ATTORNEY'S REVIEW CERTIFICATION

I, the undersigned, _____, the duly authorized and acting legal representative of the _____, do hereby certify as follows:

I have examined the attached contract(s) and surety bonds and am of the opinion that each of the agreements may be duly executed by the proper parties, acting through their duly authorized representatives; that said representatives have full power and authority to execute said agreements on behalf of the respective parties; and that the agreements shall constitute valid and legally binding obligations upon the parties executing the same in accordance with terms, conditions and provisions thereof.

Attorney's signature: _____ Date: _____

Print Attorney's Name: _____

Texas State Bar Number: _____

Exhibit A

General Decision Number: TX160052 01/08/2016 TX52

Superseded General Decision Number: TX20150052

State: Texas

Construction Type: Heavy

County: El Paso County in Texas.

HEAVY CONSTRUCTION, (INCLUDING WATER/SEWER LINES)

Note: Under Executive Order (EO) 13658, an hourly minimum wage of $10.15 for calendar year 2016 applies to all contracts subject to the Davis-Bacon Act for which the solicitation was issued on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least $10.15 (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in calendar year 2016. The EO minimum wage rate will be adjusted annually. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/08/2016

* ELEC0583-003 12/01/2014

HEAVY CONSTRUCTION (INCLUDING WATER/SEWER LINES)

	Rates	Fringes
ELECTRICIAN	$ 23.52	$6.65 + 5.25%

SUTX2005-015 05/13/2005

	Rates	Fringes
CARPENTER, Includes Form Work	$ 12.21	0.00
CEMENT MASON/CONCRETE FINISHER	$ 9.29	0.00
Laborers:		
Common	$ 7.96	0.00
Pipelayer	$ 8.48	0.00
POWER EQUIPMENT OPERATOR:		
Backhoe	$ 11.57	0.00
Front End Loader	$ 10.43	0.00
Grader	$ 11.19	0.00
TRUCK DRIVER	$ 9.17	0.00

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of "identifiers" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than "SU" or "UAVG" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the "SU" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a

new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.

Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION

Exhibit B

Exhibit B

TEXAS PARKS & WILDLIFE

Life's better outside.®

May 5, 2016

Mr. Munzer Alsarraj
Infrastructure Program Manager
El Paso County Public Works Department
800 E. Overland Street, Suite 200
El Paso, TX 79901

RE: Wiloughby Road first time Water System Project, El Paso County, Texas

Dear Mr. Alsarraj:

Texas Parks and Wildlife Department (TPWD) received the coordination request for the above-referenced project located in El Paso County. TPWD would like to offer the following information, comments, and recommendations to minimize impacts to fish and wildlife resources.

Please be aware that a written response to a TPWD recommendation or informational comment received by a state governmental agency may be required by state law. For further guidance, see the Texas Parks and Wildlife Code, Section 12.0011, which can be found online at http://www.statutes.legis.state.tx.us/Docs/PW/htm/PW.12.htm#12.0011. For tracking purposes, please refer to TPWD project number 36486 in any return correspondence regarding this project.

Project Description

The proposed project includes the installation of water service to Wiloughby Road located in the Northwest section of El Paso County. This project consists of installing approximately 2,580 linear feet of 8-inch water line, boring, hydrants, 15 service meters, valves, pavement repair and all associated appurtenances. Residents will be serviced by the El Paso Water Utilities. Construction shall take place on Wiloughby Road. The project is anticipated to benefit 46 low to moderate-income residents. The proposed improvements will allow the residents of the Wiloughby Road to a first time potable water system.

General Construction Recommendation

Recommendation: TPWD recommends the judicious use and placement of sediment control fence to exclude wildlife from the construction area. In many cases, sediment control fence placement for the purposes of controlling erosion and protecting water quality can be modified minimally to also provide the benefit of excluding wildlife access to construction areas. The exclusion fence should be buried at least six inches and be at least 24 inches high. The exclusion fence should be maintained for the life of the project and

4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291
512.389.4800
www.tpwd.texas.gov

only removed after the construction is completed and the disturbed site has been revegetated. Construction personnel should be encouraged to examine the inside of the exclusion area daily to determine if any wildlife species have been trapped inside the area of impact and provide safe egress opportunities prior to initiation of construction activities. TPWD recommends that any open trenches or excavation areas be covered overnight and/or inspected every morning to ensure no wildlife species have been trapped. Also, inspect excavation areas for trapped wildlife prior to refilling.

Federal Laws

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) prohibits taking, attempting to take, capturing, killing, selling/purchasing, possessing, transporting, and importing of migratory birds, their eggs, parts and nests, except when specifically authorized by the Department of the Interior. This protection applies to most native bird species, including ground nesting species. The U.S. Fish and Wildlife Service (USFWS) Migratory Bird Office can be contacted at (505) 248-7882 for more information on potential impacts to migratory birds.

Recommendation: If migratory bird species are found nesting on or adjacent to the project area, they must be dealt with in a manner consistent with the MBTA. TPWD recommends excluding vegetation clearing activities during the general bird nesting season, March through August, to avoid adverse impacts to this group. If clearing vegetation during the migratory bird nesting season is unavoidable, TPWD recommends surveying the area proposed for disturbance to ensure that no nests with eggs or young will be disturbed by operations. Any vegetation (trees, shrubs, and grasses) where occupied nests are located should not be disturbed until the eggs have hatched and the young have fledged.

State Laws

Parks and Wildlife Code, Section 68.015

Section 68.015 of the Parks and Wildlife Code regulates state-listed species. Please note that there is no provision for the capture, trap, take, or kill (incidental or otherwise) of state-listed species. A copy of *TPWD Guidelines for Protection of State-Listed Species*, which includes a list of penalties for take of species, is attached for your reference. State-listed species may only be handled by persons with authorization obtained through TPWD. For more information, please contact the Wildlife Permits Office at (512) 389-4647.

Texas horned lizard (*Phrynosoma cornutum*)

According to publically available aerial photographs as well as project photographs, it appears that the project area may provide suitable habitat for the state-listed Texas horned lizard (specifically in the photographs showing vacant land). If present in the project area, the Texas horned lizard could be impacted by ground disturbing activities from construction. A useful indication that the Texas horned lizard may occupy the site is the presence of harvester ant (*Pogonomyrmex barbatus*) nests since harvester ants are the primary food source of Texas horned lizards. Texas horned lizards may hibernate on-site in loose soils a few inches below ground during the cool months from September/October to March/April. Construction in these areas could harm hibernating lizards. Horned lizards are active above ground when temperatures exceed 75 degrees Fahrenheit. If horned lizards (nesting, gravid females, newborn young, lethargic from cool temperatures or hibernation) cannot move away from noise and approaching construction equipment in time, they could be affected by construction activities.

Recommendation: TPWD recommends having a qualified biologist survey the proposed project site for any Texas horned lizards that may be in the area that is proposed for disturbance. As previously mentioned, a useful indication that the Texas horned lizard may occupy the site is the presence of harvester ant nests. The survey should be performed during the warm months of the year when the horned lizards are active. If horned lizards are found on-site, TPWD recommends relocating them off-site to an area that is close-by and contains similar habitat. For projects where the disturbance is linear (county and state roads and highways, pipelines, transmission lines) after horned lizard removal, the area that will be disturbed during active construction and project specific locations should be fenced off to exclude horned lizards and other reptiles.

The exclusion fence should be constructed and maintained as follows:

a. The exclusion fence should be constructed with metal flashing or drift fence material.
b. Rolled erosion control mesh material should not be used.
c. The exclusion fence should be buried at least 6 inches deep and be at least 24 inches high.
d. The exclusion fence should be maintained for the life of the project and only removed after the construction is completed and the disturbed site has been revegetated. Any open trenches should be covered overnight and/or inspected every morning to ensure no horned lizards or other reptiles have been trapped.

Recommendation: If the site is found to contain unavoidable habitat of the Texas horned lizard, then TPWD recommends a permitted biological monitor be present during clearing and construction activities to relocate Texas horned lizards encountered during construction. TPWD also recommends providing contractor training where feasible. Because the biological monitor cannot oversee all construction activity at the same time, it's important for the contractor to be able to identify protected species and to be on the lookout for them during construction. TPWD also recommends avoiding impacts to harvester ant mounds where feasible. TPWD understands that ant mounds in the direct path of construction would be difficult to avoid, but contractors should be mindful of these areas when deciding where to place project specific locations and other disturbances associated with construction. If the presence of a biological monitor during construction is not feasible, state-listed threatened species observed during construction should be allowed to safely leave the site.

Rare Species

In addition to state and federally-protected species, TPWD tracks special features, natural communities, and rare species that are not listed as threatened or endangered. TPWD actively promotes their conservation and considers it important to evaluate and, if necessary, minimize impacts to rare species and their habitat to reduce the likelihood of endangerment and preclude the need to list as threatened or endangered in the future.

Western burrowing owl (*Athene cunicularia hypugaea*)

The project area may provide suitable habitat for the western burrowing owl. The burrowing owl is a ground-dwelling owl that uses the burrows of prairie dogs and other fossorial animals for nesting and roosting. When natural burrows are limited, this species will breed in urban habitats which may lead to problems for the owls or their young. The owls opportunistically live and nest in road and railway rights-of-ways, parking lots, baseball fields, school yards, golf courses, and airports. They have also been found nesting on campuses, in storm drains, drainage pipes, and cement culverts, on banks, along irrigation canals, under asphalt or wood debris piles, or openings under concrete pilings or asphalt. The burrowing owl is protected under the MBTA, and take of these birds, their nests, and eggs is prohibited. Potential impacts to the burrowing owl could include habitat removal as well as displacement and/or destruction of nests and eggs if ground disturbance occurs during the breeding season.

Recommendation: TPWD recommends that the project area be surveyed for mammal burrows or any urban structures that may provide suitable habitat for

burrowing owls. If mammal burrows or any urban structures that may provide suitable habitat would be disturbed as a result of the proposed project, TPWD recommends the burrows or structures be surveyed for burrowing owls. If nesting owls are found, disturbance should be avoided until the eggs have hatched and the young have fledged.

Recommendation: Please review the TPWD county list for El Paso County, as rare species in addition to those discussed above could be present, depending upon habitat availability. This list is available online at http://tpwd.texas.gov/gis/rtest/. The USFWS should be contacted for species occurrence data, guidance, permitting, survey protocols, and mitigation for federally-listed species. For the USFWS threatened and endangered species lists by county, please visit http://www.fws.gov/endangered/.

Determining the actual presence of a species in a given area depends on many variables including daily and seasonal activity cycles, environmental activity cues, preferred habitat, transiency and population density (both wildlife and human). The absence of a species can be demonstrated only with great difficulty and then only with repeated negative observations, taking into account all the variable factors contributing to the lack of detectable presence. If encountered during construction, measures should be taken to avoid impacting all wildlife.

TPWD strives to respond to requests for project review within a 45 day comment period. Responses may be delayed due to workload and lack of staff. Failure to meet the 45 day review timeframe does not constitute a concurrence from TPWD that the proposed project will not adversely impact fish and wildlife resources.

TPWD advises review and implementation of these recommendations. If you have any questions, please contact me at (512) 389-8054 or email at Jessica.Schmerler@tpwd.texas.gov.

Sincerely,

Jessica E. Schmerler

Jessica E. Schmerler
Wildlife Habitat Assessment Program
Wildlife Division

JES:gg.36486

Attachment

Protection of State-Listed Species
Texas Parks and Wildlife Department Guidelines

Protection of State-Listed Species

State law prohibits any take (incidental or otherwise) of state-listed species. State-listed species may only be handled by persons possessing a **Scientific Collecting Permit** or a **Letter of Authorization** issued to relocate a species.

- **Section 68.002 of the Texas Parks and Wildlife (TPW) Code** states that species of fish or wildlife indigenous to Texas are endangered if listed on the United States List of Endangered Native Fish and Wildlife or the list of fish or wildlife threatened with statewide extinction as filed by the director of Texas Park and Wildlife Department. Species listed as Endangered or Threatened by the Endangered Species Act are protected by both Federal and State Law. The State of Texas also lists and protects additional species considered to be threatened with extinction within Texas.

- **Animals** - Laws and regulations pertaining to state-listed endangered or threatened animal species are contained in **Chapters 67 and 68 of the Texas Parks and Wildlife (TPW) Code** and **Sections 65.171 - 65.176 of Title 31 of the Texas Administrative Code (TAC).** State-listed animals may be found at **31 TAC §65.175 & 176.**

- **Plants** - Laws and regulations pertaining to endangered or threatened plant species are contained in **Chapter 88 of the TPW Code and Sections 69.01 - 69.9 of the TAC**. State-listed plants may be found at **31 TAC §69.8(a) & (b).**

Prohibitions on Take of State Listed Species

Section 68.015 of the TPW Code states that no person may capture, trap, take, or kill, or attempt to capture, trap, take, or kill, endangered fish or wildlife.

Section 65.171 of the Texas Administrative Code states that except as otherwise provided in this subchapter or **Parks and Wildlife Code, Chapters 67 or 68**, no person may take, possess, propagate, transport, export, sell or offer for sale, or ship any species of fish or wildlife listed by the department as endangered or threatened.

"Take" is defined in **Section 1.101(5) of the Texas Parks and Wildlife Code** as:

> *"Take," except as otherwise provided by this code, means collect, hook, hunt, net, shoot, or snare, by any means or device, and includes an attempt to take or to pursue in order to take.*

Penalties

The penalties for take of state-listed species (**TPW Code, Chapter 67 or 68**) are:

- 1ST Offense = Class C Misdemeanor:
  $25-$500 fine

- One or more prior convictions = Class B Misdemeanor
  $200-$2,000 fine and/or up to 180 days in jail.

- Two or more prior convictions = Class A Misdemeanor
  $500-$4,000 fine and/or up to 1 year in jail.

Restitution values apply and vary by species. Specific values and a list of species may be obtained from the TPWD Wildlife Habitat Assessment Program.

SPECIAL CONDITIONS

SPECIAL CONDITIONS

1. SCOPE OF WORK

The Contractor may begin work immediately after receipt of the County of El Paso's written Notice to Proceed. The work of the Contractor shall be fully coordinated with that of El Paso Water Utilities (EPWU) personnel.

The work shall include the following:

> Base Bid II:
> The **Water** work for WILOUGHBY ROAD IMPROVEMENTS consists of the installation of approximately 2,758 LF of 8-Inch C900 PVC Pipe, 380 LF of 16-Inch Steel Casing (Jack or Bored), 19 3/4-Inch Water Service Installations, fire hydrant, additional fittings as needed, pavement cut and restoration, and all necessary appurtenances for the completed main or structure, including approximately 2,758 LF of Trench Safety System.

The Contractor shall satisfy himself before commencing work as to the meaning or correctness of all horizontal control points and benchmarks, and no claim of inaccuracy will be considered, unless the Contractor notified the Engineer thereof in writing before commencing the work. The Contractor will be held responsible for preservation of all control points and benchmarks in their positions. In case any of them are lost or destroyed, all expense incurred by the Owner in replacing them shall be charged against the Contractor and paid for by him before the completion and final acceptance of the work.

2. CONTRACTOR'S RESPONSIBILITY FOR INSTALLATION OF THE WATER SYSTEM

It is the intent of these specifications that the installation of the water mains be a complete workable system, functioning in accordance with the specified purpose. Therefore, it is the direct responsibility of the Contractor to furnish, install, and construct a complete system required by the plans for the prices stated in the Contract, and to take account of all subsidiary requirements of the materials and other items furnished to the end that the water and sewer mains function in accordance with the specified requirements.

3. DRAWINGS

The work is shown on a set of drawings entitled "WILOUGHBY ROAD 8-INCH PVC WATER LINE EXTENSION" (Sheets 1-4) and such detail drawings as may be included in the bound specifications.

The Contractor shall check all dimensions and quantities on the drawing furnished by the Owner or by himself and shall notify the Engineer of all errors or omissions which he may discover by examining and checking the same. He will not be allowed to take advantage of any error or omission in the drawings, as full instructions will be furnished by the Engineer, should such error or omission be discovered, and the Contractor shall carry out such instructions as if originally specified.

4. TEMPORARY PAVING

Temporary patch paving required as result of water line installation shall be as per County Engineering specifications. Cost associated with temporary patch paving will be at the Contractor's expense.

5. COORDINATION OF EXISTING FACILITY OPERATIONS

Personnel from the EPWU will assist in working out the coordination between the construction operations and the operation of the existing facilities, but it is the Contractor's responsibility to clear all his operations which might interfere with such existing operations with the Project Manager.

6. WATER BYPASSING AND DEWATERING

A. DESCRIPTION:

1. SCOPE OF WORK: This section specifies the requirements for temporary bypassing, dewatering, flushing, and abandonment of water and sanitary sewer lines. The Contractor shall keep excavations reasonably free from water during construction. The static water level shall be drawn down a minimum of 2-feet below the bottom of excavations to maintain the undisturbed state of natural soils and allow the placement of any fill to the specified density. Disposal of water shall not damage property or create a public nuisance. The Contractor shall have on hand pumping equipment and machinery in good working condition for emergencies and shall have workmen available for its operation. Dewatering systems shall operate continuously until backfill has been completed to 1-foot above the normal static groundwater level.

   Groundwater shall be controlled to prevent softening of the bottom of excavations or formation of "quick" conditions. Dewatering systems shall not remove natural soils. The Contractor shall control surface run-off to prevent entry or collection of water in excavations.

   Release of groundwater to its static level shall be controlled to prevent disturbance of the natural foundation soils or compacted fill and to prevent flotation or movement of structures or pipelines.

2. REQUIREMENTS: Contractor shall provide labor, materials, and supervision to temporarily bypass flow around the Contractor's work during water and sanitary sewer facility construction where necessary. Contractor shall also provide temporary dewatering of low-lying portions of existing sanitary sewers as necessary. Contractor shall flush all sanitary sewers and manholes to be abandoned with a minimum of twice the sanitary sewer's volumes of water. Contractor shall dewater all sanitary sewers and water lines to be abandoned. Sanitary sewer lines to be abandoned shall be cut and plugged at all open ends. Water lines shall be isolated, valves closed and depressurized prior to abandonment. All work to be closely coordinated with the Engineer.

3. SUBMITTALS: Within 14 calendar days of notice to proceed, the Contractor shall submit to the Engineer, for review and approval, drawings and complete design data showing methods and equipment he proposes to utilize in water and sanitary sewer bypassing and dewatering. The submittal shall include the following information:

   a) Drawings indicating the location of temporary water and sanitary sewer plugs and bypass discharge lines

   b) Capacities of pumps, prime movers, and stand-by equipment

   c) Design calculations proving adequacy of the system and selected equipment

4. JOB CONDITIONS:

   a) Available Data: Flow data are available for review at the Owner's office. Use of this information in no way relieves the Contractor from his responsibility for design, construction, and operation of an adequate and properly functioning bypass and dewatering system. Any additional testing or gathering of flow data is the responsibility of the Contractor.

   b) Protection: Where bypassing or dewatering is required, the Contractor shall ensure that service for connecting sanitary sewer laterals and water services is not disrupted. All flow shall be discharged into the nearest downstream manhole.

Bypassing and dewatering shall not surcharge sanitary sewers or interfere with normal operation of related sanitary sewer facilities. No discharging to the ground surface, receiving streams, storm drains, or discharging which results in groundwater contamination or potential health hazards shall be permitted. In the event accidental discharging is caused by the Contractor's operations, the Owner shall immediately be entitled to employ others to stop the discharging without giving written notice to the Contractor. All water bypassing shall conform to AWWA procedures for prevention of contamination for water lines, backflow provisions, and provisions for conduit protection and support.

c) Scheduling: The bypassing and dewatering systems shall not be shut down between shifts, on holidays or weekends, or during work stoppages without written permission from the Construction Manager.

The Contractor shall submit a detailed outage plan and time schedule for operations that will make it necessary to remove a tank, pipeline, channel, electrical circuit, equipment or structure from service. The schedule shall be coordinated with the Construction Manager and shall meet the restrictions and conditions specified in this section. The detailed plan shall describe the Contractor's method for preventing accidental discharges, the length of time required to complete said operation, the necessary plan, and equipment which the Contractor shall provide in order to prevent accidental discharges.

The Contractor shall observe the following restrictions:

Systems or individual equipment items shall be isolated, de-watered, de-commissioned, de-energized, or de-pressurized in accordance with the detailed outage plan and schedule. The Construction Manager shall be notified in writing at least one week in advance of the planned operation.

B. EXECUTION:

1. WATER AND SANITARY SEWER DEWATERING: Contractor shall dewater all sagged submerged portions of the sanitary sewer during television inspection and grouting. Sanitary sewer flow shall be reduced so that no portion of the television camera's lens is submerged during inspection. The Contractor may temporarily force the flow away from the area under inspection by water jetting or piping the line. Where these methods cannot adequately reduce the flow, the Contractor shall either pump the flow from within the sanitary sewer or water line or excavate the low portion of the line and pump the groundwater from below the pipeline. Sanitary sewers to be abandoned shall be flushed with two pipeline volumes of water prior to dewatering and abandoning.

2. WATER AND SANITARY SEWER BYPASSING:

General: Water and Sanitary sewer bypassing shall be accomplished by pumping or diverting the upstream flow around the Contractor's work or as directed by the Construction Manager.

The Contractor shall provide temporary pumps, conduits, and other equipment to bypass the water or sanitary sewer flow. Contractor shall furnish the necessary labor and supervision to set up and operate the pumping and bypass system. Engines shall be equipped with mufflers and/or enclosed to keep the noise level within local ordinance requirements. Pumps and bypass lines shall be of adequate capacity and size to handle the flows. All bypassed flow shall be discharged to the nearest downstream manhole.

Unless otherwise specified, the Contractor shall bypass flow around his work whenever the depth of flow, as measured at the inlet pipe to the upstream manhole adjacent to the

Contractor's work, exceeds the crown elevation of the pipe; or whenever the Contractor's equipment operating in the sanitary sewer provides an obstruction that restricts flow and causes the depth of flow to exceed the crown elevation.

3. STANDBY EQUIPMENT: The Contractor shall maintain on site sufficient equipment and materials to ensure continuous and successful operation of the bypass and dewatering systems. Standby pumps shall be fueled and operational at all times. The Contractor shall maintain on site a sufficient number of valves, tees, elbows, connections, tools, sanitary sewer plugs, piping and other parts or system hardware to ensure immediate repair or modification of any part of the system as necessary.

4. DAMAGES: The Contractor shall repair without cost to the Owner any damage that may result from his negligence, inadequate or improper installation, maintenance and operation of bypassing and a dewatering system including mechanical or electrical failures.

5. MEASUREMENT AND PAYMENT: Payment for the work in this section will be subsidiary to the unit prices for installing pipe, manholes, valves, or fittings, complete in place.

7. PERMITS

Before commencing operations, the Contractor will secure and pay all permits required in the prosecution of this Contract.

8. INSPECTION OF INSTALLATION AND CONSTRUCTION

The Contractor shall at all times maintain proper facilities and provide safe access to all parts of the work for purposes of inspection by the Engineer. Should any work be covered up before approval or consent of the Engineer, it must, if required by the Engineer, be uncovered for examination at the Contractor's expense.

The Contractor shall accord the same notification and access to repair work as to the work originally constructed, and the same conditions regarding acceptance shall apply.

It shall be the Contractor's responsibility to schedule, coordinate, and request any inspection required upon completion of work.

All testing and inspection of installation and construction of water and sanitary sewer systems shall be performed in accordance to the "Standard Specifications for the Installation of Water Mains, Sanitary Sewer Mains, and Related Appurtenances" included in these Specifications.

The Utility will televise the new sanitary sewer system **only twice** during Project construction - once after new street base course is complete and once after paving of the street is completed. The cost for the first televising will be paid by the EPWU. The City of El Paso will coordinate with the Contractor to halt street work after base course is complete to allow for first televising. Any defects discovered during televising will be repaired at Contractor's expense prior to paving. All follow-up televising prior to paving will be done at Contractor's expense. The cost for the second televising after the street is paved will be paid for by the Contractor. Again, any defects discovered during televising will be repaired at Contractor's expense. All follow-up televising will also be at the Contractor's expense.

The Utility will televise the quantities of sanitary sewer main line that are submitted on the final inspection report submitted by the Utility Inspector to the Engineering Developer Services Section of the Utility. Once the indicated amount of main line is televised, any additional main line televised will be billed at a rate of $0.92 per foot. In addition, a minimum mobilization charge of $250.00 will be billed to the Contractor should EPWU's crews have to re-televise a portion of main on a later date. Contractor shall actively participate in minimizing the debris found within the newly installed pipe. Prior to calling for a televising crew, the Contractor shall coordinate with the Utility Inspector for a Debris Inspection. Once the inspection has been made and the Utility Inspector is satisfied with the condition of the mains, the Utility Inspector will schedule

televising of the main line at least 48 hours in advance. Televising will be done within five (5) working days of the 48-hour notice. During the televising of the sanitary sewer main, the Developer or the Utility Contractor/Sub-contractor must be present to ensure that portions of the main lines are cleared when the Utility crews are on-site and avoid a second call to the site, thus eliminating the Mobilization Fee of $250.00. Costs for re-televising and mobilization fees must be paid to the EPWU's Accounting Department prior to final release.

9. REMOVED MATERIALS

Salvageable equipment, metal piping, appurtenances and other components removed during the course of the work, including fire hydrants, bonnet boxes, meter valves, and boxes shall be free of chemicals, oils, liquids, concrete, and plastic and shall be returned and delivered by the Contractor to the EPWU's Warehouse, 2101 Cypress Street. However, if the Contractor removes any section of pipe that is scheduled to be abandoned, then it will become the responsibility of the Contractor to properly dispose of all piping at his expense.

