used. No fraction of a sack of cement shall be used in a batch of concrete unless the cement is weighed. Bulk cement shall be weighed on scales separate and distinct from the aggregate hopper or hoppers. Batching shall be such that the accuracy of batching shall be plus or minus one percent of the required weight.
- C. Water. Unless water is to be weighed, the water-measuring equipment shall include an auxiliary tank from which the measuring tank shall be filled. In lieu of the volume method, Contractor shall be permitted to use a water-metering device.
- D. Aggregates. Aggregates shall be handled from stockpiles or other sources to the batching plant in such a manner as to secure a uniform grading of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used. Batching shall be so conducted as to result in the weights of material required for each type aggregate within a tolerance of two percent (2%).

Free water contents of the coarse and fine aggregates shall be continuously tested and concrete mixture adjusted for moisture conditions

of the aggregate in order to meet the designated water/cement ratio.

- E. Fine Aggregate. The proportion of fine aggregate shall be between thirty six and forty four percent (36 and 44%) by volume of the total aggregates in the concrete.
- F. Mixing. Ready-mixed concrete shall be either "central mixed" or "shrink mixed" concrete as defined in ASTM C 94. "Truck mixed" concrete as defined in ASTM C 94 shall not be permitted. Mixing time shall be measured from the time water is added to the mix, or cement contacts the aggregate. All concrete shall be homogeneous and thoroughly mixed, and there shall be no lumps or evidence of undispersed cement. Mixers and agitators, which have an accumulation of hard concrete or mortar, shall not be used. Ready-mixed concrete shall be mixed and transported in accordance with ASTM C 94.

The temperature of mixed concrete, immediately before placing shall not be less than fifty degrees Fahrenheit (50°F) or more than ninety degrees Fahrenheit (90°F). Aggregates and water shall be heated or cooled as necessary to produce concrete within these temperature limits. Neither aggregates nor mixing water shall be heated to exceed one hundred fifty degrees Fahrenheit (150°F).

The time elapsing from the time water is added to the mix (or the cement comes in contact with aggregate) until the concrete is deposited in place at the site of the WORK shall not exceed sixty (60) minutes when the concrete is hauled in non-agitating trucks, nor more than ninety (90) minutes when hauled in truck mixers or truck agitators.

The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first one-quarter ($\frac{1}{4}$) of the specified mixing time.

Cement shall be charged into the mixer by means that will not result in loss of cement due to the effect of wind, or in accumulation of cement on surfaces of hoppers or in other conditions which reduce or vary the required quantity of cement in the concrete mixture.

- G. Transporting Mixed Concrete – Mixed Concrete or Truck Mixers. Transporting of mixed concrete shall conform to ASTM C 94. Truck agitators shall be loaded not to exceed the manufacturer's guaranteed capacity. They shall maintain the mixed concrete in a thoroughly mixed and uniform mass during hauling.

No additional mixing water shall be incorporated into the concrete during hauling or after arrival at the delivery point, unless approved. If additional water is to be incorporated into the concrete at the site, the drum shall be revolved not less than thirty (30) revolutions at mixing speed after the water is added and before discharge is commenced. One (1) addition of water at the site to adjust mix workability is permitted but the maximum water cement ratio shall not be exceeded.

Contractor shall furnish a water-measuring device in good working condition, mounted on each transit mix truck, for measuring the water added to the mix on the site. All water tanks on transit mix trucks shall be filled prior to being batched and arrive at the construction site one hundred percent (100%) full.

Each load of ready mixed concrete delivered at the job shall be accompanied by the ticket referencing design mix and showing volume of concrete, the weight of cement in pounds, percent of free water in coarse and dry aggregates, and the total weight of all ingredients in pounds. The ticket shall also show the time of day at which the materials were batched and the reading of the revolution counter at the time the truck mixer is charged (see Paragraph 1.08).

- H. Compressive Strength. Concrete compressive strength requirements consist of a minimum strength that must be obtained before various loads of stresses are applied to the concrete and, for concrete designated by strength, a minimum strength at the age of twenty eight (28) days. Unless otherwise shown on the DRAWINGS, the twenty eight (28) day compressive strength of structural concrete shall be a minimum of forty five hundred (4,500) psi.

The mix shall be designed for required strengths in accordance with ACI 301. The ratio of water to the sum of concrete + pozzolan shall not exceed 0.41 by weight for durable, watertight, concrete. The amount of fly ash in the mix shall be between fifteen and twenty percent (15 and 20%) by weight of the total cementitious materials.

- I. Concrete Vibrators. Concrete vibrators for consolidating concrete shall be two and one-half inch (2½") diameter "high cycle" vibrators with a frequency under load of eight thousand (8,000) to ten thousand, four hundred (10,400) vibrations per minute (vpm). Concrete vibrators of lesser capacity are unacceptable for use in any part of the construction. CONTRACTOR shall have at least one standby concrete vibrator ready for use for every two (2) concrete vibrators in use during a concrete placement.