10. WATER FOR CONSTRUCTION

Water for all construction purposes will be provided at the Contractor's expense for trenching, water and sanitary sewer installation, filling, testing, disinfecting and flushing existing and proposed installations, and all storm drain, landscape, roadway construction, dust control, compaction, and clean-up. At no time will un-metered water consumption be allowed, nor will the Contractor be allowed to operate a fire hydrant. Construction water can be provided upon approval and meter deposits and fees to the Utility have been paid on an existing fire hydrant. The fire hydrant meter fee is $2,125.00, which includes a meter and backflow preventor fee of $2,000.00 and a set-up and removal fee of $125.00 for the installation and removal of the meter. The fire hydrant meter will not be removed from the assigned fire hydrant by anyone other than Utility Personnel. An outlet valve will be provided with the fire hydrant meter for Contractor's use. A water loss fee of $500.00 will be assessed to the Contractor for each occurrence that violates the above. Charges due will be deducted from the deposited amount. Charges in excess of the deposit amount must be paid before the project will be accepted into the Utilities' system. Any excess deposit will be refunded promptly.

Construction water drawn through fire hydrant meters will be charged to the Contractor at a usage rate of $3.68 per hundred cubic feet. Fire hydrant meters will be installed and removed by EPWU's personnel only. Fire hydrant meters have a locking device and a built-in backflow preventor. The Contractor is no longer responsible for providing his own backflow preventor for fire hydrant meters. Water used to fill, pressure test, and disinfect water main lines will be billed at the standard construction water rate of $3.68 per hundred cubic feet and will be calculated at one and a half times the volume of the installed pipe.

The Contractor may, with the approval of the Engineer, make other arrangements and secure water for construction purposes from a source of his own choosing, including but not limited to Reclaimed Water from the Wastewater Treatment Plants, which is available at a reasonable cost. The Contractor shall obtain information, terms and conditions of service, application process, and other requirements from the EPWU's Developer Services Section. Issuance of a construction meter or stand-pipe requires a deposit. Standard forms are available at the EPWU's Developer Services Section. The Contractor shall provide such facilities as may be required for transporting and utilizing this water at his own cost.

Upon completion of the project, the Contractor must call the Engineering Developer Services Section at 594-5647 or 594-5641 to have the meter removed. Upon meter removal, the Contractor will be assessed for the water consumed plus any damages to the fire hydrant and/or fire hydrant meter assembly.

11. NOTIFICATION OF PROPERTY OWNER

The Contractor shall be responsible for the notification of property owners, businesses and residents along the pipeline route to explain the construction to them. The Contractor shall be responsible for providing access to the businesses and residences for all property owners, customers and residents.

Notification of all businesses, residents, and property owners shall be by printed handout approved by the Owner. The Contractor shall furnish proof to the Owner that each resident along the route has been notified.

Any resident unable to park their vehicle at their residence due to the construction shall be provided with a place to park as near to the residence as possible. The Contractor shall provide security for such vehicle.

12. EXISTING UTILITIES AND FACILITIES

The Contractor shall be fully responsible for all underground facilities which are shown on the drawings or which can be located by the Contractor with reasonable effort, or which are brought to the attention of the Contractor in any manner. The Contractor shall be responsible for notifying the Engineer if any unknown facilities are uncovered and for protecting those facilities after they are uncovered.

The drawings only indicate the approximate location of existing utilities that could be located or approximated during design. Therefore, the Contractor shall be responsible for determining the exact location of all buried utilities along the pipeline routes prior to starting any excavation activities. The Contractor shall be responsible for locating and protecting all utilities and service connections along the route of construction. Prior to submittal of shop drawings and the ordering of pipeline materials, the Contractor will be required to pot-hole to located (vertical and horizontal) all existing utilities within the right-of-way and to determine adjustments to the proposed pipeline alignment of the water and sewer facilities. Adjustments to the proposed water and sewer alignments shall be as approved by the Engineer and Owner.

The Contractor shall be responsible for the protection of all electric power poles, overhead lines, light poles, etc. which occur along the various pipeline routes. The Contractor shall provide whatever temporary shoring is necessary to ensure that all poles are adequately supported, braced, etc. so that the pole does not sink, shift, tilt, or otherwise move from its original position. Any removal of guy wires or anchors and setting of any guy wires or anchors shall be done at the Contractor's expense. Any measures the Contractor takes to support any type of pole shall be based upon approval of the Engineer and the owner of the pole. The owner of the pole and the Engineer shall be notified of probable work on the pole no later than within the first week of Contractor's work, and again 5 business days prior to the work being done. Removal of temporary supports of guy wires shall be with the approval of the owner of the pole and the Engineer. Said removals of temporary facilities shall only be started after 5 business days notification and approval from the owner of the pole and the Engineer.

The Contractor shall coordinate the work with all utility companies having facilities within the area of work. Any work associated with the protection, relocation, or by-passing of existing utility lines shall be reflected in the Contractor's project schedule so that the work may be completed without delay to the project. All the requirements of the Contract Documents will apply to any subcontractor who performs any relocation, by-passing, or protection of existing utility lines. All work associated with the relocating, by-passing, or protection of existing utility lines shall be at the expense of the Contractor. Five days prior to the commencement of any protection, relocation, or by-pass work the Contractor shyall submit a work plan to the utility line owner and the Engineer for approval. No relocation or by-pass work shall be performed without prior written approval of the work by the owner of the utility line and the Engineer. Emergency protection of existing utility lines to protect the line from immediate damage may be performed by the Contractor without prior approval; however, the Contractor shall take every action to notify the owner and the Engineer of the situation as quickly as possible.

13. DAMAGE TO PRIVATE PROPERTY

The Contractor shall be responsible for any damage to private property caused by the construction project. The Contractor upon receipt of a complaint of damage, shall, within 10 days, respond in writing with a proposal to repair said damage or a letter stating reason why the damage was not caused by the construction.

Except for extenuating circumstances beyond the control of the Contractor the damage shall be repaired completely within 10 days of the complaint.

The Contractor shall not enter or occupy private land outside of acquired rights-of-way or construction easements, except by written permission of the Owner of the private property. Copies of such written permission shall be provided to the Project Manager.

14. WATER CONTRACTOR'S MINIMUM QUALIFICATIONS CRITERIA

A. The Bidder, or at least three Key Personnel employed by the Bidder, must demonstrate Successful Completion of three projects similar in nature and scope to this project within the past five (5) years.

B. Project involves the installation of steel casings by jacking or boring methods. Bidder, Superintendent, and Foreman must demonstrate a minimum of two (2) successful projects showing experience in jacking/boring of steel casings of similar size in the last five (5) years. Qualifications of Subcontractor will be considered.

C. Project requires the installation of water systems within and adjacent to TXDOT and Railroad right-of-ways. Bidder to demonstrate successful completion of at least two (2) projects within the last five (5) years with similar requirements employing approved traffic control plans.

15. MEASUREMENT AND PAYMENT

A. BID FORM - The Bid Form is a part of these Contract Documents and lists each item of work for which payment will be made. No payment will be made for items other than those listed in the Bid Form.

Required items of work and incidentals necessary for the satisfactory completion of the Project which are not specifically listed in the Bid Form, and which are not specified in this Section to be measured or to be included in one of the items listed in the Bid shall be considered as incidental to the work required under this Contract, and all costs thereof, including Contractor's overhead costs and profit, shall be considered as included in the prices bid for the various Bid Items. The Contractor shall prepare his bid accordingly.

Work includes furnishing all plant, labor, equipment, tools, and materials, and performing all operations required to complete the work satisfactorily, in place, as specified and as indicated on the Drawings.

B. MEASUREMENT AND PAYMENT - Measurement of an item of work will be by the unit indicated in the Bid Form.

Measurement will include all necessary and incidental related work not specified to be included in any other item of work listed in the Bid Form.

Unless otherwise stated in individual sections of the specifications or in the Bid Form no separate payment will be made for any item of work, materials, parts, equipment, supplies, or related items required to perform and complete the requirements of any section. The costs for all such items required shall be included in the Contract price bid for item of which it is a part.

Payment will be made at the Contract price per unit indicated in the Bid Form with total prices of the Contract being equal to the Total Bid, as specified and as modified, by extending unit prices

multiplied by quantities, as appropriate to reflect actual work included in the Project. Such price and payment shall constitute full compensation to the Contractor for furnishing all plant, labor, equipment, tools, and materials, and for performing all operations required to furnish to the Owner the entire Project, complete in place, as specified and as indicated on the Drawings.

Measurement for payment does not signify acceptance of Work.

Quantities shown in the Bid Form are approximate quantities only. Payment will be made only for measured quantities actually installed and accepted by Owner.

Measurements, such as linear feet, will be to the nearest whole unit.

The Unit Prices for Base Bid II **will** be considered in determining the low responsive/responsible bid and for changing quantities of work items indicated by the Contract Drawings upon written instructions from EPWU through the City of El Paso Engineering Department.

C. BID ITEMS

1. 8-Inch Diameter (Blue) C900 PVC Water Lines: Work under this item shall include all costs associated with the cutting, draining, and capping of existing water lines; connection of new water line to existing water lines; abandonment of valves; coordination; excavation, to include additional excavation and labor for vertical and/or horizontal adjustment of the main to clear existing utility lines and/or other structures; potholing all existing utilities; temporary by-passing; temporary valves and fittings; gate valves with bonnet boxes; concrete thrust blocks; tapping sleeves; cement stabilized backfill; backfilling and embedment; compaction and compaction testing for utilities; removal and disposal of existing utility lines when in conflict with new water mains (including AC pipe removal and disposal work); bonnet boxes, bonnet box covers, etc.; all pipe and accessories; fittings; transitional fittings; mechanical joint restraints at all tees, bends, and fittings, tie rods, as indicated on plans; bell protection system at each joint for over-insertion; disinfection; testing; dewatering and disposal of water where required; and all appurtenances defined herein to include, but not limited to the following items: marking tape, dewatering, temporary cold patch over proposed water mains where required by County, and all other items of the project not indicated as being covered under the other specific bid items shown on the proposal. All AC water pipe work shall be performed by State licensed/certified personnel. When in conflict with new line alignment, existing water and sewer line shall be removed. Such payment shall be complete compensation for the complete performance of the work in accordance with the drawings and the provisions of these specifications.

   This item will be measured for payment by the linear foot.

2. 16-Inch Steel Casing by Boring or Jacking Method: Work under this item shall include all costs associated with furnishing labor, new materials, equipment, and incidentals to furnish and install 16-inch diameter steel casing including spacers and end-rubber seals, precautionary outlet, bonnet box and cover, pressure grouting for over reaming if needed, excavation, backfill, disposal, protection of existing structures, pipeline testing, inspection and welding as indicated on the Drawings in accordance with EPWU and TXDOT requirements and according to typical steel casing installation.

   This item will be measured for payment by the linear foot.

3. Installation of NEW 3/4-Inch Water Services: Work under this item shall include all costs associated with furnishing labor, new materials, equipment, and incidentals to install water services; coordination; locating of existing service; temporary service; and all appurtenances defined herein to include, but not limited to, the following items: meter boxes, service line pipe, bends, valves and fittings in accordance with EPWU's requirements and as indicated on the drawings and in standard specifications. Contractor

shall, at his expense, completely restore to its original condition, any disturbed area associated with the installation of new water services should these services be located inside private property. Water services shall be wet-tapped with the line under pressure. No dry or direct taps are authorized.

This item will be measured for payment by size per each.

4. Installation of NEW Fire Hydrant: Work under this item shall include all costs associated with furnishing labor, materials, equipment, and incidentals to install NEW fire hydrants as indicated on the drawings in accordance with EPWU's requirements and according to typical fire hydrant installation, including, but not limited to, Davidson Anti-Terrorism Corrosion Resistant Valve Kit (DATV) and any spool extensions, as needed.

   This item will be measured for payment per each.

5. Additional Fittings: Additional fittings will be paid for at a unit price per pound (lb). The work performed and the materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Additional Fittings". This price shall be full compensation for furnishing all required materials, including all costs associated with coordination; excavation; backfill, compaction, compaction testing for utilities; disposal of excess material; equipment and materials required for cutting and removal of water mains, furnishing and installing additional valves, bends, tees, crosses, couplings, reducers, adaptors, flexible fittings, not originally shown on the Contract Drawings or drawing details, as deemed necessary by the Engineer and approved by the Owner, complete in place, including but not limited to: thrust blocking, mechanical joint restrainers, concrete anchoring, polyethylene wrapping, and provisions for corrosion protection. Additional fittings are based on the cost of material only. Mechanical joint restrainers in lieu of or in conjunction with concrete thrust blocking shall not be considered for individual payment through the "Additional Fittings" provisions. The actual amount of additional fittings may be less than, but shall not exceed the total quantities allocated on the bid proposal without approval by OWNER or ENGINEER.

   This item will be measured for payment by the pound.

6. Trench Safety System for Water Line Installation: Payment of all work prescribed under this item shall be full compensation for the trench safety system including any design, testing, monitoring, inspection, or additional excavation and backfill required, for furnishing, placing, maintaining and removing all shoring, sheeting, or bracing; for required compaction; and for all labor, materials, tools, equipment, and any incidentals necessary to complete the "Trench Safety System" work.

   This item will be measured for payment by the linear foot.

7. Pavement Cut and Restoration: Work under this item shall include all costs associated with coordination, materials, compaction, and labor required to saw-cut existing pavement and provide pavement patch where indicated on water plans, unless otherwise directed by the Engineer. Pavement shall be as per County of El Paso specifications or TXDOT specifications, as indicated on the plans.

   This item will be measured for payment by the square foot.

8. 2-Sack Cement Stabilized Backfill: Work under this item shall include all costs associated with coordination, materials, equipment, and labor required to place 12-inches of 2-sack cement stabilized under all pavement patches within the limits of construction.

This item will be measured for payment by the cubic yard.

END OF SECTION

STANDARD SPECIFICATIONS FOR THE INSTALLATION OF WATER MAINS, SANITARY SEWER MAINS AND RELATED APPURTENANCES

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STANDARD SPECIFICATIONS FOR THE INSTALLATION
OF WATER MAINS, SANITARY SEWER MAINS AND RELATED APPURTENANCES

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APPENDICES

1.0 WATER MAIN MATERIALS

1.1 POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

A. SCOPE: These specifications cover the requirements for polyvinyl chloride (PVC) pressure plastic pipe materials and installation for potable water use. These specifications shall apply to PVC pipe in sizes 4-inch through 16-inch diameters.

B. QUALITY ASSURANCE: All PVC pipe shall be coded to provide positive identification and prevent accidental damage to or interruption of the water facilities. Pipe shall conform to American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 61 "Drinking Water System Components - Health Effects" and be certified by and organization accredited by ANSI. Such compliance shall be evidenced by an affidavit from the manufacturer or vendor. If the pipe does not presently conform to this standard, information from the manufacturer regarding action being taken to comply with this standard must be submitted.

Only pipe manufactured in the United States of America will be accepted.

Pipe shall be suitable for use in the conveyance of water for human consumption. Each piece of pipe shall be marked with two seals of the testing agency that certified the pipe material as being suitable for potable water use.

C. SUBMITTALS: The contractor shall be responsible for furnishing all necessary shop drawings, certificates, etc. for review and acceptance to the Engineer. A certification from the manufacturer shall be furnished to the Engineer attesting compliance with appropriate ASTM Standards and ANSI/NSF Standard 61. Such compliance shall be evidenced by an affidavit from the manufacturer or vendor. If the pipe does not presently conform to this standard, information from the manufacturer regarding action being taken to comply with this standard must be submitted. Failure to provide this information may result in rejection of pipeline material.

Submit documentation on pipe products, fittings, and related materials as may be required by the Contract Documents or the Engineer. Review all submittals prior to submission. Submit it in a timely manner so as not to delay the project. Allow sufficient time for Engineer's review and resubmission, if necessary. Include certifications from manufacturer that the product complies with appropriate ASTM standards.

D. STANDARDS: PVC Pressure Pipe shall comply with the applicable requirements of the following:

ANSI/NSF 61	Drinking Water System Components - Health Effects
ASTM F-477	Specifications for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM D-1784	Specifications for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds
ASTM D-2241	Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series)
ASTM D-2774	Recommended Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM D-2837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
ASTM D-3139	Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
AWWA C-900	Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4-Inch through 12-Inch, for Water Distribution
AWWA C-905	Standard for Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14-Inch through 36-Inch
AWWA M-23	Manual: PVC Pipe - Design and Installation
UNI-BELL-3	Polyvinyl Chloride (PVC) Pressure Pipe (Complying with AWWA Standard C-900)
UNI-BELL-11	Polyvinyl Chloride (PVC) Water Transmission Pipe Nominal Diameters 14-36 Inch

E. DELIVERY AND STORAGE: Pipe, fittings and accessories shall be inspected upon delivery and during progress of the work. Any material found defective will be rejected by the Engineer, and shall be promptly removed from the site.

All pipe, fittings, and other accessories shall, unless otherwise directed, be unloaded at point of delivery, hauled to and distributed at the site of the work by the Contractor. In loading and unloading, materials shall be lifted by hoists or rolled on skidways so as to avoid shock or damage. Under no circumstances shall materials which have been dropped be incorporated in the work. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground.

PVC pipe shall not be stored outside exposed to prolonged periods of sunlight. Any discoloration of pipe due to such exposure is an indication of reduced pipe impact strength, and will be sufficient cause for rejection of the pipe. Any pipe rejected shall be removed from the job site.

F. PIPE MATERIALS: Pipe shall meet the requirements of AWWA C-900 for 4-inch through 12-inch sizes, and AWWA C-905 for 14-inch through 36-inch pipe. Pipe shall be Underwriters Laboratories (UL) approved. All PVC pressure pipe shall be furnished in cast iron pipe equivalent outside diameters and a standard laying length of 20 feet. Minimum pressure class shall be 235 (DR 18) for 4-inch through 12-inch diameters, and 200 psi (DR 21) for 14-inch through 16-inch pipe.

Pipe and coupling for a restrained joint pipe system shall be from un-plasticized PVC compounds having a minimum cell classification of 12454, as defined in ASTM D 1784. The compound shall qualify for a Hydrostatic Design Basis (HDB) of 4000 psi for water at 73.4° F, in accordance with the requirements of ASTM D 2837.

G. JOINTS: Pipe joints shall be push-on, flexible elastomeric gasketed or cartridge-style restrained joint. The pipe length of a push-on joint shall contain on bell-end. The bell shall be an integral part of the pipe length and have the same strength and DR as the pipe. The spigot pipe end shall be beveled and include a synthetic elastomeric gasket. The gasket shall meet the requirements of ASTM F-477.

All push-on joint PVC pipe shall be marked with dual indicator lines at the spigot end indicating proper penetration when the joint is assembled. The sockets and/or spigot configurations for the fittings and couplings shall be compatible to the pipe. Socket configuration shall prevent improper installation of gasket and shall ensure that the gasket remains in place during joining operations.

Cartridge-style restrained joint PVC pipe shall be joined using a non-metallic coupling to form an integral system. Coupling shall be designed for use at or above the pressure class of the pipe with which they are utilized and shall incorporate twin elastomeric sealing gaskets meeting ASTM F-477. High strength, flexible thermoplastic splines shall be inserted mating, machined grooves in the pipe and coupling to provide full 360° restraint.

Restrained joint pipe systems shall have a restrained joint that in and of itself prevents over belling of the pipe during assembly of the joint and every joint already assembled in that string of pipe. Restrained joint system shall allow the installer to both push and pull the pipe during installation without the risk of over belling of any of the pipe joints in the string. Joint shall not require electrical power or other additional equipment (other than hand tools) to assemble.

H. FITTINGS: Pipe fittings shall be ductile iron, cement lined, in accordance with AWWA C-110 and SECTION 5.0 of these Specifications, Valves and Fittings. Pipe fittings shall be mechanical joint (MJ) unless otherwise specified.

I. PROVISIONS FOR THRUST: For 12-inch diameter water mains and smaller, concrete thrust blocks or other approved thrust restraint method shall be installed at all fittings and valves per design plans and in accordance with SECTION 3.1 of these Specifications. If approved, thrust restraint devices may be installed in lieu of thrust blocks as per manufacturer's specifications.

For 16-inch diameter water mains and larger, thrust restraint devices must be installed at all fittings and valves per manufacturer's specifications and as shown on design plans. Concrete thrust blocks are not allowed unless approved by the Utility.

Acceptable thrust restraint devices include EBAA Iron, Ford Uni-Flange, or approved equal.

NOTE: At connection of new water line to existing main, both concrete thrust blocking (per SECTION 3.1 of these Specifications) and thrust restraint devices must be used, regardless of main size.

Thrust restraint devices shall be used for a sufficient distance from each bend, tee, plug, or other fitting to resist thrust which will be developed at the design pressure of the pipe. For the purposes of thrust restraint, design pressure shall be 1.5 times the design working pressure class indicated. Length of pipe with restrained joints to resist thrust forces shall be determined by pipe manufacturer.

J. PIPE TRENCHING, INSTALLATION, AND BACKFILL: Except as noted, Pipe Trenching, Installation and Backfill for PVC Pressure Pipe shall be in accordance with AWWA M-23, C-900, C-905 and SECTION 4.0 of this specifications.

Trench Width: The minimum clear width of the trench should be 1 foot greater than the outside diameter of the pipe. The maximum clear width of the trench at a point 1 foot above the top of the pipe is equal to the pipe outside diameter plus 2 feet. If the maximum recommended trench width is exceeded or if the pipe is installed in a compacted embankment, then pipe embedment shall be compacted to a minimum point of 2-1/2 pipe diameters from the side of the pipe or to the trench walls.

Pipe Zone Embedment: Unless otherwise specified, PVC pressure pipe shall be embedded in Class II material as defined in SECTION 4.1. Native material or imported material meeting or exceeding Class II requirements may be used.

Installation: Plastic pressure pipe shall be installed in accordance with AWWA M 23 and C-900 and/or manufacturer's printed recommendations, whichever is applicable. Where a conflict arises with this specification, this specification shall control.

For push-on joints care shall be taken to insert the pipe spigot to the reference mark to prevent buckling or separation of the pipe joint. The reference mark shall be showing and not be further than 1/2-inch from the leading edge of the pipe bell. The contractor shall verify that the manufacturer's reference mark is correct per manufacturer's literature.

Pipe and couplings for a restrained joint pipe system shall be homogenous throughout and free from voids, cracks, inclusions and other defects, and shall be as uniform as commercially practicable in color, density, and other physical characteristics. Assembly shall not require that the pipe be allowed to rest after a joint is assembled prior to it being pulled in or connections being made. Pipe and restrained joint system shall enable the installer to pull the pipe while joint assembly takes place.

Under no circumstances should the pipe or accessories be dropped into the trench. When pipe laying is not in progress, open ends of installed pipe should be closed to prevent entrance of trench water, dirt, and foreign matter into the line.

Marking Tape: PVC pressure water pipe shall be marked by concurrently installing the appropriate marking tape for detection purposes. The detectable tape shall consist of a 5.0 mil inert polyethylene plastic material. It shall be high visibility blue with the standard warning and identification for potable water imprinted on the tape. The minimum width of detectable tape shall be 6-inches for all potable water lines. The burial depth shall be 36-inches, measured from finished grade. Detecting tape shall be manufactured by Empire, Lineguard, or approved equal.

Deflection: Maximum ring deflection of installed PVC pressure pipe shall be 5 percent. Joint deflection shall not exceed manufacturer's recommendations for the particular size pipe.

Corrosion Protection: As a precaution against corrosion, all flanges, bolts, nuts and other exposed metal surfaces underground shall be coated with Texaco, Koppers, or approved equal rustproof compound.

K. TESTING: Disinfect and test the piping system as detailed in AWWA C-651 and in accordance with the SECTION 6.6 of these Specifications.

1.2 DUCTILE IRON PIPE

A. SCOPE: Furnish all labor, materials, equipment and incidentals required and install all ductile iron piping, as shown on the drawings and as specified herein.

B. QUALITY ASSURANCE: Manufacturer shall have a minimum of ten years successful experience in designing and manufacturing DIP of the type specified. The entire pipeline shall be the product of one manufacturer. The manufacturer shall have a minimum of ten years successful experience in designing and manufacturing pipe joints of similar design, pipe diameter, and pressure class as those specified. Pipe shall conform to American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 61 "Drinking Water System Components - Health Effects" and be certified by and organization accredited by ANSI. Such compliance shall be evidenced by an affidavit from the manufacturer or vendor. If the pipe does not presently conform to this standard, information from the manufacturer regarding action being taken to comply with this standard must be submitted.

C. SUBMITTALS: Submit documentation on pipe products, fittings, and related materials as may be required by the Contract Documents or the Engineer. Review all submittals prior to submission. Submit in a timely manner so as not to delay the project. Allow sufficient time for Engineer's review and resubmission, if necessary. Include certifications from manufacturer that the Ductile Iron Pipe complies with appropriate AWWA Standards and ANSI/NSF Standard 61.

Such compliance shall be evidenced by an affidavit from the manufacturer or vendor. If the pipe does not presently conform to this standard, information from the manufacturer regarding action being taken to comply with this standard must be submitted.

If requested, copies of results of factory hydrostatic tests shall be provided.

D. STANDARDS: DIP shall comply with applicable requirements of the following:

ANSI/NSF 61	Drinking Water System Components - Health Effects
ASTM A-536	Specification for Ductile Iron Castings
AWWA C-104	Standard for Cement Mortar Lining for Ductile Iron Pipe and Fittings
AWWA C-105	Standard for Polyethylene Encasement for Ductile Iron Piping
AWWA C-110	Standard for Ductile Iron and Gray Iron Fittings
AWWA C-111	Standard for Rubber Gasket Joints for Ductile Iron Pipe and Fittings
AWWA C-150	Standard for Thickness Design of Ductile Iron Pipe
AWWA C-151	Standard for Ductile Iron Pipe
AWWA C-214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C-600	Standard for Installation of Ductile Iron Water Mains and Appurtenances
AWWA C-651	Disinfecting Water Mains

E. PIPE MATERIALS: Ductile iron pipe shall be manufactured in accordance with AWWA C-151. The minimum pressure class rating shall be 350 psi, unless otherwise specified. The Ductile Iron shall conform to ASTM Specification A-536 with physical properties of Grade 60-40-18. The pipe shall be designed for five (5) feet of cover or for the depths shown on the plans, whichever is greater.

Standard joint length shall be 18 or 20 feet and inside diameter shall be industry standard. A maximum of 20% of the total number of pipe joints of each specified size may be furnished in lengths that are as much as 24" shorter than the standard laying length and an additional 10% may be furnished in length that are as much as 6" shorter than the standard laying length.

Contractor shall be responsible for all material furnished by him and shall replace, at his own expense, any material found to be defective in manufacture or damaged.

F. JOINTS: Shall be in accordance with AWWA C-111, AWWA C-151. Standard joints for ductile iron pipe shall be push-on. Where indicated on the drawings, joints shall be mechanical or flanged. Flanged joints shall have pressure ratings equal to or greater than adjacent pipe. Flange pattern shall match pattern of valve, fitting, or appurtenance to be attached.

G. FITTINGS: Shall be ductile iron in accordance with AWWA C-110 and SECTION 5.0 of these Specifications. Fittings shall be rated for a minimum working pressure of 250 psi, unless otherwise specified.

Factory welded outlets, minimum pressure rating 250 psi, may be used in lieu of tee fittings for 18-inches and larger tee fittings. Factory welded outlets may not be used near sources of vibration, such as pump stations or roads, unless specifically noted on the plans.

H. EXTERIOR COATING: The manufacturer shall provide a standard asphaltic coating in accordance with AWWA C-151, unless otherwise specified. The finished coating shall be continuous, and smooth and strongly adherent to the pipe.

Polyethylene wrap shall be used on ductile iron for sizes 30-inches and smaller. The polyethylene wrap shall be applied in accordance with AWWA C-105/A21.5 except a minimum thickness of 30 mils shall be used. Wrap shall be blue in color.

Tape coating shall be used for pipe sizes 36-inch and larger where specified. The exterior of the pipe shall have a prefabricated cold-applied tape coating system conforming to the requirements of ANSI/AWWA C-214, except as noted herein. The surface shall be blast cleaned to achieve a surface preparation at least equal to that specified in SSPC SP6. The blast profile shall have an anchor pattern as specified by the tape manufacturer. The coating shall be held back from the end of the pipe the minimum distance recommended by the pipe manufacturer for the type of joint used. Tape wrap cut back shall be tapered. Nominal thickness shall be 80 mils.

I. INTERIOR LINING: Ductile Iron Pipe and fittings shall have a cement mortar lining in accordance with AWWA C-104 and bituminous seal coat. Cement Type for lining shall be appropriate for pipe application. Lining thickness shall be as specified in AWWA C-104.

J. PROVISIONS FOR THRUST: Where indicated and where required for thrust restraint, joints shall be restrained. Restrained joints shall be mechanically interlocking joints. Restrained joints shall be U.S. Pipe "TR Flex," American Cast Iron Pipe "Flex Ring," or Clow Corporation "Super-Lock." Restrained joints shall be capable of sustaining the specified design pressure. If thrust cannot be accommodated using restrained joints, such as bends adjacent to casing pipe, use approved thrust restraint devices.

Thrust at bends, tees, plugs, or other fittings shall be resisted using thrust restraint devices. Concrete thrust blocks are not allowed unless approved by the Utility. Acceptable thrust restraint devices shall be as manufactured by EBAA Iron, Ford Uni-Flange, or approved equal.

NOTE: At connection of new water line to existing main, both concrete thrust blocking (per SECTION 3.1 of these Specifications) and thrust restraint devices must be used.

Restrained joints and thrust restraint devices shall be used for a sufficient distance from each bend, tee, plug, or other fitting to resist thrust which will be developed at the design pressure of the pipe. For the purposes of thrust restraint, design pressure shall be 1.5 times the design working pressure class indicated. Length of pipe with restrained joints and restraint devices shall be determined by pipe manufacturer and/or in accordance with the Handbook of Ductile Iron Pipe. The following parameters shall be used: laying condition equal to AWWA C-600 Type 5 soil, safety factor of 1.8, a unit bearing resistance equal to zero, an a factor for polyethylene encasement as recommended by DIPRA, if required.

K. PIPE TRENCHING, INSTALLATION AND BACKFILL: Except as noted, Pipe Trenching, Installation, and Backfill for DIP shall be in accordance with AWWA C-600 and SECTION 4.0 of these Specifications.

General: Any damage to Polyethylene wrap shall be repaired according to AWWA C-105. Pipe shall be kept clean during installation. Exposed ferrous metal which cannot be protected with field-applied tape coating, shall receive two coats of Koppers Bitumastic No. 50, or approved equal.

Pipe and fittings shall be installed to line and grade indicated. In areas where the line and grades indicated cannot be achieved using standard manufactured bends and fittings, make slight adjustments by deflecting joints according to the limitations of AWWA C-600.

Pipe Zone Embedment: Unless otherwise specified, Ductile Iron Pipe shall be embedded in Class II material as defined in SECTION 4.1. Native material or imported material meeting or exceeding Class II requirements may be used.

Marking Tape: Ductile Iron water pipe shall be marked by concurrently installing the appropriate marking tape for detection purposes. The detectable tape shall consist of a 5.0 mil inert polyethylene plastic material. It shall be high visibility blue with the standard warning and identification for potable water imprinted on the tape. The minimum width of detectable tape shall be 6-inches for all potable water lines. The burial depth shall be 36-inches, measured from finished grade. Detecting tape shall be manufactured by Empire, Lineguard, or approved equal.

Pipe Cutting: When required, the cutting shall be by machine, leaving a smooth cut at right angles to the axis of the pipe. Ends of cut pipe to be used with a push-on joint bell shall be beveled to comply with manufactured spigot end. Cement lining shall be undamaged.

Corrosion Protection: As a precaution against corrosion, all flanges, bolts, nuts and other exposed metal surfaces underground shall be coated with Texaco, Koppers, or equal rustproof compound.

L. TESTING: Disinfect and test the piping system in accordance with SECTION 6.6 of these Specifications and as detailed in AWWA C-651.

1.3 STEEL PIPE

A. SCOPE: Furnish labor, materials, equipment, and incidents necessary to install cement mortar lined, tape coated steel pipe, fittings, and specials as specified and as required for the proper installation and function of the pipe.

B. QUALITY ASSURANCE: Steel pipe and fittings shall conform to applicable standards of ASTM and AWWA. It is preferable that steel pipe conform to ANSI/NSF Standard 61 "Drinking Water System Components – Health Effects."

Pipe shall be the product of one manufacturer which has had not less than five (5) years successful experience manufacturing pipe of the particular type and size indicated. Pipe manufacturing operations (pipe, fittings, lining, coating) shall be performed at one location.

Each joint of pipe and each fitting shall have plainly marked on one end: the class for which it is designated, the date of manufacturer, and the identification number.

The quality of materials, the process of manufacture and the finished pipe will be subject to inspection and approval. Inspections may be made at the place of manufacture, on the jobsite or both places. Rejected materials shall be promptly removed from the jobsite.

Pipe may be subject to inspection by an independent testing laboratory selected and retained by the Owner. Representatives of the laboratory or the Engineer shall have access to the work whenever it is in preparation or progress, and the Pipe Manufacturer shall provide proper facilities for access and for inspection. The Pipe Manufacturer shall notify the Owner in writing, at least two weeks prior to the pipe fabrication so that the Owner may advise the Manufacturer as to the Owner's

decision regarding tests to be performed by an independent testing laboratory. Material, fabricated parts, and pipe, which are discovered to be defective, or which do not conform to the requirements of this specification shall be subject to rejection at any time prior to Owner's final acceptance of the product.

The inspection and testing by the independent testing laboratory anticipates that production of pipe shall be done over a normal period of time and without "slowdowns" or other abnormal delays. In the event that an abnormal production time is required, and the Owner is required to pay excessive costs for inspection, then the Contractor shall be required to reimburse the Owner for such laboratory costs over and above those which would have been incurred under a normal schedule of production as determined by the Engineer.

Welders shall be certified as qualified in accordance with Chapter 9 of the ASME Boiler and Pressure Vessel Code and AWWA C-206. Welds will be tested by the Owner in accordance with ASTM E-165 and welded test specimens shall be submitted upon request.

C. SUBMITTALS: The Pipe Manufacturer shall furnish record drawings of the pipe and fittings prior to fabrication. Record drawings shall include a schematic location-profile and a tabulated layout schedule, both of which shall be appropriately referenced to the stationing of the proposed pipeline as shown on the plan-profile sheets. These record drawings shall be based on the plans and specifications and shall incorporate changes necessary to avoid conflicts with existing details of reinforcement, lining, and dimensions for pipe and fittings. Details for the design and fabrication of all fittings, specials, and provisions for thrust restraint shall be included. Where welded joints are required, record drawings shall include proposed welding requirements and provisions for thermal stress control. Record drawings are for record purposes only and will not be reviewed or approved by the Engineer.

An affidavit stating that the pipe to be furnished complies with AWWA C-200, AWWA C-205, AWWA C-214, and these specifications.

Copies of the results of the factory hydrostatic tests shall be provided to the Engineer, if requested.

Certified reports of steel cylinder tests and cement mortar for linings, if requested.

Mill certificates, including chemical and physical test results for each heat of steel, if requested.

Furnish the Engineer for prior review procedure, specifications, and qualification records of welding procedures for all pipe welding to be performed. All qualification and requalification tests costs shall be at the expense of the Contractor. The contractor shall submit a list of the welders he proposes using and the type of welding for which each has been qualified.

D. STANDARDS: Steel Pipe and fittings shall comply with applicable requirements of the following:

ASTM A-307	Low Carbon Steel Externally Threaded Standard Fasteners
AWWA C-200	Standard for Steel Water Pipe 6-inches and Larger
AWWA C-205	Standard for Cement Mortar Protective Lining and Coating for Steel Water Pipe - 4-inches and Larger
AWWA C-206	Standard for Field Welding of Steel Water Pipe
AWWA C-207	Standard for Steel Pipe Flanges Waterworks Service – Sizes 4"-144"
AWWA C-208	Standard for Dimensions for Steel Water Pipe Fittings
AWWA C-209	Standard for Cold Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings
AWWA C-214	Standard for Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA M-11	Manual: Steel Pipe – A Guide for Design and Installation

E. DELIVERY AND STORAGE: Deliver, handle, and store pipe in accordance with the Manufacturer's recommendations to protect coating systems. The pipe shall be prepared for shipment to afford maximum protection from normal hazards of transportation and allow pipe to reach project site in an undamaged condition. Pipe damaged in shipment shall be delivered to the project site unless such damaged pipe is properly repaired.

Plastic end covers shall be banded to the pipe ends and maintained until pipe is to be placed in the trench. Moisture shall be maintained inside the pipe by periodic application of water, as necessary.

Pipes shall be carefully supported during shipment and storage. Each end of each length of pipe, fitting, or special and the middle of each pipe joint shall be internally supported and braced with stulls to maintain a true circular shape. Internal supports shall consist of timber or steel stulls firmly wedged and secured so that the stulls remain in place during handling. Pipe shall be rotated so that one of the stulls is vertical during storage, shipment, and installation. Stulls shall not be removed from pipe until backfill operations are complete. Pipe, fittings, and specials shall be separated so that they do not bear against each other, and the whole load shall be securely fastened to prevent movement in transit. Ship pipe on padded bunks with tie-down straps approximately over stulling. Store pipe on padded skids, sand or dirt berm, tires, or other suitable means to protect the pipe from damage.

F. PIPE MATERIALS: Steel pipe manufacture under AWWA C-200 shall be fabricated from sheet or coil conforming to the requirements of ASTM A-570, Grades 30, 33, 36, or 40. It can also be fabricated from plate in coil form conforming to the requirements of ASTM A-36, A-283, Grades C or D, or A 572, Grade 42, or coil conforming to the requirements of ASTM A-139, Grades B or C. All longitudinal and girth seams, whether straight or spiral, shall be butt welded using an approved electric-fusion weld process. Standard laying length shall be 45-feet.

Wall Thickness shall be as determined by performance requirements. The minimum pipe wall thickness shall be 0.188" or pipe O.D./230, whichever is greater for pipe and fittings with no minus tolerance. The minimum wall thickness shall also be such that the fiber stress shall not exceed 21,000 psi at design working pressure and shall not exceed 50% of the minimum yield strength of the steel used at the specified maximum working pressure for each class of pipe. In addition, the fiber stress shall not exceed 75% of the maximum yield strength at the working pressure plus transient pressure. Pipe to be placed in casing or tunnel liner shall have a minimum wall thickness of O.D./144 or 0.25" whichever is greater.

Exterior Tape Coating: Pipe shall be coated and wrapped outside with the pre-fabricated multi-layer cold-applied polyethylene tape coating that is in accordance with AWWA C-214. Machine-applied tape coating system shall be 80 mils consisting of a primer, 20 mil inner layer, and two (2) 30 mil outer layers in accordance with AWWA C-214. The coating shall be held back from the end of the pipe the minimum distance recommended by the pipe manufacturer for the specified joint type. Tape wrap cut back shall be tapered.

Hand wrap specials and fittings which cannot be machine wrapped. The application shall conform to AWWA C-209 and consist of three layers, a primer layer and two 35 mm tape layers. Allow the fitting coating system to overlap the machine-applied coating system a minimum of 6-inches and bond together. The manufacturer for hand wrap tape and machine wrap tap shall be the same. Tape coating manufacturer shall recommend the procedure and tape product required to smooth sharp or abrupt changes at bell, spigot, or flanged joints.

Cement Mortar Lining: Shop-applied cement linings shall conform to the requirements of AWWA C-205. Cement shall be ASTM C-150 Type I or II. Sand shall be silica sand.

Linings on fittings and specials, such as miters, angles, bends and reducers, may be hand troweled. Field applied cement mortar-lining shall be in accordance with ASTM C-602. The interior of the pipe shall be thoroughly cleaned by a method acceptable to the Engineer.

Mortar for Interior Joints: Mortar shall be one part cement to two parts sand. Cement shall be ASTM C-150, Type I or Type II. Sand shall be of silica base. Sand shall be plaster sand meeting

ASTM C-35. Cement and sand shall be dry mixed and sufficient water added to permit packing and troweling without crumbling.

G. PIPE DESIGN: Steel pipe shall be designed, manufactured, and tested in accordance with AWWA C-200, AWWA Manual M-11, and with the criteria specified herein. Sizes and pressure classes (working pressure) shall be as specified. For the purpose of pipe design, the total design internal pressure (transient pressure plus working pressure) shall be 1.5 times the working pressure class specified. Fittings, specials, and connections shall be designed for the same pressure as the adjacent pipe. Pipe design shall be based on trench conditions and the design pressure in accordance with AWWA Manual M-11. The trench depth shall be a specified, the Unit Weight of Fill (W) shall be 130 pcf, live load shall be AASHTO HS-20 truck load (unless otherwise specified). A deflection lag factor 1.1 and a bedding constant of 0.1 shall be used. The modulus of Soil Reaction (E') for design purposes shall be 700 and the maximum allowable horizontal or vertical deflection shall be 2% after backfill. Design calculations shall be submitted to the engineer for approval prior to the fabrication of the pipe.

Standard laying length shall be 45 feet with special lengths, field trim pieces, and closure pieces as required by plan and profile for location of elbows, tees, reducers, and other in-line fittings.

H. JOINTS: The standard field joint for steel pipe shall be either a single welded lap joint or a rubber gasket joint. Mechanically coupled or flanged joints shall be required where shown. Butt strap joints shall be used where shown. The joints furnished shall have the same or higher pressure rating as the abutting pipe.

Lap Welded Slip Joint: Lap welded slip joint shall be provided in all locations where pipe is to be installed in casing or tunnels and where specified. Clearance between the surfaces of lap joints shall not exceed 1/8-inch at any point around the periphery.

In addition to the provisions for a minimum lap of 1-1/2" as specified in AWWA C-200, the depth of bell shall be such as to provide for a minimum distance of 1-inch between the weld and the nearest tangent of the bell radius when welds are to be located on the inside of the pipe.

Lap welded slip joints shall be welded from the outside for pipe diameters 30-inches or smaller. Lap welded slip joints shall be welded on the inside for pipe diameters larger than 30-inches. If specified on the drawings, lap welded slip joints shall be welded on the inside and outside.

Bell and Spigot with Rubber Gasket: The standard joint, at locations where other joint types are not specified and for working pressures not exceeding 250 psi, shall be bell and spigot with rubber gasket. Joints shall conform to AWWA Standards C-200 and AWWA M-11. The spigot and groove designed to retain the O-ring rubber gasket shall be formed and sized by rolling on male-female dies to match the bell. The differences in diameter between the I.D. of bell and the O.D. of spigot shoulder, at point of full engagement with allowable deflection, shall be .00" to .04" as measured on the circumference with a diameter tape. The gasket shall have sufficient volume to approximately fill the area of the groove and shall conform to AWWA C-200 and AWWA M-11. The joint shall be suitable for a safe pressure equal to the pressure class of the pipe furnished and shall operate satisfactorily with a deflection tangent of which is not to exceed 0.75D where D is the outside diameter of the pipe in inches or with a pull-out of 3/4-inches.

Flanged Joints: Flanged joints shall be provided on pipe, fittings and specials on welded steel piping exposed in vaults, on buried pipe system to connect valves and appurtenances or where otherwise indicated. Ends to be fitted with slip-on flanges shall have the longitudinal or spiral welds ground flush to accommodate the type of flanges provided. Pipe flanges and welding of flanges to steel pipe shall conform to the requirements of AWWA C-207 and AWWA C-206. Pipe flanges shall be of rated pressure equal to or greater than the adjacent pipe class. Flanges shall match the fittings or appurtenances which are to be attached.

Butt Strap Closure Joints: Shall be provided where necessary to provide closure to pipe previously laid, in accordance with AWWA C-206 and applicable provisions of this specification.

Flexible Couplings: Flexible couplings shall be provided where specified. Ends to be joined by flexible couplings shall be of the plain end type, prepared as stipulated in AWWA C-200. Additionally, the welds on ends to be joined by couplings shall be ground flush to permit slipping the coupling in at least one direction to clear pipe joint. Harness bolts and lugs shall comply with AWWA Manual M-11.

I. FITTINGS AND SPECIALS: Where abrupt changes in grade and direction occur, the Contractor shall employ special shop fabricated fittings for the purpose. Fittings and specials shall be fabricated in accordance with AWWA C-200 and M-11. Fittings shall conform to the dimensions specified in AWWA C-208. Elbows shall have a minimum radius of 2.5 times the pipe O.D.. Welded fittings shall be of the sizes and types indicated on the drawings. Thickness of steel plate for fittings shall be equal to or greater than nominal thickness of steel pipe. All tees, laterals, and outlets shall be reinforced in accordance with M-11.

Field cutting the ends of the steel pipe to accomplish angular changes in grade or direction of the line shall not be permitted.

J. PROVISIONS FOR THRUST: Thrust at bends, tees, or other fittings shall be resisted by restrained joints. If thrust cannot be resisted using restrained joints, such as bends adjacent to casing pipe, use thrust blocking or concrete anchors to resist thrust.

Restrained joints shall be used a sufficient distance from each side of the bend, tee, plug, or other fitting to resist thrust which develops at the design pressure of the pipe. For the purposes of thrust restraint, design pressure shall be 1.5 times the working pressure class. Restrained joints shall consist of welded joints.

The length of pipe with restrained joints to resist thrust forces shall be determined by the pipe manufacturer in accordance with AWWA Manual M-11. The following criteria shall be applied for unsaturated soil conditions: the weight of earth shall be calculated as the weight of the projected soil prism above the pipe, soil density = 110 pcf (maximum value to be used) and the coefficient of friction = 0.25 (maximum value to be used). In locations where groundwater is encountered, the soil density shall be reduced to its buoyant weight for all backfill below the water table and the coefficient of friction shall be reduced to 0.20.

K. PIPE TRENCHING, INSTALLATION, AND BACKFILL: Except as noted, Pipe Trenching, Installation, and Backfill of Steel Pipe shall be in accordance with AWWA M-11 and SECTION 4.0 of these Specifications.

General: Just before each joint is lowered into the ditch, it is to be inspected and "jeeped" for holidays. All holidays are to be repaired before the pipe is lowered into the trench.

Place and consolidate embedment and backfill prior to removing pipe stulls.

Trench Width: The minimum clear width of the trench shall be Outer Diameter plus 36-inches.

Pipe Embedment: Unless otherwise specified or shown on the drawings, steel pipe shall be embedded in NATIVE material as defined in SECTION 4.1. If NATIVE material is not suitable, CLASS II material as defined in Article 1.3 of SECTION 4.1 shall be used.

Installation-Welded Joints: Weld joints in accordance with the AWWA C-206. Welds shall be full circle fillet welds. If the ends of the pipe are laminated, split, or damaged to the extent of satisfactory welding contact cannot be obtained, remove the pipe from the line.

Each welder shall be required to identify his work with a code marking and a listing of the names of the welders with corresponding code marks shall be furnished to the Engineer. Any welder making defective welds shall not be allowed to continue to weld.

If the Contractor disagrees with the Engineer's interpretation of welding tests, test sections may be cut from the joint for physical testing. The Contractor shall bear the expense of repairing the joint,

regardless of the results of physical testing. The procedure for repairing the joint shall be approved by the Engineer before proceeding.

Adequate provisions for reducing temperature stresses shall be the responsibility of the Contractor.

After the pipes have been joined and properly aligned and prior to the start of the welding procedure, the spigot and bell shall be made essentially concentric by shimming or tacking to obtain clearance tolerance around the periphery of the joint. In no case shall the clearance tolerance be permitted to accumulate.

Before welding, thoroughly clean pipe ends. Weld pipe by machine or by the manual shielded electric arc process. Welding shall be performed so as not to damage lining or coating. Cover the tape coating as necessary to protect from welding.

Furnish labor, equipment, tools and supplies, including shielded type welding road. Protect welding road from any deterioration prior to its use. If any portion of a box or carton is damaged, reject the entire box or carton.

Deposit metal in successive layers so that there will be at least 2 passes or beads in the completed welds. Deposit no more than ¼-inch of metal on each pass. Thoroughly clean each pass, including the final pass, by wire brushing and hammering to remove dirt, slag, or flux.

In all hand welding, the metal shall be deposited in successive layers so that there are at least as many passes or beads in the completed weld as indicated in the following table:

Plate Thickness Inches	Fillet Weld, Minimum Number of Passes
3/16”	1
1/4”	2
5/16”	2
3/8”	3
13/32”	3
7/16”	3
15/32”	4
1/2”	4
More than ½”	1 for each 1/8” and any remaining fraction thereof.

For hand welds, not more than 1/8” of metal shall be deposited in each pass. Each pass except the final one, whether in butt or fillet welds, shall be thoroughly bobbed or peened to relieve shrinkage stresses and to remove dirt, slag, or flux before the succeeding bead is applied. Each pass shall be thoroughly fused into the plates at each side of the welding groove or fillet and shall not be permitted to pile up in the center of the weld. Undercutting along the side shall not be permitted.

Welds shall be free from pin holes, non-metallic inclusions, air pockets, undercutting and/or any other defects.

Installation – Rubber Gasket Joints: Join rubber gasket joints in accordance with the manufacturer’s recommendations. Clean bell and spigot of foreign materials. Lubricate gaskets and relieve gasket tension around the perimeter of the pipe. Engage spigot as far as possible in bell, allowing for a 3/8-inch to 1-inch gap for inside joint grouting after any joint deflection.

Interior Joint Grouting for Pipe with Plant-Applied Mortar Lining: Upon completion of backfill, fill the inside joint recess with a stiff cement mortar as indicated.

Prior to the placing of mortar, clean out dirt or trash which has collected in the joint, and moisten the mortar surfaces of the joint space by spraying or brushing with a wet brush. Ram or pack the stiff mortar into the joint and take extreme care to insure that no voids remain in the joint space.

After the joint has been filled, level the surface of the joint with the interior surfaces of the pipe by steel troweling.

Carefully inspect every joint to insure a smooth continuous interior surface. Thoroughly clean the interior of the pipe and remove any obstructions that may reduce its carrying capacity.

Interior joints of pipe smaller than 21-inches in diameter shall have the bottom of the bell buttered with mortar, prior to inserting the spigots, such that when the spigot is pushed into position it extrudes surplus mortar from the joint. The surplus mortar shall be struck off flush by pulling a filled burlap bag or inflated ball through the pipe.

Field-Applied Outside Joint Coating: Clean the surface of foreign materials. Remove weld slag, splatter, and scale. Remove by grinding or filing the sharp edges or burrs that could puncture or cut the tape. Clean the surface using a solvent wash and wire brushing, dry, and prime the surface prior to tape coating.

Wrap joints with a tape coating system conforming to AWWA C-209, consisting of three layers, a primer layer and two (2) 35-mm tape layers. Overlap the factory-applied coating system with the field-applied coating system a minimum of 6-inches and bond together.

Protection of Exposed Metal: Exposed ferrous metal such as bolts and flanges which cannot be protected with field-applied tape coatings shall receive a coat of Koppers Bitumastic No. 50.

Patch of Coating: When visual inspection shows a portion of the tape system has sustained physical damage, the area in question may be subjected to an electrical holiday test to 6000 volts.

When the area is tested and there are no holidays or tearing of the material (only winkling or bruising), no patching is required.

When the damaged area has a tearing of material, remove the damaged layer(s) of outer-wrap by carefully cutting with a sharp razor type utility knife. Wipe the area clean and dry with a rag. Apply the repair tape using a "cigarette wrap" in accordance with the tape manufacturer's recommendation of sufficient size to completely cover the damaged areas, plus a minimum overlap of 6-inches tape in all directions. Apply a second patch of repair tape over the first patch. Overlap the first patch a minimum of 6-inches with the second patch.

Patch of Lining: Repair cracks larger than 1/16-inch and disbanded linings. Excessive patching of lining shall not be permitted. Field-patching of lining shall be allowed where area to be repaired does not exceed 100 square inches and has no dimension greater than 12-inches. Repair larger areas by gunite method and reinforce work. In general, there shall be not more than one patch in the lining of any joint of pipe.