- J. Delivery Tickets: A delivery ticket shall be prepared for each load of ready-mixed concrete. A copy of each ticket shall be handed to the Project Manager by the truck operator at the time of delivery. Tickets shall show the quantity delivered, the amount of each material in the batch, the outdoor temperature in the shade, the time at which the cement was added, and the numerical sequence of the delivery.

3-2 Forms:

Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions indicated on the drawings. Forms shall be substantial and sufficiently tight to prevent leakage of mortar and shall be maintained in proper position and accurate alignment.

Forms for pavement, curbs, or gutters shall be made of steel and shall be supported on thoroughly compacted earth. The top face of pavement forms shall not vary from a true plane more than 1/4 inch in 10 feet.

Forms shall be thoroughly cleaned and oiled before concrete is placed.

Where concrete is placed against gravel or crushed rock which does not contain at least 25 percent material passing a No.4 sieve, such surfaces shall be covered with polyethylene film to protect the concrete from loss of water. Joints in the film shall be lapped at least 4 inches.

- A. Form Ties: Form ties shall be of the removable end, permanently embedded body type and shall have sufficient strength and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders.
- B. Edges and Corners: Chamfer strips shall be placed in forms to bevel all salient edges and corners except the top edges of walls and slabs which are to be tooled and edges which are to be buried. Unless otherwise noted, bevels shall be 3/4 inch wide.
- C. Form Removal: Forms shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all dead and live loads. Care shall be taken in form removal to avoid surface gouging, corner or edge breakage, and other damage to the concrete.

3-3 Reinforcement:

Reinforcements shall be accurately formed and positioned and shall be maintained in proper position while the concrete is being placed and compacted.

Unless otherwise indicated on the drawings, the details of fabrication shall conform to ACI 315 and 318. In case of conflict, ACI 318 shall govern.

3-4 Prior to Placement:

Prior to placing concrete Contractor shall remove all debris and thoroughly dampen the surfaces that will be in contact with the concrete to be placed.

Contractor shall use compressed air from an air-compressor to blow-out construction debris and dirt at the bottom of members to be placed such as walls, beams and columns, prior to final placement of forms that will obscure any joint. Contractor shall demonstrate to Engineer that all debris, such as concrete particles, saw dust, loose tie wire, bar tags, tape, trash and dirt, have been thoroughly removed.

No concrete shall be placed when form surfaces that will be in contact with the concrete, reinforcement, embedded items or sub-base is less than thirty-two degrees Fahrenheit (32°F). When the mean daily outdoor temperature is less than forty degrees Fahrenheit (40°F), the temperature of the concrete shall be maintained between fifty degrees Fahrenheit (50°F) and seventy degrees Fahrenheit (70°F) for the required curing period. When necessary, arrangements for heating, covering, insulating, or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury due to concentration of heat. Combustion heaters shall not be used during the first twenty four (24) hours unless precautions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide.

Concrete shall not be placed against forms exposed to heating unless the temperature of the forms is first cooled to less than or equal to ninety degrees Fahrenheit ($\leq 90^\circ\text{F}$).

3-5 Placement:

Placement shall conform to ACI 301, Chapter 8 "Placing," ACI 304R, "Guide of Measuring, Mixing, Transporting and Placing Concrete," ACI 306 "Recommended Practice for Cold Weather Concreting," ACI 305 "Recommended Practice for Hot Weather Concreting," and ACI 309, "Standard Practice for Consolidation of Concrete." No concrete shall be placed until all formwork, reinforcement, installation of parts to be embedded, bracing of forms, and preparation of surfaces involved in the placing have been reviewed by Engineer.

No concrete shall be placed in water except with the written permission of Engineer. All surfaces of forms and embedded materials that have become encrusted with dried mortar or grout from concrete previously placed shall be cleaned of all such mortar or grout before the surrounding or adjacent concrete is placed. Immediately before placing concrete, all surfaces upon or against which the concrete is to be placed shall be free from standing water, mud, debris, or loose materials. The surfaces of absorptive materials against or upon which concrete is to be placed shall be moistened thoroughly so that moisture will not

be drawn from the freshly placed concrete. The concrete shall be placed by equipment that will prevent segregation or loss of ingredients. The stream of concrete shall not be allowed to separate by permitting it to fall freely over rods, spacers or other embedded materials.

No wetting of concrete surfaces during slab finishing operations shall be permitted. Further, no concrete finishing operation shall be permitted while there is water on the surface of slabs and other flatwork.

Unless otherwise called out in these Specifications or shown in the Drawings, the placement lift depth of concrete in walls shall be limited to two (2) feet or less to minimize surface defects such as air voids that can form on concrete surfaces. Lift depths will be limited to one foot if, in the opinion of Engineer, the quality of the finish is unacceptable at the two-foot (2') lift depth.