Wherever necessary to patch the pipe, make the patch with the mortar indicated. Do not install patched pipe until the patch has been properly and adequately cured and unless approved for laying by the pipe manufacturer's technician and by the Engineer.

L. TESTING: Disinfect the piping system in accordance with SECTION 6.6 of these Specifications and as detailed in AWWA C-651.

Test the field-applied joint coating for holidays after field-applied coating and prior to backfilling as per AWWA C-209.

Where welds cannot be tested by hydrostatic tests, such as fittings adjacent to test valves, Contractor shall perform a dye penetrant test in accordance with ASTM E-165. Replace or repair welds, whichever is deemed necessary by Engineer that prove to be defective at the Contractor's expense. The Engineer shall approve all patch work necessary during such tests.

M. CATHODIC PROTECTION:

1. Anodes:

a. Magnesium bar in pre-packaged backfill with test lead wire, in weights following Drawings.

b. Chemical Composition of Magnesium Anodes: Percent by weight.

	Standard	High Potential
Aluminum	5.0 – 7.00	0.010 Max.
Zinc	2.0 – 4.00	0.05 Max.
Manganese	0.150 Min.	0.50 – 1.30
Copper	0.100 Max.	0.020 Max.
Silicon	0.300 Max.	0.05 Max.
Iron	0.003 Max.	0.030 Max.
Nickel	0.003 Max.	0.001 Max.
Others	0.300 Max.	0.050 each or 0.300 Max. Total
Magnesium	Balance	

c. Pre-packaged Backfill:

1) 75 percent ground hydrated gypsum

2) 20 percent powdered bentonite

3) 5 percent anhydrous sodium sulfate

4) In water permeable fabric sack with anode centered in sack

d. Lead Wire: No. 12 AWG 600 volts solid copper wire with THW, THWN, or THHN white insulation, at least 15-feet long and factory connected to core with silver brazing alloy with minimum silver content of 15 percent.

2. Detectable Warning Tape: Yellow Mylar encased aluminum foil, minimum of 6-inches wide, with imprinted words "CATHODIC PROTECTION".

3. Thermite Welding Of Wires:

a. Thermite weld test lead and joint bond wires to ductile iron and steel pipe joints and fittings, except where limited use of lugs is permitted following Standard Details. This weld process may be specified for use on other metallic structures.

b. Select and use thermite welding equipment following equipment manufacturer's instructions and Standard Details.

1) Use equipment and molds to accommodate wire size, metallic structure's shape, wire position of attachment (vertical or horizontal) and other criteria specified.

2) Before a mold is used, remove and clean slag, dirt, and other foreign matter from mold.

3) Use cartridge and charge size based on manufacturer's recommendations for specific application.

4) Different charges are required for steel and ductile iron.

c. Surface Preparation:

1) Surfaces with Little or No Coating: Clean to bare metal by grinding or filing area approximately 3-inches square to produce bright metal surface. Remove coating, dirt, mill scale, oxide, grease, moisture, and other foreign matter from weld areas.

2) Surfaces with High Performance or Thick Coating: Cut 4-inch square window through coating and clean 3-inch square of surface to bright metal, avoiding damage to surrounding coating.

d. Preparation for Welding: Before welding, remove wire insulation as required to fit mold, avoiding damage to exposed copper wire.

1) If wire is cut or nicked over half way through its diameter, cut off and strip new end.

2) If manufacturer requires use of copper sleeve, crimp it securely to wire and remove excess wire protruding from end of sleeve.

e. Test Connection:

1) After charge is set, remove mold and slag from weld area with welder's hammer.

2) Strike top and sides of weld with hammer to test secureness of connection.

3) If weld does not hold, remove scrap weld material, clean, and begin weld process again.

4) After welding and before coating cleaned weld area, Engineer may test joint bond wires for electrical continuity.

f. Weld Caps:

1) When weld passes test for soundness and electrical continuity, repair coating in weld area with petrolatum or petroleum wax mastic and weld cap placed over weld following Standard Details.

2) Apply mastic to fill weld cap or pre-filled weld cap and cover exposed metal of structure and wire to minimum thickness of 1/4-inch. Repair damage to coating around weld area following coating manufacturer's recommendations.

3) If weld cap will not fit due to physical space limitations, coat bare metal and wire in weld area with minimum 1/4-inch thickness of petrolatum or petroleum wax mastic.

END OF SECTION

2.0 SEWER MAIN MATERIALS

2.1 POLYVINYL CHLORIDE (PVC) FLEXIBLE PIPE

A. SCOPE: These standard specifications designate the requirements for the furnishing and installation of PVC (polyvinyl chloride) gravity pipe for sanitary sewage, with a standard dimension ratio (SDR) as shown in the drawings and/or specified herein. The Contractor shall furnish all materials, equipment, tools, labor, superintendence, and incidentals required for the complete construction of the work designated.

B. QUALITY ASSURANCE: All PVC pipe shall be coded to provide positive identification and prevent accidental damage to or interruption of the sanitary sewer facilities.

Only pipe manufactured in the United States of America will be accepted. All pipe, fittings, and accessories shall be new. Manufacturer's physical and chemical tests shall be performed according to the ASTM standard applicable to the respective PVC pipe type and diameter herein specified, in order to demonstrate pipe quality.

C. SUBMITTALS: Submit documentation on pipe products, fittings, and related materials as may be required by the Contract Documents or the Utility Engineer. Review all submittals prior to submission. Submit in a timely manner so as not to delay the project. Allow sufficient time for Engineer's review and resubmission, if necessary. Include certifications from manufacturer that the product complies with appropriate ASTM standards.

D. STANDARDS: PVC pipe shall comply with applicable requirements of the following:

ASTM D-1784	Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D-2321	Specification for Underground Installation of Flexible Thermoplastic Sewer Pipe
ASTM D-3034	Specification for Type PSM Poly (Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM D-3212	Joints for Drain and Sewer Pipes Using Flexible Elastomeric Seals
ASTM F-477	Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F-679	Specification for Poly (Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F-789	Specification for Type PS-46 Poly (Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings
ASTM F-794	Specification for Poly (Vinyl Chloride) (PVC) Large Diameter Ribbed Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

E. DELIVERY AND STORAGE: Pipe, fittings and accessories shall be inspected upon delivery and during progress of the work. Any material found defective will be rejected by the Engineer, and shall be promptly removed from site.

Contractor shall be responsible for all material furnished by him and shall replace, at his own expense, any material found to be defective in manufacture or damaged.

All pipe, fittings, and other accessories shall, unless otherwise directed, be unloaded at point of delivery, hauled to and distributed at the site of the work by the Contractor. In loading and unloading, materials shall be lifted by hoists or rolled on skidways so as to avoid shock or damage. Under no circumstances shall materials which have been dropped be incorporated in the work. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground.

PVC pipe shall not be stored outside exposed to prolonged periods of sunlight. Discoloration of pipe due to such exposure is an indication of reduced pipe strength and may be sufficient cause for rejection of the pipe. Any pipe rejected shall be removed from the job site.

F. PIPE SCHEDULE: Polyvinyl Chloride (PVC) pipe shall be designated as gravity sewer conduit and shall meet the requirements as set forth in the following schedule in the various diameters and types shown:

PIPE SIZE	ASTM STANDARD	MATERIAL	WALL TYPE	MINIMUM STIFFNESS	STANDARD LENGTH
8" 12" 15"	D-3034	PVC	SOLID SDR-35	46 psi	20'
	F-789	PVC	SOLID T1-WALL	46 psi	20'
18"	F-679	PVC	SOLID T1-WALL	46 psi	20'
	F-789	PVC	SOLID T1-WALL	46 psi	20'
	F-794	LARGE DIA PVC	PROFILE OPEN	46 psi	13'
21"-27"	F-679	PVC	SOLID T1-WALL	46 psi	20'
	F-794	LARGE DIA PVC	PROFILE OPEN OR CLOSED	46 psi	13'
30"-36"	F-794	LARGE DIA PVC	PROFILE OPEN OR CLOSED	46 psi	13'
39"-60"	F-794	LARGE DIA PVC	PROFILE CLOSED	46 psi	13'

Pipe shall be furnished in the standard lengths shown although not more than 15 percent may be in random lengths.

G. JOINTS: Joints shall be push-on, bell and spigot type, with elastomeric seals and conform to the requirements of ASTM D-3212. Gaskets shall be factory installed and chemically bonded to the bell end of the pipe. Gasket material shall conform to the requirements of ASTM F-477.

H. PIPE MATERIALS: Pipe and fittings shall be made from polyvinyl chloride compounds which comply with the requirements for minimum cell classification defined by ASTM D-1784. Fittings, service risers, and laterals shall be PVC with a SDR 35 rating.

I. PIPE TRENCHING, INSTALLATION AND BACKFILL: Except as noted, Pipe Trenching, Installation, and Backfill of PVC gravity sewer pipe shall be in accordance with ASTM D-2321 and SECTION 4.0 of these Specifications.

Trench Width: Trench width shall be as specified for FLEXIBLE PIPE in SECTION 4.2 of these Specifications.

Pipe Installation: Following the preparation of the trench bottom and trench bracing installed where required, pipe laying shall generally proceed upgrade with spigot ends pointing downgrade. Pipe shall be laid true to lines and grades as indicated on the drawings. Grade may be established by laser beam, or batter boards (not exceeding 50 foot intervals), and string line may be used with each pipe set to grade, from the string line, with a grade rod equipped with a "shoe" designed to fit into the flow line of the pipe.

J. TESTING: PVC shall be inspected, tested for leakage and deflection in accordance with

SECTION 7.3 of these Specifications.

2.2 DUCTILE IRON PIPE

A. SCOPE: Furnish all labor, materials, equipment and incidentals required and install all ductile iron piping, as shown on the drawings and as specified herein.

B. QUALITY ASSURANCE: Manufacturer shall have a minimum of ten years successful experience in designing and manufacturing DIP of the type specified. The entire pipeline shall be the product of one manufacturer. The manufacturer shall have a minimum of ten years successful experience in designing and manufacturing pipe joints of similar design, pipe diameter, and pressure class as those specified. Pipe shall conform to American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 61 "Drinking Water System Components - Health Effects" and be certified by and organization accredited by ANSI. Such compliance shall be evidenced by an affidavit from the manufacturer or vendor. If the pipe does not presently conform to this standard, information from the manufacturer regarding action being taken to comply with this standard must be submitted.

C. SUBMITTALS: Submit documentation on pipe products, fittings, and related materials as may be required by the Contract Documents or the Engineer. Review all submittals prior to submission. Submit in a timely manner so as not to delay the project. Allow sufficient time for Engineer's review and resubmission, if necessary. Include certifications from manufacturer that the Ductile Iron Pipe complies with appropriate AWWA Standards and ANSI/NSF Standard 61.

Such compliance shall be evidenced by an affidavit from the manufacturer or vendor. If the pipe does not presently conform to this standard, information from the manufacturer regarding action being taken to comply with this standard must be submitted.

If requested, copies of results of factory hydrostatic tests shall be provided.

D. STANDARDS: DIP shall comply with applicable requirements of the following:

ASTM A-746	Specification for Ductile Iron Gravity Sewer Pipe
AWWA C-104	Standard for Cement Mortar Lining for Ductile Iron Pipe and Fittings
AWWA C-105	Standard for Polyethylene Encasement for Ductile Iron Piping
AWWA C-110	Standard for Ductile Iron and Gray Iron Fittings
AWWA C-111	Standard for Rubber Gasket Joints for Ductile Iron Pipe and Fittings
AWWA C-150	Standard for Thickness Design of Ductile Iron Pipe
AWWA C-151	Standard for Ductile Iron Pipe

E. PIPE MATERIALS: Ductile iron pipe shall be manufactured in accordance with AWWA C-151. The minimum pressure class rating shall be 150 psi, unless otherwise specified. The Ductile Iron shall conform to ASTM Specification A-746 with physical properties of Grade 60-40-18. The pipe shall be designed for five (5) feet of cover or for the depths shown on the plans, whichever is greater.

Standard joint length shall be 18 or 20 feet and inside diameter shall be industry standard. A maximum of 20% of the total number of pipe joints of each specified size may be furnished in lengths that are as much as 24" shorter than the standard laying length and an additional 10% may be furnished in length that are as much as 6-inches shorter than the standard laying length.

Contractor shall be responsible for all material furnished by him and shall replace, at his own expense, any material found to be defective in manufacture or damaged.

F. JOINTS: Shall be in accordance with AWWA C-111, AWWA C-151. Standard joints for ductile iron pipe shall be push-on. Where indicated on the drawings, joints shall be mechanical or flanged. Flanged joints shall have pressure ratings equal to or greater than adjacent pipe. Flange pattern shall match pattern of valve, fitting, or appurtenance to be attached.

G. FITTINGS: Shall be ductile iron in accordance with AWWA C-110 and SECTION 5.0 of these Specifications. Fittings shall be rated for a minimum working pressure of 250 psi, unless otherwise specified.

Factory welded outlets, minimum pressure rating 250 psi, may be used in lieu of tee fittings for 18-inches and larger tee fittings. Factory welded outlets may not be used near sources of vibration, such as pump stations or roads, unless specifically noted on the plans.

H. EXTERIOR COATING: The manufacturer shall provide a standard asphaltic coating in accordance with AWWA C-151, unless otherwise specified. The finished coating shall be continuous, and smooth and strongly adherent to the pipe.

Polyethylene wrap shall be used on ductile iron for sizes 30" and smaller. The polyethylene wrap shall be applied in accordance with AWWA C-105/A21.5 except a minimum thickness of 30 mils shall be used. Wrap shall be green in color.

Tape coating shall be used for pipe sizes 36-inch and larger where specified. The exterior of the pipe shall have a prefabricated cold-applied tape coating system conforming to the requirements of ANSI/AWWA C-214, except as noted herein. The surface shall be blast cleaned to achieve a surface preparation at least equal to that specified in SSPC SP6. The blast profile shall have an anchor pattern as specified by the tape manufacturer. The coating shall be held back from the end of the pipe the minimum distance recommended by the pipe manufacturer for the type of joint used. Tape wrap cut back shall be tapered. Nominal thickness shall be 80 mils.

I. INTERIOR LINING: Ductile Iron Pipe and fittings shall have an epoxy lining in accordance with ASTM D714. Epoxy lining shall be appropriate for wastewater pipe application. Lining thickness shall be 40 mils (min.).

J. PROVISIONS FOR THRUST: Where indicated and where required for thrust restraint, joints shall be restrained. Restrained joints shall be mechanically interlocking joints. Restrained joints shall be U.S. Pipe "TR Flex," American Cast Iron Pipe "Flex Ring," or Clow Corporation "Super-Lock." Restrained joints shall be capable of sustaining the specified design pressure. If thrust cannot be accommodated using restrained joints, such as bends adjacent to casing pipe, use approved thrust restraint devices.

Thrust at bends, tees, plugs, or other fittings shall be resisted using thrust restraint devices. Concrete thrust blocks are not allowed unless approved by the Utility. Acceptable thrust restraint devices shall be as manufactured by EBAA Iron, Ford Uni-Flange, or approved equal.

NOTE: At connection of new water line to existing main, both concrete thrust blocking (per SECTION 3.1 of these Specifications) and thrust restraint devices must be used.

Restrained joints shall be used for a sufficient distance from each bend, tee, plug, or other fitting to resist thrust which will be developed at the design pressure of the pipe. For the purposes of thrust restraint, design pressure shall be 1.5 times the design working pressure class indicated. Length of pipe with restrained joints to resist thrust forces shall be determined by pipe manufacturer in accordance with the Handbook of Ductile Iron Pipe. The following parameters shall be used: laying condition equal to AWWA C-600 Type 5 soil, safety factor of 1.8, a unit bearing resistance equal to zero, an a factor for polyethylene encasement as recommended by DIPRA, if required.

K. PIPE TRENCHING, INSTALLATION AND BACKFILL: Except as noted, Pipe Trenching, Installation and Backfill for DIP shall be in accordance with AWWA C-600 and SECTION 4.0 of these Specifications.

General: Any damage to Polyethylene wrap shall be repaired according to AWWA C-105. Pipe shall be kept clean during installation. Exposed ferrous metal which cannot be protected with field-applied tape coating, shall receive two coats of Koppers Bitumastic No. 50, or approved equal.

Pipe and fittings shall be installed to line and grade indicated. In areas where the line and grades indicated cannot be achieved using standard manufactured bends and fittings, make slight adjustments by deflecting joints according to the limitations of AWWA C-600.

Pipe Zone Embedment: Unless otherwise specified, Ductile Iron Pipe shall be embedded in Class II material as defined in SECTION 4.1. Native material or imported material meeting or exceeding Class II requirements may be used. Class I material may be acceptable only in groundwater conditions if approved by the Utility.

Pipe Cutting: When required, the cutting shall be by machine, leaving a smooth cut at right angles to the axis of the pipe. Ends of cut pipe to be used with a push-on joint bell shall be beveled to comply with manufactured spigot end. Cement lining shall be undamaged.

Corrosion Protection: As a precaution against corrosion, all flanges, bolts, nuts and other exposed metal surfaces underground shall be coated with Texaco, Koppers, or equal rustproof compound.

L. TESTING: Disinfect and test the piping system in accordance with SECTION 6.6 of these Specifications and as detailed in AWWA C-651.

END OF SECTION

3.0 MISCELLANEOUS MATERIALS

3.1 CONCRETE *(May be superseded by governing agency)*

A. SCOPE: The Contractor shall furnish all materials, equipment, labor superintendence and incidentals necessary to mix and place concrete, consisting of Portland cement, fine aggregate, coarse aggregate, admixtures, and water in the proper proportions as specified herein.

B. QUALITY ASSURANCE: Concrete shall be proportioned to give the necessary workability and strength and shall conform to the following requirements:

CLASS	MINIMUM 28-DAY COMPRESSIVE STRENGTH	MINIMUM CEMENT (bag/cu yd)	MAXIMUM SIZE COARSE AGGREGATE	SLUMP (inches)
A	3,000 psi	5.5	3/4"	3-1/2"
B	2,500 psi	4	1-1/2"	4"
C	4,000 psi	6	3/4"	4"

The class designations provided above are as defined by the Utility.

Class A shall be used for curb, gutter and sidewalk replacement.

Class B shall be used for thrust blocks, sewer pipe encasement, ground anchors for piping, and as noted in the plans.

Class C shall be used for special structures or as required by manufacturer's specifications for pre-cast structures and cast-in-place sewer manhole bases.

C. SUBMITTALS: Submit certified test reports regarding concrete mix design and reinforcing steel as may be required by the Contract Documents or the Utility Engineer. Submit in a timely manner so as not to delay the project. Allow sufficient time for Engineer's review and resubmission, if necessary.

D. STANDARDS: Concrete and related products shall comply with applicable requirements of the following:

ASTM C-33 Specification for Concrete Aggregates
ASTM C-150 Specification for Portland Cement
ASTM C-260 Specification for Air-Entraining Admixtures for Concrete
ASTM C-494 Specification for Chemical Admixtures for Concrete

E. MATERIALS: Portland Cement: Shall conform to ASTM C-150 for the appropriate required Type.

Aggregates: Shall conform to ASTM C-33. Fine aggregate shall consist of natural, washed and screened sand having clean, hard, strong, durable, un-coated grains complying with ASTM C-33. Coarse aggregates shall comply with ASTM C-33 Size 467, or Size 57, or Size 67. Local aggregates of proven durability may be used when acceptable to the Engineer.

Air-Entraining Admixture: Shall be used for concrete of 3,000 psi or greater and shall comply with ASTM C-260. The total average air content shall be in accordance with ACI 211.1.

Water Reducing Admixture: Shall be used when required by job conditions and shall comply with ASTM C-494. Use only admixtures which have been tested and accepted in mix designs, unless otherwise acceptable. Shall be used according to manufacturer's recommendations.

Set Retarding Admixtures: Shall comply with ASTM C-494 and be used with approval of the Engineer. Shall be used according to manufacturer's recommendations.

Water: Shall be clean and free from impurities. Drinking and ordinary household water is acceptable.

F. MANUFACTURED PRODUCTS: The forms shall be of wood or metal and shall be of sufficient strength to support the concrete without bulging between supports and sufficiently water tight to hold the concrete mortar. The forms shall be so constructed that the finished concrete shall be of the form and dimensions shown on the plans. All form work for exposed surfaces shall be of such material and so constructed so as to produce a smooth, even surface when the concrete is poured. All forms shall be oiled before use. In general, wall forms may be removed after the concrete has been in place for 24 hours. All exposed edges shall have a 3/4-inch chamfer whether or not so shown on the details. Immediately upon removal of the form, any honeycombed sections shall be repaired as directed.

Embedded Items: All bolts, pipe, pipe sleeves, inserts or other fixtures, required by the plans or these specifications to be embedded in the concrete, shall be set accurately in place and maintained in such positions during concreting operations.

Reinforcing Steel: Metal reinforcements shall conform to the following requirements. Bar Reinforcement shall be round, deformed bars, Grade 60, conforming to either "Specification for Rail Steel Deformed and Plain Bars for Concrete Reinforcement" (ASTM A-616), or "Specifications for Axle Steel Deformed and Plain Bars for Concrete Reinforcement" (ASTM A-617).

Rail Steel Bars will be permitted only where bending is not required. All reinforcement bars shall be permanently marked with grade identification marks or shall, on delivery, be accompanied by a manufacturer's guarantee of grade which will identify variation. Reinforcement stored on the site shall be protected from accumulation of grease, mud or other foreign matter and from rust producing conditions. Bars shall be free from rust, scale, oil, mud or structural defects when incorporated in the structures. Reinforcements shall be accurately placed and securely held in place during placement of concrete in accordance with the ACI Detailing Manual.

G. CONCRETE THRUST BLOCKING: All underground piping shall be blocked with concrete, bearing solidly against undisturbed trench walls, at all changes in direction.

The concrete blocking shall be placed against undisturbed trench walls with a minimum 18-inches between trench wall and pipe. Blocking shall extend a minimum of 0.75 **x** pipe diameter below and above the centerline of pipe and shall not extend beyond any joints. Blockings shall be placed in accordance with the recommendations of "A Guide for the Installation of Ductile Iron Pipe" published by Cast Iron Pipe Research Association.

If requested by the Owner, the ends of the thrust blocks shall be contained in wood or metal forms. Where upward thrusts are to be resisted, concrete anchor shall be reinforced.

Concrete used for Blocking shall be Class B. The minimum square feet of area of concrete bearing against undisturbed trench bank shall be in accordance with the following table:

BEARING SURFACE PER BEND		
PIPE SIZE	**TEE, DEAD END, 90 DEGREE BEND**	**45 AND 22-1/2 DEGREE BEND**
6"	4 sq. feet	3 sq. feet
8"	6 sq. feet	3 sq. feet
12"	13 sq. feet	7 sq. feet
16"	23 sq. feet	12 sq. feet

3.2 GROUT

A. SCOPE: Where called for in the plans or specifications, the Contractor shall provide all labor, materials, equipment, and incidentals required for grouting.

B. STANDARDS: Grout shall comply with applicable requirements of the following:

ASTM C-33 Specification for Concrete Aggregates
ASTM C-150 Specification for Portland Cement

C. MATERIALS: Types of grout may include the following

NON-SHRINK, EPOXY TYPE: Shall be a non-metallic, 100% solids, high strength epoxy grout such as Epoxtite as manufactured by A.C. Horn Company, or Five Star Epoxy Grout by U.S. Grout Corporation, or equal.

NON-SHRINK, NON-METALLIC TYPE: Shall be a premixed nonstaining cementitious grout requiring only the addition of water at the job site. Provide Darex In-Pakt Grout Pre-mix by A.C. Horn Company, or Masterflow 713 by Master Builders Company, or equal.

ORDINARY CEMENT-SAND GROUT: Consisting of 1 part by weight of Portland cement complying with ASTM C-150, Type V, to 3 parts by weight of clean sand of suitable gradation and complying with ASTM C-33.

At the Contractor's option, ordinary grout may be 4 sacks of masonry cement per cubic yard of clean sand, together with approved air-entraining agent and a minimum of clean water for placing. Where water repelling and shrinkage reducing requirements are shown or specified, use approved admixtures.

WATER: Use clean, fresh, potable water free from injurious amounts of oils, acids, alkalies, or organic matter.

END OF SECTION

4.0 SITE WORK

Submittals shall include certified test reports for embedment material. Certified test reports shall be from an independent laboratory. Test reports shall include sieve analysis and Atterberg limits.

4.1 PIPE ZONE AND FINAL BACKFILL MATERIALS

A. STANDARDS: Embedment materials shall comply with applicable requirements of the following:

ASTM D-75	Methods for Sampling Aggregates
ASTM D-448	Specification for Standard Sizes of Coarse Aggregate for Highway Construction
ASTM D-2321	Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe
ASTM D-2487	Classification of Soils for Engineering Purposes

B. DEFINITIONS: For the purpose of this specification, "pipe zone" shall define the area extending from the bottom of the trench to 12 inches above the top of the pipe and to the undisturbed trench walls on either side of the pipe.

"Embedment" shall be defined as those vertical stratas of backfill material in the pipe zone consisting of bedding, haunching, and initial backfill, as defined in ASTM D-2321, and shown in the Utility's Standard Detail No. 170 (see Design Standards for Water and Sanitary Sewer Facilities).

C. Submittals: Submittals shall include certified test reports for embedment material. Certified test reports shall be from an independent laboratory. Test reports shall include sieve analysis and Atterberg limits.

A gradation of Class I material shall be submitted by the Contractor to the Engineer for approval prior to use.

D. PIPE ZONE BACKFILL: Based on project specific criteria, the Utility will approve one of the following embedment materials for use in pipe zone. Refer to Section 4.3 for additional information.

CLASS I material shall be manufactured angular, well-graded, crushed stone per ASTM D-2321, ¼-inch to 1-1/2-inch size. The following materials shall be acceptable under this class designation: ASTM D-448 - Stone Sizes 4, 67, 5, 56, 57, and 6. Pea Gravel and other uniformly graded material are not acceptable under this class.

CLASS II material shall be coarse sands and gravels per ASTM D-2487 with maximum particle size of 1-1/2 inches, including variously graded sands and gravels, containing less than 12 percent fines (material passing the #200 sieve) generally granular and non-cohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class.

CLASS III material shall be fine sand and clayey (clay filled) gravels, per ASTM D-2487, including fine sands, sand-clay mixtures, and gravel-clay mixtures. Class III includes soil Types GM, GC, SM, and SC.

Under no circumstances shall Class IV or V material, as defined in ASTM D-2487, be used for embedment of flexible pipe.

Materials shall be classified according to The Unified Soil Classification System as defined in ASTM D-2487 (Refer to Appendix Section B).

E. FINAL BACKFILL: Material for backfilling above the pipe zone shall be defined as follows:

NATIVE: The most granular material excavated from the trench comprising the spoil bank may be used, provided it is devoid of rocks larger than three inches in greatest dimension, organic material, and other unsuitable material. If initially saturated during the excavation, the backfill shall be

allowed to dry sufficiently, being manipulated if necessary, prior to placing back into trench, to achieve the specified compaction at plus or minus 2 percent of optimum moisture content.

SELECT: If material excavated from the trench is unsuitable as backfill material, or the required compaction is unattainable for the particular spoil backfill material, the Contractor shall, at his expense, import select material to be mixed with or used in place of the spoil material. Select material shall be designated as Class II as described in SECTION 4.1.

SOIL CEMENT: Where cement stabilized backfill is shown on the Drawings, or required by governing jurisdiction or utility, it shall consist of a mixture of soil or sand and two sacks of Portland cement per cubic yard. Soil shall be a sandy material, free from lumps, clods, or organic material. If excavated material is not suitable, pit-run sand shall be used. Cement stabilized backfill shall be mixed in a concrete mixer or transit mixer.

F. SOURCES AND EVALUATION TESTING: Materials to be used for embedment and for backfill shall be obtained in accordance with a sampling plan and ASTM D-75. Testing of materials to certify conformance with specification requirements shall be performed by an independent testing laboratory approved by the Owner, at the Contractor's expense. Contractor's testing agency shall perform tests upon change of source and at sufficient intervals to certify conformance of all material furnished for use on this project.

4.2 TRENCH EXCAVATION AND PREPARATION

A. GENERAL: Classification of excavation shall be "unclassified" and involves removing unnecessary materials and excavating trenches to the alignment, width, and depth as indicated in the plans or as required for the proper installation of the pipe and appurtenances. Adjacent structures shall be protected from damage by construction equipment. All excavated material shall be piled along the trench in a manner which will not endanger the work.

B. TRENCH WIDTH: The trench walls in the "pipe zone" shall be vertical.

Trench width for **FLEXIBLE PIPE** shall generally be:

FLEXIBLE PIPE - TRENCH WIDTH		
PIPE DIAMETER	**TRENCH WIDTH = BARREL OUTER DIAMETER PLUS**	
	Minimum	**Maximum**
Less than 24"	15"	18"
24" - 48"	18"	24"
Greater than 48"	24"	½" Pipe O.D.

Trench width at the top of the pipe for **RIGID PIPE** shall not exceed the outside diameter of the pipe barrel, plus the following allowance:

RIGID PIPE - TRENCH WIDTH	
PIPE DIAMETER	**TRENCH WIDTH = BARREL OUTER DIAMETER PLUS**
Less than 18"	16"
18" - 24"	19"
27" - 39"	22"
42" & Larger	½" Pipe O.D.

If maximum trench width specified above is exceeded at the top of the pipe, the Contractor shall provide, at his expense, additional load-bearing capacity by means of improved bedding, concrete cradle, cap, or encasement, or other means approved by the Engineer.

Trench walls above the pipe zone may be laid back or benched, where space permits, as necessary to satisfy the requirements of OSHA. Additional requirements are specified in Article E of this SECTION 4.2 for Trench Support.

Wherever the prescribed maximum trench width is exceeded, the Contractor shall remove all loose and sloughed-in material from the trench and replace with compacted granular material such that haunching and initial backfill is compacted to at least 2.5 pipe diameters from either side of the pipe or to the trench walls at no additional cost to the Owner.

Unless otherwise agreed upon, no additional payment will be made to the Contractor for extra material and labor required to fill excessive trench widths caused by the Contractor's equipment or natural collapse of trench walls.

C. TRENCH BOTTOM: Excavate the trench to an even grade so that the full length of the pipe barrel is supported and joints may be properly assembled.

For 30-inch diameter and smaller pipe, the trench shall be "rough cut" a minimum of 4 inches below the bottom of the pipe. For 33 inches and larger pipe, the trench shall be "rough cut" a minimum of 6 inches below the bottom of the pipe. The "rough cut" dimension shall be increased as necessary to provide a minimum clearance of 2 inches from the bottom of the trench to the bottom of the bells, flanges, valves, fittings, etc.

The entire foundation area at the bottom of all excavations shall be firm, stable material. Loose material shall be removed, leaving a clean, flat trench bottom, and material shall not be disturbed below required subgrade except as hereinafter described.

If the subgrade is soft, spongy, disintegrated, or where the character of the foundation materials is such that a proper foundation cannot be achieved at the elevation specified, the Contractor shall deepen the excavation, not less than 6-inches to a depth where a satisfactory foundation may be obtained. The subgrade shall then be brought back to the required grade with Class I coarse gravel compacted to seventy percent (70%) relative density per ASTM D-4254.

D. OVER EXCAVATION: If the trench is excavated to a faulty grade (at a lower elevation than indicated), correct the faulty grade at no additional cost to the Owner, as specified below:

1. In uniform, stable dry soils, correct the faulty grade with Class II granular embedment material thoroughly compacted to ninety percent (90%) Modified Proctor Density per ASTM D-1557.

2. In soft spongy disintegrated soils, or where necessary to allow proper drainage, correct the faulty grade with Class I coarse gravel compacted to seventy percent (70%) of relative density.

E. ROCK EXCAVATION: When pipe is to be laid in rock cut, provide a clearance of at least 6 inches below parts of the pipe, valves or fittings. Provide adequate clearance at bell holes to permit proper jointing of pipe laid in rock trenches. Refill excavation to pipe grade with Class II granular embedment material compacted to ninety percent (90%) Modified Proctor Density. Unless specifically required and called for in the specifications, and with a permit issued by governing authorities, blasting shall not be permitted.

F. BELL HOLES: Bell holes of ample dimension shall be dug in trenches at each joint of pipe to permit the jointing to be made properly, visually inspected, and so that the pipe will rest on the full length of the barrel.

G. DEWATERING: Dewater excavations so that the work is performed in the "dry". Bailing, pumping, and dewatering shall be at the Contractor's expense. Use coarse gravel instead of embedment material under the pipe in dewatered excavations to provide for the free drainage and flow of water in the pipe trench, where it is necessary, in order to keep the water level below the pipe barrel and bell holes for joints. The elevation of the groundwater level prior to dewatering shall be determined and recorded.

Unless otherwise specified, the method of dewatering shall maintain a phreatic water surface a minimum of 18-inches below pipe grades. Should over-excavation be necessary due to unsuitable foundation conditions, the ground water shall be additionally lowered as necessary.

The water removed from trenches shall be conducted to natural drainage ways, drains, or storm sewers in such a manner as to prevent damage to adjacent property or to the public. Pumps of ample capacity and in duplicate must be provided to insure that once an excavation is dried, the water level remains below the trench depth until that portion of the work is completed. The Contractor shall be responsible for obtaining approval for discharge from the appropriate governing agency. Under no circumstances will the Contractor be permitted to discharge into the sanitary sewer system.

When dewatering on a particular project may affect the production of private wells along the route, the Contractor shall determine if any wells used for domestic purposes are affected by the dewatering and shall furnish potable water to any affected residents. Metered connections to the existing public water system will be made by the Owner. The Contractor shall install any temporary lines from these meters to properly serve the affected residents.

Where dewatering is required, the Contractor shall submit to the Engineer, a dewatering plan indicating proposed locations of dewatering wells, pumping facilities, collector and discharge pipe-lines, and discharge points (names of ditches, laterals, etc.) for his records. The plan shall be available for El Paso County Water Improvement District No. 1 (EPCWID #1) approval and comments. To comply with the requirements of the discharge permit between the Owner and the EPCWID #1, the Contractor shall provide discharge monitoring points to El Paso Water Utilities (EPWU) personnel, who will obtain samples for laboratory analysis to check water quality limitations imposed by the permit. The Contractor shall assist the Owner's personnel in recording pumping rates at dewatering wells, pump times, and flows and shall become familiar with the methods of measurements according to the following schedule:

DATA RECORDED	METHOD OF MEASUREMENT	FREQUENCY OF MEASUREMENT
Pumping Rate At Each Dewatering Well or Discharge Point	"California-Pipe Method"	Daily If Changes Occur
Pumping Time	Hours	Daily
Total Dissolved Solids (TDS)	PSB Laboratory	Twice Per Month
Total Discharge	Rate x Time	Continuous

The data obtained shall be recorded by the Contractor on a standard data sheet, and submitted monthly to the EPCWID #1. The Contractor shall be responsible for coordination of all requirements with the EPCWID #1.

It is the responsibility of the Contractor to dispose of the water from the dewatering operation according to the conditions of the discharge permit. However, the Contractor will not be required to pay fines, imposed by the EPCWID #1, regarding the quality of discharge.

Engines or engine generators used to run the dewatering pumps shall be equipped with residential grade silencers. The silencers shall have an attenuation range of 25 to 30 dBA as required by the El Paso Municipal Code, Title 9, Chapter 9.40.

The Contractor shall coordinate the dewatering effort with El Paso Water Utilities Engineering staff, insofar as compliance with discharge permit is concerned, and where dewatering effluent will enter drainage ditches operated and maintained by the District.

EPCWID #1 which authorizes dewatering into its facilities under certain terms and conditions and with whom the Owner has negotiated specific basic fees and procedures.

The selected Bidder is required to submit a Dewatering Plan, a Final Schedule for Dewatering, and an estimate of fees due EPCWID #1 to the ENGINEER. The Plan is due within fifteen (15) working days from the date of the Notice to Proceed. The Plan is a mandatory Submittal and shall include the estimated quantities of dewatering for each month of the Project and the point(s) of discharge. ENGINEER will review and approve the Dewatering Submittal and forward it, through the Owner, to the District. The Owner must receive the approved plan at least two weeks in advance of the planned dewatering operations. Dewatering Fees due are to be estimated on the following basis:

1. Drain Maintenance Fee of $1,000 for each six (6) months a discharge occurs;
2. Dewatering performed between February 16th-October 14th at $50 per acre foot;
3. Dewatering performed between October 15th-February 15th at $25 per acre foot.

The Contractor will prepay dewatering fees to EPCWID #1 based upon the estimates in the approved Submittal. Contractor shall provide a copy of their receipt and release from EPCWID #1 before OWNER will allow dewatering to begin.

The Contractor shall provide monthly reports of discharge quantities and quality (TDS and sulfates), which specific requirements may be more particularly described in the Technical Specifications, to the OWNER through the ENGINEER for submittal to EPCWID #1.

The Contractor may thereafter apply for reimbursement as detailed in the Measurement and Payment Clause of the Technical Specifications. It is anticipated that such reimbursements will be processed under similar terms and conditions as those for Stored Materials.

Final Payment to the Contractor shall not be made unless and until Contractor settles final dewatering fees due EPCWID #1 based upon final quantities of dewatering performed and provides a copy of their Final Release from the District.

The Contractor is responsible for all Dewatering Fees, including those for water pumped in addition to the quantities presented in the approved Dewatering Plan.

H. TRENCH SUPPORT: Excavations shall be braced and sheeted to provide complete safety to persons working therein and bracing shall comply with applicable federal (OSHA), state and local laws and ordinances. All trenches exceeding five (5) feet in depth, as measured from the ground surface at the highest side of the trench to the trench bottom, shall meet the requirements specified in the Utility's Specifications section entitled TRENCH EXCAVATION SAFETY SYSTEM attached in Appendix Section F of these Specifications.

Contractor shall be fully responsible for providing sufficient and adequate bracing for excavations with respect to work under construction and to adjacent utility lines and private property. Where soil conditions within trench area require support, Contractor may elect to use tight sheeting, skeleton sheeting, stay bracing, trench jacks, movable trench shield, or other approved methods to support the trench during pipe installation operations such as bedding preparation, pipe laying, and backfilling of haunches and initial zone.

Whenever possible, trench support shall not extend below the pipe crown. Where trench support must extend below the crown, such support should either be left in place or consist of approved steel sheets which can be retracted with minimal disturbance. Remaining voids shall be treated with grout or granular embedment material.

When a movable trench shield is used, the trailing half of the shield should be notched to the height of the top of the pipe. This will allow the haunch area of the pipe to be compacted properly to the wall of the trench. Dragging of a trench shield at pipe grade may be done provided such practice does not disturb the bedding. Voids created by the shield shall be filled and compacted properly.

I. TRENCHING IN PUBLIC RIGHT-OF-WAY: Except where otherwise specified, indicated on the Plans, or accepted in writing by the Engineer, the maximum length of open trench, where the construction is in any stage of completion, shall not exceed the linear footage as set forth in the following. The definition of "open trench" for the purposes of this description will include excavation, pipe laying, backfilling, and pavement replacement. The descriptions under the area designations are general in nature and may be amended in writing by the Engineer due to particular or peculiar field conditions.

BUSINESS DISTRICT AREAS - 300 LINEAR FEET: Store front areas.

COMMERCIAL AREAS - 300 LINEAR FEET: Industrial, shopping centers, churches, schools, hotels, motels, markets, gas stations, government and private office buildings, hospitals, fire and police stations, and nursing homes.

RESIDENTIAL AREAS - ONE (1) BLOCK OR 300 LINEAR FEET, WHICHEVER IS THE LEAST: Single and multi-family residences, apartments, and condominiums.

UNDEVELOPED AREAS - 1,500 LINEAR FEET: Parks, golf courses, farms, undeveloped subdivided land.

Any excavated areas shall be considered as "open trench" until all pavement replacement has been made, or until all trenches outside of pavement replacement areas have been backfilled and compacted in accordance with these Contract Documents. Trenches across streets shall be completely backfilled with temporary or permanent pavement in place within 72 hours after pipe laying. An open trench shall not be permitted overnight, unless adequately barricaded and approved by the Engineer.

Contractor shall provide steel plates with adequate trench shoring and bracing, designed to support traffic loads where required to bridge across trenches at street and alley crossings, commercial driveways, and residential driveways where trench backfill and temporary patch have not been completed during regular working hours. Safe and convenient passage for pedestrians shall be provided. The Engineer may designate a passage to be provided at any point he deems necessary. Access to fire stations, fire hydrants, and hospitals shall be maintained at all times.

4.3 PIPE INSTALLATION

A. GENERAL: Pipe shall be laid true to lines and grades as indicated on the drawings. All pipe and fittings shall be inspected before laying in the trench. Clean all joint surfaces and soiled materials prior to connecting one another. As work progresses, maintain interior of pipes clean.

B. STANDARD COVER: Standard cover shall depend on the water main size and installation conditions. Standard cover shall generally be as follows:

6-Inch & 8-Inch Diameter Main:	Minimum of 4-foot cover from top of pipe to finished grade
12-Inch & Larger Diameter Main:	Minimum of 5-foot cover from top of pipe to finished grade

C. POTHOLING: Existing utilities shown on plans are for informational purposes only. Prior to new pipe installation, Contractor shall pothole all existing utilities and structures to confirm their location, depth, and size. In the event of conflict or discrepancy that affects the project design, Contractor shall notify the Engineer before proceeding with pipe installation in order to formulate a solution.

D. PIPE ZONE EMBEDMENT: Unless otherwise specified or shown in the drawings, pipelines shall be embedded in either Class I, II, or III material defined in Article C, SECTION 4.1 and installed as here forth described. Contractor may use native or imported material for embedment provided material conforms to these Specifications.

Embedment materials shall be placed in lifts not exceeding 8 inches loose depth. Unless otherwise specified or directed in writing by the Engineer, all material in the embedment zone shall be homogeneous.

Bedding shall be placed to provide uniform and adequate longitudinal support under the pipe. Place the first lift of bedding material from the bottom of the trench to slightly above the bottom of the pipe grade. Unless otherwise shown in the drawings, bedding shall be a minimum of 4 inches in depth for pipe sizes 30 inches and smaller, and 6 inches for pipe sizes greater than 30 inches. Material shall be true to line and grade with bell holes of ample dimension to permit pipe to rest on the full length of the barrel and to permit joint make-up and coating application at joints. Consolidate and compact the bedding material as described in Articles E and F of this SECTION 4.3, and lay pipe to indicated grade.

Place a second lift, and if required, subsequent lifts, of embedment material to the springline of pipe. This process shall be defined as **Haunching**. Material shall be sliced under the haunches of the pipe, carefully filling all voids, and using care to prevent movement of the pipe.

Place **Initial Backfill** using a third lift from the springline of the pipe to the pipe crown, and a fourth lift from the pipe crown to a point 12 inches above the pipe.

E. GROUNDWATER INSTALLATION: In areas where the pipe is installed below existing or future ground water levels, Class I material shall be used throughout the pipe zone and enclosed with a layer of approved geotechnical filter fabric. The fabric shall be placed carefully along the bottom of the trench and up the side of the trench a sufficient distance to lap over the top of the completed pipe installation. Fabric shall lap a minimum of 3 feet in the longitudinal at the end of one roll and beginning of the next, and lap 2 feet in the transverse at the top of pipe, except that for trench widths greater than 3 feet measured at the top of pipe, the top overlap shall be 3 feet. Follow manufacturer's

recommendations for installation. Fabric shall be either Mirafi 140N, Dupont Typar 3401, or approved equal.

F. EMBEDMENT CLASS SCHEDULE: Unless otherwise shown in the project drawings, the Utility Standard Embedment Class designations for the pipe material types listed in Appendix Section C shall be used to define each particular pipe's **Embedment Condition** allowed under these specifications. The detail drawings shall be examined for additional information or other special bedding requirements.

G. CONSOLIDATION METHODS IN EMBEDMENT ZONE: Embedment backfill shall be compacted by equipment that is suitable for the type of soil encountered, and is capable of producing the degree of compaction specified. Where applicable, backfill materials shall be moisture conditioned to produce the required degree of compaction.

Hand or mechanical tamping shall be used to compact Class II or III material used in bedding, haunching, and initial backfill, except that the use of mechanical tampers or vibratory compactors directly over the pipe in the embedment area is prohibited. Caution in the use of mechanical compactors in the haunch and initial backfill to 12" above the pipe, shall be exercised to avoid damaging or mis-aligning the pipe.

Flooding or jetting shall not be used for compaction of embedment material for flexible pipe.

H. COMPACTION AND TESTING OF PIPE EMBEDMENT ZONE: Class I material used in the embedment zone may be placed by loose dumping with a minimum of compactive effort, except that care should be taken to assure proper placement of material under the pipe haunches. Class I material shall not specifically require testing unless directed by the Engineer, in which case, such test shall be measured by ASTM D-4254 by percent of relative density.

Class II material used in the embedment zone shall be compacted to a density of not less than 90% of Standard Proctor Density defined by ASTM D-698.

Class III material used in the embedment zone shall be compacted to a density of not less than 90% of Standard Proctor Density defined by ASTM D-698.

Moisture content in Class II or III material shall not exceed 3% over the optimum to assure proper compaction.

Unless otherwise directed by the Engineer, one compaction test in the embedment zone for Class II or III material shall be taken at 200 feet intervals along the trench on either side of the pipe, or at any other intervals as may be judged by the Engineer to be warranted by questionable installation conditions. For pipe sizes 8 to 12 inches diameter, the first test shall be performed on the side level with the top of pipe. For sizes 15-inches and larger, the first test shall be at the springline of the pipe. For all sizes, the second test shall be made at the top of the embedment zone.

I. DENSITY CONTROL AND LABORATORY TESTING: Unless otherwise specified, reference to "maximum dry density" shall mean maximum density defined by ASTM D-1557 or D-698. Determination of density of backfill in-place, shall be in accordance with the requirements of ASTM D-2922.

Unless otherwise specified, the Owner shall select a soils testing laboratory and shall provide for initial density testing of in-place backfill; however, the Contractor shall pay for all additional density testing of backfills found not to be within the minimum requirements of the specifications.

Laboratory materials testing, including but not limited to determination of Atterberg Limits, Proctor Curves, Grain Size Analysis, as well as laboratory certification of manufactured materials, shall be at the Contractor's expense, and as further required by Section 4.1 of these specifications.

In the case of subdivisions or private ventures, where the developer has retained a Contractor to perform utility installations as allowed by the Utility's Public Service Board's Rules and Regulations, the word "Owner" above shall be deemed to be the developer.

Contractor shall notify the soils testing laboratory and City Engineering Field Inspection Department 24 hours in advance to obtain soil density tests to fulfill the compaction requirements of the project.

4.4 CASING CONSTRUCTION AND CARRIER PIPE INSTALLATION

A. GENERAL REQUIREMENTS: The Contractor shall install casings at the locations and to the lines and grades indicated on the drawings, of the sizes indicated, using either jacking, boring, tunneling, or approved open-cut methods. The Contractor shall install carrier pipes of the sizes indicated on the drawings within the casings, and he shall install the required vent piping, casing insulators, end seals, pipe supports and skids, and other incidental features required to complete work described in this section and as shown on the drawings.

The Contractor shall furnish all materials, equipment, tools, labor, superintendence, and incidentals, including all necessary field welding, to install casings, carrier pipes, and accessories as indicated on the drawings and as specified herein. The Contractor shall provide adequate lights, ventilation, signal systems, fire extinguisher, safety equipment, and other equipment required and maintain such equipment in good repair.

The Contractor shall be solely responsible for determining soil conditions at the various locations where casings are to be installed, and he shall make such other investigations to obtain that information as he may deem necessary. The costs of such investigations shall be included in the Contractor's cost for performing the work.

Methods of construction, whether by tunnel boring machine or by hand digging, shall be at the Contractor's option subject to the approval of the governing agencies and approval of the Engineer.

The work of excavating, lining, grouting and construction of the casing or tunnel shall be so executed that ground settlement is minimized.

Where casings are installed by open-cut method, all requirements for trenching and backfilling as described in these specifications shall apply, except as otherwise required by the plans or supplemental specifications.

Access shafts or pits shall be located at the beginning and end of each casing or tunnel segment to be constructed.

Unless superseded by the requirements of other governing authorities under whose facilities or right-of-way the casing is to be installed, the face of any shaft shall be at least 20-feet from existing adjacent roadways or structures. Sizing of shafts or pits shall provide adequate room to meet the Contractor's operational requirements for tunnel construction.

B. SUBMITTALS: Contractor shall submit for review complete working drawings which show details of the proposed method of construction and the sequence of operations to be performed during construction. The plan shall show the method of jacking, boring, or tunneling, muck removal and disposal, type and method of installation of the primary casing or tunnel liner, access pit size and construction shoring and bracing, and dewatering methods proposed. Drawings shall be sufficiently detailed to allow the Engineer to judge whether or not proposed materials and procedures will meet the contract requirements.

The Contractor's submittal shall include the design criteria used and a certification that the structural design of the casing or tunnel liner meets these design criteria. The tunnel liner shall be capable of carrying H-20 vehicle load distributions in accordance with AASHTO as well as the anticipated dead loads and include an appropriate design factor of safety.

The submittal shall also include the layout and design of the access shafts. A certification shall be submitted that the structural design of the shoring and bracing meets the design criteria as submitted by the Contractor.

All structural designs shall be sealed by a Professional Engineer registered in the State of Texas and qualified to perform such work.

C. STANDARDS: All OSHA regulations and all requirements of the specific private and governmental agencies under whose facilities the casings and pipe area to be installed shall apply to these operations.

The Contractor shall be responsible for protecting the facilities under which the casings and pipe are installed, for providing protection at the excavations, and for carrying out the trench safety procedures per all OSHA regulations that may be required because of these operations (Refer to Appendix Section F - Trench Excavation Safety System).

Referenced within this section is the "Standard Specification for Construction of Highways, Streets and Bridges," most current Edition of the Texas State Department of Highways and Public Transportation (now called the Texas Department of Transportation), and hence referred to herein as TxDOT-Specification.

D. MATERIALS: Steel Casing Pipe shall be new, unused, and suitable for the purpose intended and shall have a minimum yield strength of 36,000 psi. Casing shall meet ASTM A-53 or approved equal. Pipe shall be coated and lined with coal tar epoxy (15 mils min.) in accordance with AWWA C-210. Pipe joints shall be welded in accordance with AWWA C-206. After pipe is welded, coating and lining shall be repaired. Unless specified otherwise, the minimum wall thickness of steel casing pipe shall be 0.3125 (5/16) inches.

Tunnel Liner shall be constructed of cold-formed steel plates of the sizes, thickness, and dimensions required, as indicated on the drawings, and as manufactured by Commercial Shearing, Contech, or equal.

Reinforced Concrete Pipe for casing where specified or shown shall be straight-wall RCP pipe casing conforming to ASTM C-76 Class IV of the size and length specified.

Grout Holes shall be welded half-coupling. Tapped holes shall be provided with a pipe plug screwed in place.

Bolts and Nuts with liner plates shall be not less than 1/2 inch diameter and conform to ASTM A-307 Grade A.

E. INSTALLATION OF CASINGS: Casings shall be installed using either jacking, boring, or tunneling methods. Equipment used in this work shall be of such size and capacity as to allow the placement of the casings to proceed in a safe and expeditious manner.

Casing pipe shall be installed from the end which will create a minimum of access and utility relocation problems. Prior to casing installation, Contractor shall pothole utilities and all other permanent structures within the project area in order to identify potential conflicts. In the event a conflict exists, Contractor shall notify Engineer before proceeding with casing installation so a solution can be formulated.