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement.

Concrete shall not be dropped more than five (5) feet unless confined by closed chutes or pipes. Care shall be taken to fill each part of the form by depositing the concrete as near final position as possible. The coarse aggregate shall be worked back from the forms and worked around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred and strain shall not be placed on the ends of projecting reinforcement.

Where steep slopes are required, the chutes shall be equipped with baffle boards or be in short lengths that reverse the direction of movement.

Concrete shall not be pumped through aluminum alloy pipe.

All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete.

3-6 Consolidation:

All concrete shall be thoroughly consolidated with internal vibrators as recommended in ACI 309 immediately after deposition. The concrete shall be thoroughly worked around the reinforcing steel, around embedded items and into corners of forms. Vibration shall be supplemented by spading, rodding, or forking to eliminate all honeycomb and voids around embedded items.

The vibrator shall be inserted vertically, allowing it to penetrate rapidly to the bottom of the lift and at least six (6) inches into the previous lift. The vibrator shall be held at the bottom of lift for five to fifteen (5 - 15) seconds. The vibrator shall be pulled up at a rate of about three (3) inches per second.

The vibrator shall be inserted so that the fields of action overlap. The field of action is approximately eight (8) times the vibrator's head diameter. Thus for a two and one-half (2½) inch diameter vibrator, the spacing of each insertion shall be approximately twenty (20) inches.

Vibration shall be stopped when the concrete surface takes a sheen and large air bubbles no longer escape.

Do not use a vibrator to move concrete horizontally.

3-7 Openings and Inserts:

Pipe sleeves, inserts for pipe connections, anchors, and forms for pipe holes must be accurately placed and securely fastened to the forms in such a manner that the placing of concrete shall not alter their alignment or location. In the event that openings are inadvertently omitted or improperly placed, Engineer may require the concrete to be cored at the proper location. Filling of improperly placed openings shall be done with expansive grout or dry pack or mortar applied with an accepted epoxy adhesive. The surfaces of the opening shall be roughened prior to filling.

3-8 Embedded Items:

At the time of concrete placement, embedded items should be clean and free from mud, oil, and other coatings that may adversely affect bonding capacity. Aluminum embedments shall be coated with a bituminous material to prevent electrolytic action between the embedded item and reinforcing steel that results in concrete deterioration. Embedment items shall be accurately placed and securely fastened to the forms in such a manner that the placing of concrete shall not alter their alignment or location. Contact between embedded items and reinforcing steel or tendon ducts is unacceptable and is not permitted.

3-9 Construction Joints:

The location of all construction joints shall be subject to the acceptance of Engineer. The surface of all construction joints shall be thoroughly cleaned and all laitance and standing water removed. Clean aggregate shall be exposed by abrasive blast cleaning. Wire brushing and air water jets may be used while concrete is fresh provided results are equal to abrasive blast cleaning. Construction joints shall be keyed at right angle to the direction of shear. Except where otherwise shown on the Drawings, keyways shall be at least one and one-half (1½) inch in depth over at least twenty five percent (25%) of the area of the section.

3-10 Evaporative Retardant:

The use of an evaporative retardant is required to assist in proper placement of concrete (see Section 03390). When an evaporative retardant is used, it shall be applied two (2) times: after screeding and after the first floating operation. The retardant should be applied at a rate of one gallon of sprayable solution per two hundred to four hundred (200 – 400) square feet by spraying with an industrial type sprayer. If the nozzle of the sprayer becomes plugged, Contractor shall clean, or replace, the nozzle. Under no circumstances shall the retardant be used except by spraying a mist with a nozzle. The retardant shall be applied in strict conformance with the manufacturer's recommendations and precautions. In no case shall the retardant be used as a finishing agent. The use of an evaporative retardant requires review and approval by Engineer.

3-11 Finishing:

Recesses from form ties shall be filled flush with mortar. Fins and other surface projections shall be removed from all formed surfaces except exterior surfaces that will be in contact with earth backfill.

Slabs, pavement, curbs, and other unformed surfaces shall be screeded and given an initial float finish followed by additional floating or belting. Unformed surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance with no unnecessary working of the surface.

Initial floating shall be followed by belting or a second floating at the time of initial set. The belting or second floating shall produce a finish of uniform texture and color. The completed finish for unformed surfaces shall be the finish produced by the belting or second floating.

3-12 Curing:

Concrete shall be protected from loss of moisture by water saturation or membrane curing for at least 7 days after placement.

3-13 Testing:

An air content test and a slump test shall be made from one of the first three batches mixed each day. The Contractor shall provide all equipment and supplies necessary for the testing.

END OF SECTION

APPENDIX C
STANDARD DETAILS

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