Lateral or vertical variation in the final position of the pipe casing from the line and grade established by the Engineer shall be permitted only to the extent of 1-inch in 10-feet, provided that such variation shall be regular and only in the direction that will not detrimentally affect the function of the carrier pipe. Casing pipe found to be considerably off-grade or alignment shall be removed and re-installed, or abandoned and another casing placed as required at no additional cost to the Owner.

Any detectable settlement of the roadway overlying the casing or tunnel shall be immediately repaired at the Contractor's expense. Slight settlement of the roadway, should it occur, shall result

in cessation of casing/tunneling operations, posting of appropriate highway safety signs, and placement of an asphaltic hot-mix overlay to return the roadway to original grade. Where applicable, hot-mix shall meet the requirements of TxDOT-Specifications. The surface to receive hot-mix shall be primed as directed by the Engineer. The Contractor shall submit an emergency road repair procedure plan to the Texas Department of Transportation or applicable governing agency, prior to beginning any casing/tunneling operations.

When installing casing by boring, installation of the casing and the excavation and removal of the material within the casing shall proceed simultaneously. The completed casing shall be free of dents, bends, weld protrusions, or other obstructions to allow the smooth sliding of the carrier pipe through the casing.

INSTALLING CASING BY TUNNELING: The tunnel shall be of sufficient size to permit efficient excavation operations, to provide sufficient working space for placing the tunnel lining, and to allow for construction of the carrier pipe as shown on the drawings or indicated on the specifications. Determination of an adequate tunnel size and section to meet these requirements shall be the sole responsibility of the Contractor. It shall be understood and agreed that the dimensions shown on the drawings represent the approximate dimensions acceptable to the Engineer and do not necessarily represent the size and/or section suitable for the construction methods or operational procedures as may be proposed and/or conducted by the Contractor.

Casing pipe to be installed by tunneling methods shall use structural steel plates assembled from the inside of the tunnel and field bolted to provide a full round casing pipe. Excavation for tunnel shall be held to the minimum possible diameter required for installation of liner plate. The limits of excavation shall be as required to prevent caving. The annular space between the tunnel liner and the tunnel bank shall be pressure grouted. Grouting shall be accomplished through 2-inch diameter plugs provided in the liner plates at spacing of 5'-0" or as specified by the Engineer. Any excess groundwater encountered shall be removed by the Contractor in a manner to allow the tunneling operation to proceed according to schedule.

F. INSTALLATION OF CARRIER PIPE IN CASING PIPE OR TUNNEL LINER: After the casing or tunnel liner has been installed and accepted by the Engineer, the carrier pipe shall be pushed or pulled through the casing by exerting pressure on the barrel of the pipe in such a manner that the pipe joints are always in compression.

Insulated spacers shall be used when specified for providing cathodic protection. Pipeline spacers shall consist of pre-manufactured steel bands with plastic lining and plastic runners. Casing spacers shall fit snug over the carrier pipe and position the carrier pipe approximately in the center of the casing pipe, to provide adequate clearance between the carrier pipe bell and the casing pipe. Casing spacers shall be Model C12G-2, coated for the ultimate in strength, toughness and corrosion resistance, or Model A12G-2, painted for unusually heavy pipe, for long casings or whenever maximum strength and toughness are required, as directed by the Engineer, for carrier pipes 4" - 56" in diameter. Casing spacers shall be as manufactured by Pipeline Seal and Insulator, Inc. (PSI) or approved equal.

The carrier pipe shall be installed in the casing in accordance with the recommendations of the pipe manufacturer.

If tunnel liner is used, the bottom 120 degrees of the liner shall be grouted to the top of the tunnel liner ribs to aid in the installation of the carrier pipe.

After installation of the carrier pipe inside the casing pipe or tunnel liner, the ends shall be sealed to prevent water or other material from entering the casing or liner and causing corrosion. Method of sealing the ends shall be one of the following methods as directed or specified:

a) End shall be sealed by method of Brick and Mortar.

b) End shall be sealed with Bulkhead and Grout.

c) End shall be sealed with a synthetic rubber end seal. End Seals shall be PSI, Inc. Standard Pull-On (Model C), or approved equal. The end seals shall be appropriate for the size and type of carrier pipe and casing.

G. GROUTING: Unless otherwise specified or directed by the Engineer, grout material shall be ordinary cement-sand grout as described in SECTION 3.2 of these Specifications.

Fill all excavation outside the casing or tunnel liner with pressure-applied grout or other approved fill unless otherwise directed by the Engineer. Use care in grouting operations to prevent damage to adjacent utilities or other properties. Pressure used in grouting shall not be great enough to distort or imperil any portion of the work.

All voids outside the limits of the casing or tunnel excavation created by caving or collapse of earth cover over the excavation, or by other cause shall also be completely filled with grout. All grouting to eliminate voids outside the casing or tunnel limits shall be at the Contractor's expense.

When hand tunneling methods are used, place grout behind the tunnel liner at the end of each day or at every 10 feet of tunnel installed, whichever spacing is acceptable to the Engineer.

The annular space between the casing and carrier pipe shall be treated by one of the following methods as directed or specified. Where applicable, the annular space shall be filled according to the regulations specified by the governing agency for the area where the casing is to be installed.

a) Annular space shall be left open for cathodically protected systems where both casing and carrier pipes are metallic material.

b) Annular space shall be filled with pneumatically placed sand. This shall be the standard method for pipes in all installations other than groundwater.

c) Annular space shall be filled with grout. Pressure used to grout shall be such that the carrier pipe is not damaged or distorted. Submit method for approval prior to starting work. This method is mandatory for installations in groundwater, optional on all other dry installations.

4.5 FINAL BACKFILL

A. GENERAL: As soon as practicable after laying and jointing of the pipe, the completion of embedment and the completion of structures, the trench shall be backfilled.

Take the necessary precautions to protect the pipe during backfilling operations.

Remove sheeting and shoring as backfilling operations progress. Incorporate methods so that a good bond is achieved between the backfill material and the undisturbed trench walls. Where sheeting or trench protection is intact below the top of pipe and their removal cause obvious damage to the bedding and haunching, it may be necessary to leave portions of sheeting or bracing in place.

Caution, in the use of mechanical compactors in the haunch and initial backfill to 12-inches above the pipe, shall be exercised to avoid damaging or mis-aligning the pipe. Provide at least 3 feet of compacted cover over the top of the pipe before the trench is wheel-loaded, and 4-feet of cover before using pneumatic hammers during compaction. Contact between the pipe and compaction equipment shall be avoided at all times.

B. CONSOLIDATION METHODS: Backfill above the pipe zone to surface subgrade shall be with backfill material as indicated on the drawings and described in Article D of SECTION 4.1 of these

Specifications. Backfill above the pipe zone shall be compacted by mechanical means. Water consolidation (flooding) may be used if approved by the City Engineer.

For mechanical compaction, place the backfill material above the pipe zone in lifts not exceeding 8-inches loose depth, moisten or aerate to obtain optimum moisture, and compact to the required density as described in Article C of this SECTION 4.5 of these Specifications.

The jetting method of water tamping will not be allowed.

When the ponding method of water tamping is permitted, backfill material above the pipe zone shall be placed in the trench not to exceed 3-feet loose depth, and flooded until free water is evident on the surface for at least two hours. Approximately one foot of water shall then be placed in the trench and subsequent lifts shall be started by depositing backfill material in the water until a maximum lift of 3-feet is placed. Additional water shall then be added to the backfill material until free water is again evident as before. This procedure shall be repeated until the entire trench is filled and thoroughly settled.

C. SOIL CEMENT BACKFILL: Where the drawings indicate that backfill for trenches under roads, driveways, concrete slabs, and in the zone of excavation for structures shall be cement stabilized, the backfill material shall be stabilized with a minimum of two sacks of Portland Cement per cubic yard of material placed. Cement stabilized soil shall be placed around all adjusted manholes.

D. COMPACTION AND TESTING FINAL BACKFILL: Under existing or proposed paved streets, final backfill shall be compacted to the following Modified Proctor Densities per ASTM D-1557 (refer to standard drawing details in Appendix Section D, "Typical Trench Backfill Detail under Existing or Proposed Paved Streets"):

ZONE	SOIL CONDITION	% OF PROCTOR
Top of Pipe Embedment to 18" Below Finished Subgrade	Native Material As Specified	90%
Top of Finished Subgrade to 18" Below Top of Subgrade	Cohesive Non-cohesive	90% 95%

For all backfill in the areas not in existing or proposed paved streets, density of not less than 85% ASTM D-1557 shall be obtained from top of pipe bedding to ground surface.

Compaction tests will be required on backfill under proposed or existing streets and easements, and shall generally be as follows, unless otherwise directed by the Engineer:

a) Tests at 8-inches below subgrade at 200-foot intervals and not less than two per street at this level.

b) One test for every 2-feet of vertical trench backfill between top of pipe bedding and 18-inches below subgrade, at 200-foot horizontal intervals and not less than two per street at each level.

Additional tests shall be taken by the Owner as deemed necessary.

The provisions for selection of the testing laboratory and Owner/Contractor responsibilities for density control as described in Article E of SECTION 4.1 and Article F of SECTION 4.3 shall apply to backfilling in this section.

END OF SECTION

5.0 VALVES AND FITTINGS

5.1 SCOPE

The Contractor shall furnish all valves where indicated on the Plans, as called for in these Specifications, or as required for proper operation of the equipment in general. Unless otherwise indicated on the Plans or specified in other sections of these Specifications, valves shall conform to the requirements as specified herein.

Where proper operation and utilization of equipment and facilities require installation of valves not indicated or specified, the Contractor shall provide and install, upon acceptance by the Engineer, valves similar and comparable to valves specified for similar and comparable duty in other parts of the project.

5.2 QUALITY ASSURANCE

Valves and fittings shall conform to the latest revision of the National Sanitation Foundation/American National Standards Institute (NSF/ANSI) Standard 61, Annex F "Drinking Water system Components - Health Effects" and be certified by an organization accredited by ANSI. Such compliance shall be evidenced by an affidavit from the manufacturer or vendor. If the pipe does not presently conform to this standard, information from the manufacturer regarding action being taken to comply with this standard must be submitted.

All valves and fittings shall have the manufacturer's name or trademark permanently stamped or cast on it and "No Lead" brass alloy, e.g. "NL" shall be cast or stamped on the valves and fittings.

All valves installed in a given line shall be designed to withstand the test pressure for that particular line and shall be fabricated with ends to fit the piping.

5.3 SUBMITTALS

Complete shop drawings and specifications shall be furnished prior to acceptance and approval of the bid proposal. If requested, the valve manufacturer shall also submit a list of similar installations which have been in satisfactory operation for at least three years.

The manufacturer shall furnish a complete set of installation, operation, and maintenance instructions for each type of valve furnished. Instructions shall be bound in a cover.

5.4 VALVES

A. NON-RISING STEM DOUBLE DISC GATE VALVES: Non-Rising Stem Gate Valves are to be iron-body, bronze mounted, parallel seat internal wedging type with non-rising stem and designed for a working pressure of 200 psig. NRS gate valves shall comply with AWWA C-500 "Gate Valves for Water and Sewage Systems," latest revision.

Valves 12-inches or smaller shall be for horizontal installation. The number of turns to open shall be a minimum of three times the valve diameter.

Acceptable manufacturers and models shall be:

American-Darling	52NRS (Flanged Ends), 55NRS (Mechanical Joint Ends)
Clow	F5065 (Mechanical Joint Ends), F5070 (Flanged Ends)
Kennedy	561X (Flanged Ends), 571X (Mechanical Joint Ends)
M&H	Style 67NRS
Mueller	A-2380-6 (Flanged), A-2380-20 (Mechanical Joint Ends)

Submittals: Submittals shall be provided in accordance with Article 5.3 of this Section. Also, the manufacturer shall provide an Affidavit of Compliance in accordance with Section 1.4, AWWA Standard C-500. Records of all tests performed in accordance with Section 2.2 and Section 5.1, AWWA Standard C-500 shall be provided. These records will be representative test results for

Section 2.2 and certificate of testing for Section 5.1. An affidavit of testing for the valve assembly as outlined in Section 3.1, AWWA Standard C-500 (300 ft-lbs) shall also be provided.

Markings: Shall be cast on the bonnet or body of each valve. Markings shall include the manufacturer's name or mark, the year the valve casting was made, the size of the valves, and the designated working pressure.

Valve Ends: Valve ends shall be mechanical joint or flanged with drilling in compliance with ANSI B16.1. Valve ends and size as specified.

Valve Body and Bonnet: Shall be cast iron conforming to ASTM A-126 Class B, or ductile iron conforming to ASTM A-395 or ASTM A-536.

Gate: Shall be cast iron or Grade A bronze. Gate rings, constructed of Grade A bronze, shall be rolled, peened, or pressed into grooves machined in the discs, or may be fastened by some other accepted method.

Body-Seat Ring: Shall be constructed of Grade A bronze, and shall be back-faced threaded and machined screwed into the valve body.

Wedges: Double-disc gate valves shall be equipped with a free and positive-operating internal device which will press the disc seats firmly against the body seats when the valve is closed and release the load before the discs begin to move when the valve is opened. Wedges shall be simple and rugged in design. The wedge material shall be as specified in AWWA C-500 and contact surface shall not be iron to iron.

Valve Stem: Shall be constructed of low zinc bronze CDA Copper Alloy No. C99500 with a minimum yield strength of 40,000 psi and minimum elongation in 2-inches of 10%.

Stem Seals: Shall consist of two O-rings such that the seal above the stem collar can be replaced with the valve under pressure in the fully open position. O-rings shall meet the requirements of ASTM D-2000 and have physical properties suitable for the application.

Valve Operator: Shall be a cast iron, ASTM A-126 Class B, wrench nut. The nut shall have a 2-inch square base and shall be 1-15/16-inches square at the top and be 1-3/4-inch high and shall open counterclockwise (left). The wrench nut shall be painted black and an arrow indicating direction of opening shall be cast on the nut, according to AWWA C-509.

Protective Coating: An epoxy coating shall be applied to all exterior and all stationary interior ferrous surfaces including all interior openings in the valves body. The coating shall not be applied to the gasket surfaces of the end flanges.

The coating shall be applied in accordance with AWWA C-550 and the manufacturer's instructions. After the coating is completely cured, the coated surface shall be tested for porosity, holidays, and pinholes using a holiday detector. All holidays or irregularities shall be repaired and the coating again tested.

B. OUTSIDE SCREW AND YOKE (OS&Y) GATE VALVES: Outside Screw and Yoke Gate Valves are to be iron-body, bronze mounted, parallel seat internal wedging type with outside screw and yoke and shall comply with AWWA C-500 "Gate Valves for Water and Sewage Systems". OS&Y Gate Valves shall be provided for the size specified.

Acceptable manufacturers and models shall be:

American Darling	52 OS&Y
Clow	F5072
Kennedy	566
M&H	STYLE 68
Mueller	A-2483-6

Submittals: Submittals shall be provided in accordance with Article 5.3 of this Section. Also, the manufacturer shall provide an Affidavit of Compliance in accordance with Section 1.4, AWWA Standard C-500. Records of all tests performed in accordance with Section 2.2 and Section 5.1, AWWA Standard C-500 shall be provided. These records will be representative test results for Section 2.2 and certificate of testing for Section 5.1. An affidavit of testing for the valve assembly as outlined in Section 3.1, AWWA Standard C-500 (300 ft-lbs) shall also be provided.

Markings: Shall be cast on the bonnet or body of each valve. Markings shall include the manufacture's name or mark, the year the valve casting was made, the size of the valves, and the designated working pressure.

Valve Ends: Valves ends shall be flanged, with drilling in compliance with ANSI B16.1, or as otherwise specified.

Valve Body and Bonnet: Shall be cast iron conforming to ASTM A-126 Class B, or ductile iron conforming to ASTM A-395 or ASTM A-536.

Gate: Shall be cast iron or Grade A bronze. Gate rings, constructed of Grade A bronze, shall be rolled, peened, or pressed into grooves machined in the discs, or may be fastened by some other accepted method.

Body-Seat Ring: Shall be constructed of Grade A bronze, and shall be back-faced threaded and machined screwed into the valve body.

Wedges: Double-disc gate valves shall be equipped with a free and positive-operating internal device which will press the disc seats firmly against the body seats when the valve is closed and release the load before the discs begin to move when the valve is opened. Wedges shall be simple and rugged in design. The wedge material shall be as specified in AWWA C-500 and contact surface shall not be iron to iron.

Valve Stem: Shall be constructed of low zinc bronze CDA Copper Alloy No. C99500 with a minimum yield strength of 40,000 psi and minimum elongation in 2-inches of 10%. The opening through the bonnet for the stem shall be bushed with grade A, B, C, D, or E bronze as defined in AWWA C-500.

Yoke: The yoke may be either integral or bolted on to bonnet. The design shall be such that a hand may not be jammed between the yoke and handwheel.

Valve Operator: Shall be a cast iron, ASTM A-126 Class B, wrench nut. The nut shall have a 2-inch square base and shall be 1-15/16-inches square at the top and be 1-3/4-inch high and shall open counterclockwise (left). The wrench nut shall be painted black and an arrow indicating direction of opening shall be cast on the nut, according to AWWA C-509.

Protective Coating: An epoxy coating shall be applied to all exterior and all stationary interior ferrous surfaces including all interior openings in the valves body. The coating shall not be applied to the gasket surfaces of the end flanges.

The coating shall be applied in accordance with AWWA C-550 and the manufacturer's instructions. After the coating is completely cured, the coated surface shall be tested for porosity, holidays, and pinholes using a holiday detector. All holidays or irregularities shall be repaired and the coating again tested.

C. TAPPING VALVES: Tapping Valves are to be iron-body, bronze mounted, parallel seat internal wedging type with non-rising stem. Tapping Valves shall conform to AWWA C-500 "Gate Valves for Water and Sewage Systems" except that tapping valves shall have over-sized seat rings to accommodate full size cutters. Tapping Valves shall be provided for the size specified.

Acceptable manufacturers and models shall be:

American Darling	565
Clow	2640 (Figure F-6114)
Kennedy	8950 Ken-Seal II
M&H	STYLE 751
Mueller	H-667

The number of turns to open shall be a minimum of three times the valve diameter.

Submittals: Submittals shall be provided in accordance with Article 5.3 of this Section. Also, the manufacturer shall provide an Affidavit of Compliance in accordance with Section 1.4, AWWA Standard C-500. Records of all tests performed in accordance with Section 2.2 and Section 5.1, AWWA Standard C-500 shall be provided. These records will be representative test results for Section 2.2 and certificate of testing for Section 5.1. An affidavit of testing for the valve assembly as outlined in Section 3.1, AWWA Standard C-500 (300 ft-lbs) shall also be provided.

Markings: Shall be cast on the bonnet or body of each valve. Markings shall include the manufacture's name or mark, the year the valve casting was made, the size of the valves, and the designated working pressure.

Valve Ends: Outlet end of the valve shall be mechanical joint or as otherwise specified.

Valve Body and Bonnet: Shall be cast iron conforming to ASTM A-126 Class B, or ductile iron conforming to ASTM A-395 or ASTM A-536.

Gate: Shall be cast iron or Grade A bronze. Gate rings, constructed of Grade A bronze, shall be rolled, peened, or pressed into grooves machined in the discs, or may be fastened by some other accepted method.

Body-Seat Ring: Shall be constructed of Grade A bronze, and shall be back-faced threaded and machined screwed into the valve body.

Wedges: Double-disc gate valves shall be equipped with a free and positive-operating internal device which will press the disc seats firmly against the body seats when the valve is closed and release the load before the discs begin to move when the valve is opened. Wedges shall be simple and rugged in design. The wedge material shall be as specified in AWWA C-500 and contact surface shall not be iron to iron.

Valve Stem: Shall be constructed of low zinc bronze CDA Copper Alloy no. C99500 with a minimum yield strength of 40,000 psi and minimum elongation in 2-inches of 10%.

Stem Seals: Shall consist of two O-rings such that the seal above the stem collar can be replaced with the valve under pressure in the fully open position. O-rings shall meet the requirements of ASTM D-2000 and have physical properties suitable for the application.

Valve Operator: Shall be a cast iron, ASTM A-126 Class B, wrench nut. The nut shall have a 2-inch square base and shall be 1-15/16-inch square at the top and be 1-3/4-inch high and shall open counterclockwise (left). The wrench nut shall be painted black and an arrow indicating direction of opening shall be cast on the nut, according to AWWA C-509.

Protective Coating: An epoxy coating shall be applied to all exterior and all stationary interior ferrous surfaces including all interior openings in the valves body. The coating shall be applied in accordance with AWWA C-550 and the manufacturer's instructions. After the coating is completely cured, the coated surface shall be tested for porosity, holidays, and pinholes using a holiday detector. All holidays or irregularities shall be repaired and the coating again tested.

D. NON-RISING STEM (NRS) RESILIENT-SEATED GATE VALVES: Non-Rising Stem Gate Valves are to be resilient seat, non-rising stem and shall have a minimum rated working pressure of 200 psig and shall comply with AWWA C-509 "Resilient-Seated Gate Valves for Water and Sewage Systems" and AWWA C-550 "Standard for Protective Coatings for Valves and Hydrants". The valves design shall not have any recesses, insets in the bottom of the waterway which would promote build-up or collection of residue and debris. Resilient Seated Gate Valves shall be provided for the size specified.

With the valve open, the valve shall provide an unobstructed waterway that has a diameter not less than the full nominal diameter of the valve. The minimum number of turns to open the valve shall be three times the valve diameter.

Acceptable manufacturers and models shall be:

AMERICAN FLOW CONTROL	Series 500, Series 2500
CLOW	2640 (Figure F-6100)
KENNEDY	8571 KS - FW
M&H	3067
US PIPE	METROSEAL 250
MUELLER	A-2360
J&S	Series 6800, Series 6900

Submittals: Submittals shall be provided in accordance with Article 5.3 of this Section. Also, the manufacturer shall provide approved certified test data or an affidavit stating that the valve complies with AWWA C-509 Section 6.1 and the following, in accordance with Section 6.2:

Hydrostatic Test: The manufacturer shall pressure test one valve of each size and class with 400 psi applied to one side and zero to the other. The test shall be made in each direction across the closed gate.

Torque Test: The manufacturer shall over-torque a valve of each size to demonstrate that no distortion of the valve stem occurs. The applied torque shall be 250 ft-lb for a 4-inch valve and 350 ft-lb for the larger valves in both the open and closed position.

Leakage Test: The manufacturer shall select two valves of each size to be fully opened and closed for 500 complete cycles with a 200 psi differential pressure across the gate. The valve shall be drip tight upon completion of the test.

Pressure Test: One valve of each size shall be tested, with the gate fully open, to a pressure of 500 psi. There shall be no evidence of rupture or cracking of valve body, bonnet or seal plated.

Markings: Shall be cast on the bonnet or body of each valve. Markings shall include the manufacture's name or mark, the year the valve casting was made, the size of the valves, and the designated working pressure.

Valve Ends: Shall be mechanical joint or flanged ends as specified.

Valve Body and Bonnet: Shall be cast iron conforming to ASTM A-126, or ductile iron conforming to ASTM A-536 or A-395.

Bolts: All bonnet and seal plate bolts shall be factory installed and made from stainless steel ASTM A-276 with either regular square or hexagonal heads with dimensions conforming to ANSI B18.2.1.

Wedge: The wedge shall be cast iron or ductile iron fully encapsulated with resilient rubber material bonded to the disc. The method for bonding the resilient material shall be confirmed by ASTM D-429 as required by AWWA C-509.

Valve Stem: Shall be constructed of low zinc bronze CDA Copper Alloy no. C99500 with a minimum yield strength of 40,000 psi and minimum elongation in 2-inches of 10%.

Stem Seals: Shall consist of two O-rings such that the seal above the stem collar can be replaced with the valve under pressure in the fully open position. O-rings shall meet the requirements of ASTM D-2000 and have physical properties suitable for the application.

Valve Operator: Shall be a cast iron, ASTM A-126 Class B, wrench nut. The nut shall have a 2-inch square base and shall be 1-15/16-inch square at the top and be 1-3/4-inch high and shall open counterclockwise (left). The wrench nut shall be painted black and an arrow indicating direction of opening shall be cast on the nut, according to AWWA C-509.

Protective Coating: An epoxy coating shall be applied to all exterior and all stationary interior ferrous surfaces including all interior openings in the valves body. The coating shall not be applied to the gasket surfaces of the end flanges.

The coating shall be applied in accordance with AWWA C-550 and the manufacturer's instructions. The epoxy coating shall have a minimum dry film thickness of 8 mils. After the coating is completely cured, the coated surface shall be tested for porosity, holidays, and pinholes using a holiday detector. All holidays or irregularities shall be repaired and the coating again tested.

E. BUTTERFLY VALVES: Shall be of the tight-closing, rubber-seated type for Class 150B service. Butterfly valves shall comply with the requirements of AWWA C-504, "Standard for Rubber-Seated Butterfly Valves." Butterfly valves shall be provided for the size specified.

Acceptable manufacturers and models shall be:

Val-Matic	Class 150B Flanged or Mechanical Joint
M&H	450, 4500, 1450
Kennedy	30A, 30C
Mueller	Lineseal III
Pratt	Groundhog Flanged or Mechanical

Submittals: Submittals shall be provided in accordance with Article 5.3 of this Section. Also, the Manufacturer shall provide approved certified test data or an affidavit stating that the valve complies with the performance tests, leakage tests, hydrostatic test and proof-of-design tests as described in Section 5.2 of AWWA C-504.

Valve Ends: Shall be short body flanged, mechanical joint or as otherwise specified.

Valve Bodies shall be constructed of cast iron ASTM A-126, Class B, or ASTM A-48, Class 40 or Ductile Iron, ASTM A-536, Grade 65/45/12.

Valve Discs shall be cast iron conforming to ASTM A-126, Class B or Ductile Iron conforming to ASTM A-536, Grade 65/45/12. Valve disc shall seat in a position of 90 degrees to the pipe axis and shall rotate 90 degrees between full open and tight closed position. Dimensions of clearance for valve discs are required.

Valve Shafts, keys, dowel pins, or taper pins used for attaching valve shaft to the valve disc shall be Type 304 or 316 Stainless Steel, conforming to ASTM A-276, or equivalent corrosion resistant material. All portions of shaft bearings shall be stainless steel or bronze.

Valve shafts may consist of a one-piece unit extending completely through the valve disc, or may be of the "stub shaft" type as defined in AWWA C-504.

Butterfly valves shall be provided with an extended bonnet, unless otherwise specified.

Shaft Seals shall be a Split-V or O-ring type. Replacement shall be possible without removing the valve shaft.

Valve Seats shall be new natural or synthetic rubber resilient seats to provide tight shut off at the specified pressure. Seats shall be attached to either the disc or the body. Seats shall be clamped, mechanically secured, bonded or vulcanized to either the disc or body. Seat rings shall be stainless steel and fastened by stainless steel cap screws.

Mating Seat Surface shall be ASTM A-276, stainless steel 18-8, Type 304, or have a 95% pure nickel overlay.

Valve Bearings shall be sleeve type. Bearings shall be manufactured from corrosion resistant and "self-lubricated" materials that will not damage natural or synthetic rubber.

Valve Operators shall be manual with a 2-inch square operating nut and turn left (counterclockwise) to open. Operators shall have all gearing totally enclosed and shall be pre-lubricated or grease packed. Operators shall be of the worm gear or traveling nut and link type with field adjustable stops capable of withstanding 300 ft. lbs. input torque, as required by AWWA C-504.

Protective Coating: Except as otherwise specified, all interior steel or cast iron surfaces shall be shop coated in accordance with the requirements of AWWA Standard C-504. All external surfaces for buried valves shall be shop coated with two coats of asphalt varnish according to AWWA C-504.

When specified, a standard epoxy interior coating shall be applied in accordance with AWWA Standard C-550, "Standard for Protective Interior Coatings for Valves and Hydrants."

F. AIR RELEASE, AIR/VACUUM, and COMBINATION AIR VALVES: Air-Release, Air/Vacuum and Combination Air Valves shall comply with AWWA C-512 and the following specifications. These specifications shall apply to valve sizes 6" and smaller.

Air Release Valves (AR) shall be designed to automatically release accumulated air pockets within the pipeline while in operation and under pressure. Air release valves shall be APCO Model 200, Val-Matic Model 38, or Crispin Model P.

Air/Vacuum Valves (AV) shall be designed to allow large volumes of air to escape through the valve orifice when filling a pipeline and to close watertight once the air has been expelled. Air and vacuum valves shall also permit large volumes of air to enter through the valve orifice when the pipeline is being drained to break the vacuum. Air and vacuum valves shall be APCO Series 140, Val-Matic Series 100, or Crispin Model AL.

Combination Air Valves (CAV) shall be heavy-duty air and vacuum valves with air release. Combination Air Valves shall be designed to release accumulations of air at high points within a pipeline by exhausting large volumes of air as the pipeline is being filled and by releasing accumulated pockets of air while the pipeline is in operation and under pressure. Combination air valves shall also be designed to permit large volumes of air to enter the pipeline during pipeline drainage. Combination Air Valves shall be APCO, Val-matic Series 200, or Crispin Model C.

Submittals: The manufacturer shall provide an affidavit stating that the valve and all materials used in its construction conform to the applicable requirements of AWWA C-512 and these specifications. When required, the manufacturer shall provide and affidavit stating that the valve has been tested and is in compliance with the requirements specified in Section 5.1 of AWWA C-512.

Markings: Manufacturer's name or trademark, size of valve, and the designated maximum working pressure rating shall be cast in the body or marked on a corrosion-resistant name plate.

Body and Cover: Each air valve shall have a cast or ductile iron body and cover. Cast iron shall comply with ASTM A-126 Class B, or ASTM A-48 Class 35. Ductile iron shall comply with the requirements of ASTM A-536, Grade 65-45-12. Bolting material shall meet or exceed the strength requirements of ASTM A-307. All internal trim shall be of stainless steel.

Float: Shall be stainless steel. Float shall be baffled to prevent air from blowing valve closed until air is exhausted. Valve body, float, etc., shall be designed for a working pressure equal to that of the system in which it is installed. Floats for valves with inlet sizes less than 4" shall be capable of withstanding a collapse pressure of 1000 psig. For larger inlet sizes, floats shall be capable of withstanding a collapse pressure of 750 psig.

Valve Outlet: Shall be fitted to attach discharge pipe as indicated. Valve inlet shall be N.P.T. for 2-inch and smaller valves. Valve inlet shall be ANSI flange for 3-inch and larger valves. Flange rating shall equal or exceed the maximum working pressure of the system in which it is installed.

Installation: Air release and air/vacuum valves shall be installed within valve vaults, or manhole, in accordance with Utility Standard Details 263-1, 263-2, 263-3, 263-4 and plans.

Protective Coatings: Interior surface coatings shall not be required unless otherwise specified. External surfaces shall be coated with the manufacturer's standard primer.

G. SWING CHECK VALVES: Shall comply with the requirements of AWWA C-508 and be tight seating to prevent the backflow of the media during pump shut-off or power failure. The closure assembly shall be designed to assume the closed position by gravity under no flow conditions in a horizontal position. Fully open swing check valves shall have a net flow area not less than the area of a circle with a diameter equal to the nominal pipe size. Check valves shall be either Swing Type Spring and Lever or Swing Type Lever and Weight.

Acceptable Manufacturers shall be Kennedy Company, Mueller, or equal.

All internals shall be replaceable in the field without removing the main valve from the pipeline.

Valves 2-1/2 inches to 12 inches in diameter shall withstand a working pressure of 175 psig.

Submittals: The manufacturer shall provide an affidavit stating that the valve and all materials used in its construction conform to the applicable requirements of AWWA C-508 and these specifications. When required, the manufacturer shall provide an affidavit stating that the valve has been tested and is in compliance with the requirements specified in Section 5.2 of AWWA C-508.

Markings: Shall be cast on the cover or body and show the manufacturer's name or mark, check valve size, working water pressure, and flow-direction arrow.

Valve Ends: Shall be flanged unless otherwise specified.

Body: Shall be heavy cast-iron conforming to ASTM Standard A-126, Class B.

Disc: Disc shall be cast-iron conforming to ASTM Standard A-126, Class B. The disc shall be either Rubber-Faced, or Bronze-Faced conforming to ASTM B-584 "Specification for Copper Alloy Sand Castings for General Applications."

Disc Seat or Plate: Shall be resilient Buna-N material or Bronze conforming to ASTM Standard B-62 for drip tight shut-off and shall be easily replace in the field without the use of special tools.

Seat Ring: Shall be Bronze conforming to ASTM Standard B-584 and shall be mechanically attached to machined surfaces in the body.

Hinge or Clapper Arm: Shall be bronze conforming to ASTM Standard B-584.

Hinge Pins: Shall be Stainless Steel conforming to ASTM A-276 "Specification for Stainless and Heat Resisting Steel Bars and Shapes" in accordance with AWWA C-508.

Lever: For Swing-Type Lever and Weight, the lever shall have an adjustable counterweight to control opening and closing of clapper arm. For Swing-Type Spring and Lever, lever shall have an adjustable spring tension to control opening and closing of clapper. Installation of lever shall be on either side of valve.

Protective Coating: An epoxy coating shall be applied to all stationary interior ferrous surfaces including all interior openings in the valves body. The coating shall not be applied to the gasket surfaces of the end flanges. The coating shall be applied in accordance with AWWA C-550 and the manufacturer's instructions.

Valve Exterior: Shall be painted with Red Oxide Phenolic Primer Paint as accepted by the FDA for use on materials in contact with potable water.

H. PRESSURE REDUCING VALVES: Shall maintain a constant downstream pressure regardless of varying inlet pressure. Unless otherwise specified, Water Pressure Reducing Valve shall be a direct acting, spring loaded, normally open globe pattern valve designed to permit flow when controlled pressure is less than the spring setting.

2-inches and Smaller: Shall be bronze body, nylon reinforced diaphragm, single seat, composition disc, Watt No. 223 or Masoneilan No. 227, or equal.

Larger than 2-inches: Shall have a cast iron body (conforming to ASTM B-61), bronze main valve trim (conforming to ASTM B-61), a reinforce neoprene diaphragm, stainless steel stem and flanged ends.

Acceptable Manufacturers and Models: Shall be Cla-Val Co., Model 90, Fisher Governor Co., Type 616 Bailey Model 30A, or approved equal.

Pressure Rating: Shall be 125 psi with an adjustment range of 30-300 psi.

Valve Components: Shall be removable and repairable while the valve body remains in the line.

Diaphragm Assembly: Shall be synthetic rubber with a stem fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. The diaphragm shall not be used as a seating surface.

Resilient Disc: Shall form a sealed chamber against the disc seat when the valve is closed. The seat shall be removable and shall have a smooth surface that will not induce seal cutting or wear.

Strainer: Valves 3-inches and smaller shall have a standard flow clean strainer mounted in the inlet supply port of the main valve.

Valves 4-inches and larger shall have a standard y-strainer externally mounted for the protection of the control circuit.

Protective Coating: An epoxy coating shall be applied to all interior and exterior ferrous surfaces of the valve body. The coating shall be applied in accordance with AWWA C-550 Standards.

5.5 INSTALLATION

Carefully handle and install valves horizontally in such a manner as to prevent damage to any parts of the valves. Installation shall be in accordance with manufacturer's instruction. Valves delivered closed to the site shall be opened by the Contractor prior to installation. The Contractor shall record the number of turns required to open the valve. This information shall be submitted to the Utility on the standard valve report.

Valves shall be polyethylene-wrapped in accordance with AWWA C-105, unless otherwise specified. Thrust blocking shall be provided as specified in Section 3.1 of these specifications.

5.6 TESTING

Upon completion of installation of the valves, an acceptance test shall be conducted to verify the satisfactory operation of the valves. The unit shall be checked for operation and leakage. The valves must perform in a manner acceptable to the Engineer before final acceptance will be made by the Owner.

5.7 FITTINGS

A. GENERAL: Fittings as specified herein shall be ductile iron (DI) for use with ductile iron or polyvinyl chloride (PVC) water pressure or transmission pipe.

All fittings shall be smooth cement lined in accordance with AWWA C-104 and shall be outside asphaltic coated per AWWA C-110.

The size, body type, type of joint ends, and applicable reference standard, shall be as shown on engineering drawings or as specified.

Standards: Fittings shall comply with applicable requirements of the following:

ANSI B16.1	Cast Iron Pipe Flanges and Fittings
AWWA C-104	American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C-105	Standard for Polyethylene Encasement for Ductile Iron Pipe and Fittings
AWWA C-110	American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 Inches through 48 Inches, for Water and Other Liquids
AWWA C-111	Rubber-Gasket Joints
AWWA C-153	American National Standard for Ductile-Iron Compact Fittings, 3 Inches through 16 Inches, for Water and Other Liquids

B. The following minimum requirements of TABLE A and TABLE B shall apply to the specified fittings.

TABLE A - STANDARD SHORT-BODY FITTINGS PER AWWA C-110			
TYPE OF JOINT	**DIAMETER (inches)**	**RATED WORKING PRESSURE (psi)**	**MATERIAL**
Mechanical (Rubber Gasket/C-111)	4-24	350	DI
Flanged	4-24	250	DI
All types	30-80	250	DI
Push-On (Rubber Gasket/C-111)	4-24	250	DI

TABLE B - COMPACT SHORT-BODY FITTINGS PER AWWA C-153			
TYPE OF JOINT	**DIAMETER (inches)**	**RATED WORKING PRESSURE (psi)**	**MATERIAL**
Mechanical or Push-On (Rubber Gasket/C-111)	4-24	350	DI

C. All joint accessories such as gaskets, glands, bolts, and nuts shall be furnished with mechanical joints, and gaskets and lubricant shall be furnished with push-on joints in sufficient quantity for assembly of each joint.

D. Push-on joint fittings shall be marked with the proprietary name or trademark of the joint.

E. Fittings shall be marked on the outside with their applicable AWWA Standard and information called for by the Standard.

F. Fittings shall be polyethylene wrapped in accordance with AWWA C-105.

5.8 VALVE VAULTS

A. GENERAL: Pre-cast vaults shall be as shown on the Plans. Bases shall be pre-cast or cast-in-place as indicated on the Drawings.

B. QUALITY ASSURANCE: Vaults shall meet the requirements of ACI 318. All vaults shall be designed for a minimum H-20 loading per AASHTO Specifications, plus a 30 percent impact factor, or greater if indicated on the Drawings or specified.

Mark date of manufacture and name or trademark of manufacturer on inside of each pre-cast vault section.

C. SUBMITTALS: Structural calculations sealed by a Structural Engineer registered in the State of Texas shall be submitted for approval, along with Shop Drawings.

D. PRODUCTS AND MATERIALS: Concrete shall have a minimum 28-day compressive strength of 4,000 psi. Reinforcing steel shall meet the requirements of SECTION 3.1, Concrete.

An approved flexible joint shall be provided between each pipe entering and exiting the vault. The joint shall provide a watertight installation. Submit jointing system or material for approval.

Metal frames, covers, steps, toe pockets and similar required items shall be provided as shown.

E. INSTALLATION: Cast-in-place bases shall be placed on suitable foundations after the pipes are laid. Special care shall be taken in placing the concrete around the bottom of the pipes to obtain a waterproof structure. An approved bell shall be cast in the base to receive the pipe sections forming the barrel.

Pre-cast bases shall be set on a concrete or crushed stone foundation as shown. Pre-cast bases shall be set at the proper grade and carefully aligned. Set pre-cast vault sections vertical in true alignment. Install sections, joints, and gaskets in accordance with manufacturer's recommendations.

Lifting holes shall be sealed tight with a solid rubber plug driven into hole and the remaining void filled with cement-sand mortar.

END OF SECTION

6.0 WATER SYSTEM

6.1 QUALITY ASSURANCE

Fittings, valves, and meters in contact with potable water shall conform to the latest revision of NSF/ANSI Standard 61 (Annex F). Such compliance shall be evidenced by an affidavit from the manufacturer or vendor.

All fittings, valves, and meters shall have the manufacturer's name or trademark permanently stamped or cast on it and "No Lead" brass allow, e.g. "NL" shall be cast or stamped on the valves and fittings.

6.2 WATER SERVICE CONNECTIONS

A. SCOPE: This section covers the requirements for materials and installation of water. Furnish labor, materials, equipment, and incidentals necessary to install water service connections, complete for potable water supply. New water meters, unless otherwise specified, will be furnished by the Utility. All other materials required, including meter boxes, shall be furnished and installed by the Contractor.

B. SUBMITTALS: Submittals shall include certifications from manufacturers that the products comply with appropriate ASTM, AWWA, and Utility Standards.

C. MANUFACTURED PRODUCTS:

Castings and Washer Nuts: Shall be of certified cast bronze composition, 85-5-5-5 percent per ASTM B-62, fully formed, tapped threads meeting requirements of AWWA C-800 for underground service. (Not in contact with potable water)

Gaskets: Shall be self-sealing, 100 percent neoprene or Buna-N rubber, formulated for water service.

Service Saddles: Shall be two or three piece all-bronze, double strap with National Coarse Class 2 thread. Saddles shall be suitable for Class 200 asbestos cement pipe, cast iron pipe and ductile iron pipe with double straps. Saddles for C-900 or C-905 polyvinyl chloride (PVC) pipe shall be single strap. Saddle body shall extend 180 degrees around pipe. Acceptable manufacturers and models are as follows:

Ford Meter Box Co.	Model S90
James Jones Co.	J-996
A.Y. McDonald Mfg. Co.	3805
Mueller	H-1344X

Straps: Shall be silicon bronze, approximate tensile strength of 70,000 psi chamfered for easy nut starting and flattened to provide wide bearing surface

Valves: Shall be in accordance with Utility acceptable standards. Valves for copper pipe shall be bronze with minimum 85 percent copper content casting. Valves for PVC pipe shall be cast-iron and conform to requirements for Gate Valves (see Section 5.0).

Corporation stops shall be ball valve style and conform to the requirements of AWWA C800. Acceptable manufacturers are Ford Meter Box Co., McDonald, Mueller or approved equal.

Angle ball valves with padlock wings shall be copper flared inlet and female iron pipe thread outlet such as James Jones Company Model J-1965W, McDonald MFG Model 76101W, or approved equal. Outlet meter coupling nut shall be used for 3/4-inch and 1-inch meters. Valves for 1-1/2-inch and 2-inch meters shall be inlet female iron pipe by outlet oval flange ends.

Service Pipe: Shall be copper Type "K" for sizes up to and including 2-inch, meeting ASTM B-88. Pipe for 3-inch services shall be 4-inch PVC per AWWA C-900, with reducers at meters. Pipe for 4-inch services and larger shall be PVC pipe per AWWA C-900.

Fittings: Shall be bronze for copper pipe. Fittings for PVC pipe shall be ductile iron.

Meter Boxes: Shall be manufactured and installed in accordance with Utility Standard Details and SECTION 6.3 of these Specifications.

Meter Couplings: Shall be brass with no lead alloy, manufactured in compliance with ANSI/AWWA C800, ASTM B584, and shall have an identifying "NL" on body. Certified to NSF/ANSI 61 and NSF/ANSI 372. Acceptable manufacturers are Ford Meter Box Co., AY McDonald (74620, 74620H), Mueller, or approved equal.

Curb Stop: Shall be ball valve style, brass with no lead alloy, manufactured in compliance with ANSI/AWWA C800, ASTM B584, and shall have an identifying "NL" on body. Rated for 300 psig water pressure and certified to NSF/ANSI 61 and NSF/ANSI 372. Acceptable manufacturers are Ford Meter Box Co., AY McDonald (76101W, 74646B, 746060B), Mueller (B-25204, B-25174), or approved equal.

D. INSTALLATION: Service taps for 3/4-inch to 2-inch services shall be made with service saddle to be furnished and installed by the Contractor. No direct taps, i.e. without the saddle, shall be made. Taps for 3-inch and 4-inch services shall be made using 4-inch tapping sleeve and valve. Copper service pipe attached to metallic water mains shall be insulated at the corporation stop with a dielectric insulator. Installation shall comply with Utility Standards for Excavating, Backfilling, and Compacting.

Multiple tapping, two or more taps on a length of pipe, shall not be on a common line parallel to the longitudinal axis of the pipe and shall be no closer than 18-inches on the longitudinal axis of the pipe.

No splices shall be allowed in any portion of the service pipe run between the main line connection and the meter assembly. No dry or direct taps are authorized.

When specified, meter installations larger than 1-inch shall be made with a bypass meter connection according to the following schedule:

1-1/2-inch and 2-inch meters	1-inch bypass
3-inch and 4-inch meters	2-inch bypass
6-inch and 8-inch meters	3-inch bypass

E. EXISTING SERVICES: Where existing water services are indicated on the Drawings to be replaced, relocated, or reconnected to new water lines, the Contractor shall make prior arrangements with each water customer as to the time and length of shutdown necessary. The customer shall be notified 24 hours before any connections are made. A maximum shut-off time of four (4) hours will be allowed for making connections, after which time the Contractor shall supply the customer with potable water from an approved source.

F. METALLIC TRACER TAPE: For 3-inch services and larger (i.e. PVC), width shall be a minimum of 6-inches or twice the line diameter. The burial depth shall not exceed 36-inches below final grade nor be at an elevation of less than 12-inches above the utility line. Recommended burial depth shall be according to the tape manufacturer. Color of tape shall conform to American Public Works Association (APWA) color code. Acceptable manufacturer shall be THOR Enterprises, Inc., "Magnatec" or equivalent as approved.

G. TESTING AND FLUSHING PROCEDURES: All services shall be pressure tested for leakage by opening the corporation or service valve at the main service connection point, maintaining the meter angle valve closed, and visually observing all connections and piping for leaks. If no leaks are observed, the service line shall then be flushed as follows. The angle valve is opened to "full" and then the corporation valve is slowly opened to full capacity. Water is allowed to flow until piping has been thoroughly flushed. Then the angle valve is slowly closed to prevent water hammer or shock pressure which might rupture the main or adjacent water service connections. If no customer

piping is currently connected to the meter outlet connection, a fitted plug shall be used at the end of this connection to prevent the entrance of dirt or muddy water.

6.3 WATER METERS

A. SCOPE: This section provides the requirements for purchasing and installing water meters. Generally, the EPWU shall be responsible for the purchase of all meters within the EPWU distribution system.

B. QUALITY ASSURANCE: Any manufacturer desiring initial approval must first, at his own expense, supply the City with a minimum of ten sample meters. The meters will then be placed in various areas of the City and undergo a three-year field performance test. At the end of the three-year period, the meters will be evaluated for accuracy, wear, system compatibility, etc., and returned to the manufacturer. If the City determines that the meter(s) performs acceptably, and is compatible with the City water system, the meter(s) will be deemed to be in compliance with these specifications.

A representative of the meter manufacturer shall meet regularly, in El Paso, with the Utility. Meetings shall occur at intervals not exceeding every three months. Said representative shall be a direct employee of the meter manufacturer.

The manufacturer or vendor shall maintain a local or toll-free WATS telephone line for customers on a maintenance agreement. Representatives shall be available during normal EPWU operating hours.

C. SUBMITTALS: Manufacturer/vendors shall advise the El Paso Water Utilities Purchasing Department of their intent to bid and submit one sample meter of each proposed size and type to the El Paso Water Utilities Meter Shop a minimum of twenty (20) days prior to the bid date. Technical data on each size and type of meter shall be submitted with the meter(s). Failure to make submittals shall be sufficient cause for meter rejection.

Technical data shall include, but is not limited to, three copies of each of the following:

Descriptive literature defining material, dimensions, operation, etc.

Parts list covering all the various parts of the meter(s) offered.

Accuracy, pressure, and performance curves.

Installation, maintenance, and repair instructions.

Manufacturers/vendors shall submit with their proposal, two copies of parts lists covering all the various parts of the meter(s) offered and prices of those parts. Any price discounts shall be stated.

Manufacturers/vendors shall submit with their proposals two copies of all maintenance agreements and contracts and/or their exchange rebuilding programs. The office and representatives that would be responsible for the sales and support services shall be defined.

Manufacturers/vendors shall submit with their proposals two copies of the nationally published guarantee for each model and size of meter proposed.

Manufacturers/vendors shall submit two copies of a letter from NSF International on NSF letterhead documenting compliance with the latest revision of NSF/ANSI Standard 61, Annex F, which requires leaching of less than 5 ppb for all NSF Standard 61 certified products.

Manufacturers/vendors shall submit two copies of a letter from NSF International on NSF letterhead documenting compliance with NSF/ANSI Standard 61, Annex G, which allows a maximum weighted average lead content level of 0.25% of the wetted surface area.

The successful bidder shall deliver the water meters to the EPWU Meter Shop at 2101 Cyprus Avenue, El Paso, Texas. The bidder shall not be responsible for storage at the delivery site.

All water meters must be repairable by the EPWU's meter shop employees. Repairs and maintenance information shall be submitted to signify compliance with this provision.

D. STANDARDS: All meters shall comply with applicable AWWA Standards and the latest revision of NSF/ANSI Standard 61 (Annex F & G). Such compliance shall be verified by an affidavit from the manufacturer/vendor.

Each meter shall be accompanied by a factory test tag certifying compliance with applicable AWWA accuracy standards.

E. BASIS FOR REJECTION: Rejection of Bid - Manufacturers shall have a minimum of five (5) years' experience in manufacturing and supplying similar type water meters in all proposed sizes and models. Manufacturers shall submit a list of five municipalities or utility organizations comparable in size to the City of El Paso, or El Paso Water Utilities, where at least 10 percent of the total number of meters in the system has been in service for a minimum five-year period. The submittal shall include the name and telephone numbers of individuals to contact at each municipality or utility. The bid may be rejected if verification of information reveals discrepancies.

Rejection of Meters - All meters failing to satisfy the requirements of applicable AWWA Standards and these Specifications shall be rejected. Replacement or repair of all rejected meters shall be paid for by the manufacturer.

The El Paso Water Utilities reserves the option to perform accuracy tests on new meters within ninety (90) days of receipt of a partial or full shipment. If more than five (5) percent of the meters received fail to comply with the accuracy requirements, the El Paso Water Utilities shall have the right to reject all meters received. The El Paso Water Utilities shall have the option of requiring the manufacturer/vendor to replace the rejected meters at no additional cost, or declaring the entire purchase order void and purchasing meters by another manufacturer.

F. GUARANTEES: The manufacturer shall provide the nationally published guarantee for each model and size of proposed meter. Each guarantee shall state the registration reading, in cubic feet or other similar units, to which the meter is guaranteed. Register guarantees shall be provided and stated in terms of years warranted against leakage, sweating, jamming, or operating erratically.

Availability of parts shall be guaranteed, a minimum of ten years, by the manufacturer receiving the award. The parts price list shall be guaranteed, a minimum of one year from the bid date, by the manufacturer. Acceptance of the order and delivery of the first group of meters shall be evidence of the manufacturer's agreement to this condition and acceptance of the liability, and further guarantee that the cost of parts to the EPWU will not exceed the price charged to other cities within 600 miles of El Paso except for differences in freight costs.

Meters shall meet the following minimum requirements:

All parts shall be guaranteed free of defects in material and workmanship for a one year period from shipment date.

Registers shall be guaranteed free of defects in materials and workmanship for a period of ten years after shipment date.

Meters shall comply with AWWA accuracy standards for new meters.

Meters damaged by sand, heat vandalism, etc. shall not be considered part of the guarantee responsibility of the manufacturer.

G. COLD WATER METERS - POSITIVE DISPLACEMENT TYPE: This section covers the various types and classes of cold-water, positive displacement meters in sizes 5/8" x 3/4", 3/4", 1", 1-1/2", and 2". Meters shall be of the positive displacement nutating disc or piston oscillating type with magnetic drive and shall comply with all provisions of AWWA C-700 "Standard for Cold-Water Meters - Displacement Type, Bronze Main Case".

The types of meters acceptable under these specifications shall be Neptune (Schlumberger) Model Trident 10, Badger Model Record-All Series, Sensus Model SRII Series, Hersey Model 400 Series II and 500 Series, Kent C700 1" BP Water Meter, or any other meter type approved by the EPWU a minimum of five (5) days before the bids are to be received.

Meters 1-inch and smaller in size shall have a bronze bottom cap which bolts to the body of the main casing. All threaded main case bolt holes shall be covered.

All 1-1/2-inch and 2-inch meters shall be the flanged type. If these meters utilize O-rings between the top plate and body of the main casing, a vent screw, or other appropriate method of relieving the internal pressure shall be provided.

Markings: Size, model, NSF certification, and direction of flow arrow through the meter shall be marked permanently on outer case of all meters. Manufacturer's meter serial number shall be permanently imprinted on outer case. Register box shall be permanently marked with manufacturer's name and the serial number of the lid.

Main Casing: Shall consist of two sections bolted together. Both upper and lower sections shall be fabricated of cast bronze. Meters shall not be more than 9-3/8 inches in height as measured from bottom of the main casing to the top of the closed register lid. Each meter of the 5/8-inch x ¾-inch size shall have the EPWU Serial Number stamped on the outlet side of the main case. Minimum height of the characters shall be 3/16-inches. Serial numbers will be furnished at the time of the award and will be in numerical order, but not necessarily in numerical sequence.

Measuring Chambers: Shall be of two or three piece construction and shall be of a rigid, durable, corrosion-resistant bronze or a suitable synthetic polymer. The measuring chamber diaphragm shall be rigid, shall be made of a firm and durable non-corrosive material and shall be held securely in place.

Registers: The magnetically driven register shall be permanently, hermetically sealed by the manufacturer and shall read in cubic feet with a red center sweep hand. All registers shall have a minimum of six number wheels with additional zero plainly stamped on the dial face to provide a maximum reading capacity of 900,000 cubic feet. The register numbered wheels shall be black on white for volumes of 100 cubic feet and greater. The dials reading less than 100 cubic feet shall have white numerals on black backgrounds.

Only registers that are moisture and dust proof under normal operating conditions shall be acceptable. The register glass shall be of high impact heat tempered glass and shall be inserted from the interior. Registers shall have a low flow indicator. Register boxes shall be secured to the meter main case by means of a tamper resistant device.

Register design shall be such that the register can be removed from the meter main case and replaced without removing the meter from service or without removing other integral parts of the meter. Register of each size and manufacture of meter shall be interchangeable with registers of other meters of the same size and manufacture.

Strainer: Screens shall be provided in each meter. Screens shall be of non-corrosive material that will not be damaged by temperatures of 100 degrees Fahrenheit. Screens shall fit securely and be easily removed.

Bolts: All external bolts, washers, and related items shall be brass, bronze, or stainless steel. Prior to installation, the bolt threads shall be coated with Never-Seez manufactured by Never Seez Compound Corp., WLR No. 111 manufactured by Oil Research Inc. or equal.

Pressure Loss: Meters shall not exceed the maximum pressure loss limits at maximum pressure as outlined in AWWA Standards.

Overall Meter Length: The dimensions from face to face of the main casing spuds and flanges shall be as stated in AWWA C-700.

Accuracy Testing: All new meters received under these specifications shall be tested for accuracy at the Meter Shop within ninety (90) days after delivery. Meters shall indicate on the registers not less than 98% nor more than 101.5% of the actual water flow through the meter while being tested at the "normal rate" of flow as shown in the following table. The meter shall indicate not less than 95% of the water actually passed through them when being tested at the "minimum rate" of flow indicated in the table when tested with water at a temperature of 80 degrees F plus or minus 5 degrees:

METER SIZE	NORMAL TEST FLOW LIMITS	MINIMUM TEST FLOW
5/8" x 3/4"	1.0 to 20 GPM	0.25 GPM
3/4"	2.0 to 30 GPM	0.50 GPM
1"	3.0 to 50 GPM	0.75 GPM
1-1/2"	5.0 to 100 GPM	1.50 GPM
2"	8.0 to 160 GPM	1.00 GPM

All meters failing accuracy test conducted by the EPWU shall be rejected and returned to manufacturer, freight collect, and manufacturer shall replace such meters within 30 days, freight prepaid.

After one year from date of shipment, meters shall comply with the accuracy limits indicated in Table 5-3 of AWWA Manual M-6 "Water Meters - Selection, Installation, Testing, and Maintenance", for either of the following specified time periods or register reading, whichever event occurs first:

METER SIZE	TIME PERIOD (years)	REGISTER READING (ft)
5/8" x 3/4"	10	133,600
3/4"	10	200,000
1"	10	260,000
1-1/2"	10	370,000
2"	10	690,000

Meters with a non-repairable sealed register shall be guaranteed to be repairable to new meter accuracy as specified above by replacing the measuring chamber and piston or disc after registering a flow of 900,000 cubic feet. Other meters shall be repairable to "new" meter accuracy by changing not more than two readily accessible change gears and either the piston/disc or chamber but not both.

H. BRONZE CASE TURBINE TYPE COLD WATER METER WITH MAGNETIC DRIVE: This section covers the various types and classes of bronze case, turbine type cold water meters in sizes 2-inch through 8-inch. The turbine type water meters shall comply with all provisions of AWWA C-701 "Cold-Water Meters -Turbine Type, For Customer Service". Turbine water meters shall be in-line, horizontal-axis, high velocity type turbines.

Meters acceptable under these specifications shall be Rockwell Series W, Hersey, Neptune, Badger, Sensus, Kent 4-inch, or other brands approved a minimum of 5 days bids are to be received.

Meter case end connections shall be two bolt ovals. For meter sizes 3", 4", 6", and 8" end connections shall be round flanges, faced and drilled and shall conform AWWA C-110.

Main Casing: Shall consist of two sections bolted together. Both upper and lower sections shall be fabricated of a high grade bronze composition with case bolts and straightening vanes of non-corrosive material compatible with main case material.

Measuring Chamber: Shall include, in one assembly, the measuring element, calibration device and register and shall be easily removed. Measuring chamber turbine shall be mounted in a horizontal position so that the water passes in a straight through pattern in the meter casing and measuring chamber housing.

Measuring Turbine: Shall be constructed of vulcanized hard rubber or suitable plastic material having an approximate specific gravity of one. It shall be equipped with near frictionless replaceable bearings that rotate on a stationary replaceable stainless steel shaft.

Register: The magnetically-driven register assembly shall be hermetically sealed, straight reading in cubic feet with center sweep hand. All registers shall have a minimum of six number wheels with additional zero or zeros plainly stamped on the dial face immediately following the last number wheel in order to provide a maximum reading capacity of the register. The numbers on the register number wheels shall be black on white except for the last two digits including the zeros stamped on the register dial face. These shall be of a contrasting color, specifically white on black. The center sweep hand shall be painted red.

Only registers that are moisture and dust proof under normal operating conditions shall be acceptable. The register exterior housing and lid shall be made of bronze or a suitable synthetic polymer and shall be so constructed that they can be changed in the field without removing the meter or any fie parts of the meter from service. The register glass shall be of high integral heat tempered glass and shall be inserted from the inside.

Strainer: All 3-inch through 8-inch Turbine Meters shall have a separate strainer case with a strainer screen that shall be easily removed. The screen shall be 3-1/2 mesh/inch cast bronze or stainless steel with a clear opening of not less than 45%. Strainer cases for 3-inch through 6-inch shall be made of bronze or cast iron with an easily removable lid. If constructed of cast iron, the metal shall be good quality, durable, of even grain, free from strains and defects of any nature, thoroughly hot dipped galvanized. When bolted together, cases shall be designed to safely withstand a working pressure of 150 psi and a hydrostatic pressure test of 300 psi.

Overall Meter Length: The dimension from face to face of the meter case flanges, nominal capacity ratings, and related pressure loss limits shall be as specified in the following table, in accordance with AWWA C-701:

METER SIZE	MAXIMUM LAYING LENGTH	NORMAL TEST FLOW LIMITS & CAPACITY	MAXIMUM LOSS OF HEAD
2"	18"	4 - 160 gpm	7 psi
3"	24"	8 - 350 gpm	7 psi
4"	29"	15 - 630 gpm	7 psi
6"	36.50"	30 - 1400 gpm	7 psi
8"	43.75"	50 - 2400 gpm	7 psi

Accuracy Testing: Meters furnished shall indicate on the registers not less than 98% nor more than 102% of the actual water flowing through the meter while being tested at the "normal rate" of flow.

I. COLD WATER METERS, CHECK VALVE FIRE SERVICE TYPE: This section covers the various types cold-water, check valve fire service meters in sizes 2-inch through 10-inch. These are meters of the "detector check" model consisting of a dual range water flow path. The "detector check" valve on the main line shall allow flow when full flow capacity is required. The small bypass meter shall detect and measure low flows. The combination shall be designed to sustain a nearly frictionless path to provide unobstructed flow when required for firefighting purposes.

Acceptable manufacturers shall be Sensus, Rockwell, Hersey, Badger, Grinnell, Febco, or any other type approved minimum of 5 days before bids are to be received.

Detector Check Valve Case and Construction: Shall be a homogeneous bronze composition for the 2-inch meter. The valve case for the 3", 4", 6" 8" and 10" valves shall cast iron or ductile iron. The cast iron shall be of good quality, durable, of even grain, free from strains and defects of any nature, and thoroughly hot dipped galvanized. If made of ductile iron, the interior shall be epoxy coated.

When bolted together, cases shall be designed to safely withstand a working pressure of 150 psi and a hydrostatic test pressure of 300 psi.

The dimensions from face to face of the valve case flanges, excluding the companion flanges or cast iron connections, shall be as follows:

DETECTOR CHECK VALVE SIZE	FACE TO FACE DIMENSIONS
2-inch	17-inches
3-inch	12 to 16-1/2 inches
4-inch	16 to 16-1/2 inches
6-inch	19 to 22-1/2 inches
8-inch	23 to 26-1/2 inches
10-inch	29 to 36 inches

The valve shall be of the counter-balanced lever mechanical type or a spring loaded center stem check valve. If the counter-balanced type is used, it shall consist of a clapper, clapper arm and a supplemental weight. It shall be arranged so that the clapper will close by gravity and there shall be ample clearance in the valve to prevent danger of any catching during operation. The clapper arm shall be bronze and secured to the clapper swing arm to prevent separation during operation, prohibit leakage at the connection and provide proper seating. The clapper shall be faced with a ring of medium hard rubber and backed up to its full width by a finished surface on the clapper. The rubber shall be held in position by a bronze clamping ring and shall come to a stop to prevent squeezing the rubber surface out of place.

Clapper swing arm shall be bronze. Supplemental weight shall be bronze shell properly weighed with lead. Supplemental weight may be attached to or be operated by clapper swing arm but in either case, it shall be organized so that its weight is nearly released immediately when clapper begins to open.

Hinge spindles shall be phosphor bronze, shall have sufficient strength to insure rigidity, and shall be well supported at each end, and shall be easily removed. The hinge spindle bearings in the clapper swing arm and supplemental weight shall be bushed with hard vulcanized rubber and they have sufficient play for proper water lubrication.

The valve case shall be fitted with bronze or stainless steel valve seat ring and it shall be installed by the expansion fit method or screwed into position. Valve seat rings shall have machined faces, the correct width of face and shall be removable.

Valve Case Connections: Meter case end connections shall be two bolt ovals for the 2-inch size, other sizes shall be regular flanges. The drilling shall be on the horizontal axis and shall be 3/4-inch and the diameter of the bolt circle shall be 4-1/2 inches. Valve case flanges for the 3-inch, 4-inch,

6-inch, 8-inch and 10-inch sizes shall be flanged, faced and drilled and the dimensions and drilling shall conform to the American 125 pound standard flange for diameter and thickness.

Bypass Assembly: Size of the bypass meter, tapping in the main meter case and size of the piping and valves to be used in the bypass assembly shall be as indicated in the following table:

MAIN METER	BY-PASS METER	BY-PASS TAPPING	BY-PASS PIPING	MAIN METER	BY-PASS METER	BY-PASS TAPPING	BY-PASS PIPING
2"	5/8" x 3/4"	3/4"	3/4"	6"	5/8" x 3/4"	1-1/2"	3/4"
3"	5/8" x 3/4"	3/4"	3/4"	8"	1"	2"	1"
4"	5/8" x 3/4"	1"	3/4"	10"	1-1/2"	2"	1-1/2"

Valve cases shall be tapped for standard screw pip so that bypassing around the valve seat and clapper can be made on either side of valve case.

The 1-1/2 inch taps for the 6-inch valve cases shall be reduced with bronze bushings 3/4-inch standard pipe size. The 2-inch taps for the 8-inch valve cases shall be reduced with bronze bushings to 1-inch standard pipe size. The 2-inch taps for the 10-inch valve case shall be reduced with bronze bushings to 1-1/2 inch standard pipe size.

The bypass assembly and bypass meter shall be preassemble and installed on each detector check. Bypass meter shall register in cubic feet and shall be model already in service for the EPWU system.

Delivery and Pressure Loss: When open wide, all check valves shall have an unobstructed waterway equal to the area of the pipe and the toe of the clapper swing arm and the supplemental weight thereon, shall not exceed 4 psi and immediately upon reaching the capacity of the bypass meter for this pressure, the check valve will open and the loss of pressure thereafter, due to the weight of the clapper swing arm, shall not exceed 1 psi.

Pressure Tests: All check valves shall be perfectly tight on two tests, one against 300 psi opposite in direction of the flow and one against 1.5 psi with the direction of the flow.

6.4 CONCRETE METER BOXES

A. SCOPE: Furnish labor, materials, equipment, and incidentals to fabricate, furnish, and install pre-cast concrete meter boxes and vaults.

B. QUALITY ASSURANCE: The Owner reserves the right to request results of compressive tests, to inspect the manufacturing process at any time, to perform tests on materials used, and to extract cores from completed meter boxes for compressive strength testing and placement of reinforcement.

C. SUBMITTALS: Submit shop drawings on molds, meter boxes, and associated hardware to the Engineer for approval prior to fabrication. Provide manufacturer's certification that products comply with appropriate ASTM, AWWA, and Utility standard details.

D. STANDARDS:

ASTM A-27 Specifications for Steel Castings, Carbon, for General Application
ASTM A-36 Specification for Structural Steel
ASTM A-48 Specification for Gray Iron Castings
ASTM C-33 Specification for Concrete Aggregates
ASTM C-150 Specification for Portland Cement
ASTM C-309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C-615 Specification for Granite Building Stone

E. MATERIALS: Cement shall be Portland Cement conforming to ASTM C-150, Type I or Type III. Concrete shall have a minimum 28-day compressive strength of 4,500 psi; a water cement ratio of 0.5 or less by weight; and a maximum 5.5 gallons water per sack cement.

All concrete shall be handled from the mixer or transport vehicle to the place of final deposit in a continuous manner, as rapidly as practicable, and without segregation or loss of ingredients, until the operation is completed. Concrete shall be placed in layers not over two feet deep. Each layer shall be compacted by mechanical internal or external vibrating equipment. Duration of the vibration cycle shall be limited to the time necessary to produce satisfactory consolidation without causing objectionable segregation.

Aggregates, other than lightweight aggregates, shall conform to specifications outlined by ASTM C-33. Aggregates shall be free of deleterious substances and graded in a manner as to produce a homogeneous concrete mix. All materials are to be accurately weighed at a central batching facility for mixture.

Curing for the purposes of early re-use of forms, the concrete may be heated in the mold, after initial seat has taken place. The temperature shall not exceed 160 degrees and the temperature shall be raised from normal ambient temperatures at a rate not to exceed 40 degrees per hour. The cured unit shall not be removed from the forms until sufficient strength is obtained for the unit to withstand any structural strain that may be subjected during the form stripping operation. After the stripping of forms further curing by means of water spraying or a membrane curing compound may be used and shall be of a clear or white type, conforming to ASTM C-309.

Steel Reinforcing shall comply with ASTM A-615 Grade 60 steel, FY=60,000 psi. Minimum concrete cove on re-bar top slab shall be 1.25-inches and 1.5-inches on re-bar for walls. Bar bending and placement to comply with latest ACI Standards. All reinforcing steel, including welded wire mesh, shall be of the size and in location as shown on the plans. All reinforcing shall be sufficiently tied to withstand displacement during the pouring operation. Lifters shall be designed to handle the imposed weights, and shall be placed as specified on the drawings or manufacturer's requirements.

Steel Frames and Covers shall conform to ASTM A-27, Grade 70-36. Structural welded steel shall conform to the requirements of ASTM A-36 with dimensions as specified on the drawings.

Cast Iron Ring and Covers shall conform to the requirements of ASTM 48, Class 30. All castings shall be of uniform quality, free from blowholes, shrinkage, distortion, or other defects. They shall be smoothed and well cleaned by shot-blasting.

All castings shall be manufactured true to pattern. Component parts shall fit together in a satisfactory manner. Round frames and covers shall have continuously machined bearing surfaces to prevent rocking and rattling.

Tolerances shall not exceed 1/16 inch per foot. Deviation in weight shall not exceed 5 percent.

F. INSTALLATION: Meter boxes shall be installed in accordance with these specifications and Utility Standard Details. Install to grade matching top of curb. Meter boxes shall not be installed under sidewalks, driveways, or proposed above-ground structures. Where no curbing exists, install boxes in accessible locations beyond limits of street surfacing, walks, and driveways.

The following standard meter boxes shall be installed for their respective meter size, unless otherwise determined and approved by the Utility.

STANDARD METER BOXES			
METER SIZE	**BOX TYPE**	**CONSTRUCTION**	**DIMENSIONS W x H**
3/4"	Type A	Single Unit	19.25" O.D. x 17"
1"	Type B	Single Unit	26" O.D. x 17"
1-1/2" to 2"	Type C	Single Unit	50" SQ x 24"
3" and larger	Type D	Modular	7'-8" SQ x 4'-6"

Where it is necessary to install Type A or B boxes for ¾-inch or 1-inch meters under roadways or traffic bearing surfaces, boxes shall be encased in 12-inch concrete 3,000 psi minimum.

6.5 TAPPING SLEEVES AND PIPE COUPLINGS

A. SCOPE: The Contractor shall furnish labor, materials, equipment, and incidentals necessary to install tapping sleeves and pipe couplings as specified. All tapping sleeves and pipe couplings furnished for incorporation in the work shall be suitable for operation at pressures as specified for the pipelines in which they will be installed, including test pressures and surge allowances.

B. SUBMITTALS: The Contractor shall furnish all necessary shop drawings as required.

C. CAST TAPPING SLEEVES: Tapping sleeves shall be of suitable construction and reinforced to provide resistance to line pressures. They shall be designed for the pipe size and material on which they will be used. Tapping sleeves shall be built in halves for assembly around the main to be tapped.

The branch outlet shall have a flanged face for bolting to the tapping valve. The inside diameter of outlet branch shall be sufficiently larger than the nominal size to provide clearance for the full size cutters of the tapping machine.

Acceptable manufacturers shall be:

Mueller Company
Kennedy Valve Squareseal
M&H

Type 1: Cast tapping sleeve allows water to circulate between the sleeve and the outside surface of the pipe. Gaskets of suitable material, designed for use on potable water shall form watertight joints along the entire length of the sleeve. Circumferential joints at the ends of the run of the sleeves shall be sealed by mechanical joints, conforming to AWWA C-111 as to dimensions, clearances, and materials, except that gaskets and glands form mechanical joints shall be totally confined or compressed between ridges or grooves extending continuously for the full length of both halves of the sleeve casting. Bolts shall be located close to the outside of the gaskets and spaced so as to exert sufficient pressure to form a watertight joint and withstand stresses imposed by the intended use.

Type 2: Water is confined to the immediate area of the tap opening. The outlet half of each sleeve shall be fitted with a continuous gasket of approximately circular cross section, permanently cemented into a groove surrounding the outlet opening. The back half of each sleeve shall be fitted with elastomeric pads, a metal shoe, or other device for developing adequate pressure on the gasket to prevent leakage at any pressure within the design capacity of the pipe.

Protective Coating: All surfaces exposed to flow shall be coated in accordance with AWWA C-550.

D. FABRICATED TAPPING SLEEVES: Fabricated tapping sleeves shall be rated for a working pressure of 150 psi. All tapping sleeves shall meet the following requirements:

Acceptable manufactures of fabricated tapping sleeves shall be:

Ford	FTSC
JCM	412
Romac	FTS 420
Powerseal	3490

Markings: Each tapping sleeve shall be permanently marked to identify the outer diameter size range.

Test Plug: Shall be a 3/4" NPT with standard square head.

Nuts and Bolts: Shall be high strength, corrosion resistant 18-8 Type 304 Stainless Steel.

4" -12": Tapping sleeve body and flange shall be 18-8 Type 304 Stainless Steel or AWWA C111 Carbon Steel with fusion epoxy coating. The body, lug, and gasket armor plate shall be in compliance with ASTM A-240. All metal surfaces shall be passivated, in accordance with ASTM A-380, after fabrication.

Gasket: Shall provide a watertight sealing surface around the full circumference of the pipe. Gaskets shall be formed of natural or synthetic rubber.

Lugs: Shall be welded to the shell and prevent alignment problems by allowing the bolts to pass through. Bolts shall not be welded to the sleeve.

16" and Larger: Tapping sleeves shall have a heavy welded steel body in compliance with ASTM A-36 or ASTM A-285, Grade C.

Gasket: Shall be natural or synthetic rubber compounded for water use and shall provide a watertight sealing surface.

Flange: Shall be in constructed in accordance with AWWA C-207 Class D, and shall be properly recessed for aligning the sleeve and tapping valves.

Protective Coating: Steel tapping sleeves shall be coated with epoxy. Minimum thickness shall be 8 mils.

E. FLEXIBLE COUPLINGS: Shall be furnished and installed where shown on the drawings, specified, or in locations, as approved by the Engineer. Flexible couplings installed underground shall be ductile iron and Type 316 Stainless Steel nuts and bolts shall be used. When flexible couplings are used as expansion joints, the pipe ends shall be separated to allow for expansion. Where indicated on the drawings or required by field conditions, flexible couplings shall be suitable for connecting pipes having different outside diameters. Flanged coupling adapters shall be restrained with tie rods.

Protective Coating: Entire coupling assembly shall be given a 20 mil coating of T.C. Mastic as manufactured by Tape Coat Company, Bitumastic No. 50 as manufactured by Koppers Company, or approved equal.

Ductile Iron Pipe: Flexible Joint Couplings shall be Dresser Style 38, Rockwell Style 411, or equal. Flanged coupling adapters for ductile iron pipe shall be Dresser Type 127, Rockwell International 112, Baker Series 600, or equal.

Steel Pipe: Flexible couplings shall be Dresser Style 38, Rockwell International 411, or equal, except where other styles are required for special conditions.

Gaskets: Shall be neoprene rubber or equal.

F. INSTALLATION: Tapping sleeves shall be installed in accordance with the manufacturer's recommendations. Tapping valves shall meet the requirements of SECTION 5.0, Gate Valves. Disc and seat ring shall be so constructed that the inside diameter of the ring is at least 3/16-inch larger than nominal size of valve. Tapping sleeve and valve assembly shall be blocked as indicated.

6.6 HYDRANTS *(approved 9/1/94)*

A. SCOPE: Furnish labor, materials, equipment and incidentals to furnish and install fire hydrants as indicated on the drawings, in accordance with Utility requirements and according to typical fire hydrant installation.

B. SUBMITTALS: Submittals shall include certified drawing showing dimensions and construction details and certification from manufacturers that the products comply with appropriate AWWA Standards and these Specifications. Catalog data illustrating equipment to be furnished and a schedule of parts and materials shall be submitted.

Friction loss shall be guaranteed by the manufacturer to meet the requirements of AWWA C-502.

C. STANDARDS: Fire hydrants shall comply with requirements of AWWA C-502, Dry-Barrel Fire Hydrants, and AWWA C-550, Protective Epoxy Interior Coatings for Valves and Hydrants.

D. MANUFACTURED PRODUCTS: General: Fire hydrants shall be dry-barrel compression type, with the main valve opening against the pressure, in accordance with AWWA C-502. The hydrant shall be designed for a minimum working pressure of 150 psi and tested at 300 psi hydrostatic pressure.

Hydrant shall have permanent markings identifying name of manufacturer, size of main valve opening and year of manufacture. Markings shall be easily located and legible after the hydrant has been installed.

Hydrants shall be constructed so that the standpipe may be rotated to eight (8) different positions.

Center of the lowest nozzle shall have a minimum ground clearance of 15-inches. Hydrants shall be supplied with extension sections in multiples of 6-inches with rod and coupling as required to increase barrel length.

The fire hydrant manufacturer shall provide local representation and support services, through an established vendor, within the county of El Paso. Acceptable manufacturers and models shall be:

American Flow Control	American Darling B84B
Clow	Medallion
Kennedy	Guardian K81D
M&H	Model 129
Mueller	Centurion

Size: Minimum inside barrel diameter shall be 7-inches. Minimum diameter of the main valve opening shall be 5-inches.

Traffic Type: The barrel and operating mechanism shall be so designed that in the event of an accident, damage, or breaking of the hydrant above or near the grade level, the main valve will remain closed and reasonably tight against leakage.

Manufacturer shall guarantee that the hydrant valve stem will not be bent when the hydrant is damaged or broken at or near ground level. A safety breaking flange or thimble shall be provided. Provisions shall be made in the design of the stem to disconnect the stem from the hydrant parts above the standpipe break point in the event of a traffic accident.

If breakable couplings are used, the design shall be such that the barrel safety flange and stem safety collar will break before any other hydrant part in the event of an accident. Design of coupling shall be such that no part of the coupling will drop into the hydrant barrel in the event of an accident.

Corrosion Resistant Valve: Each fire hydrant installed after **November 1, 2011** shall include a Davidson Anti-Terrorism Corrosion Resistant Valve Kit (DATV) designed to protect against accidental backflow and intentional contamination of drinking water via the hydrant. The DATV shall be a stealth check valve located internal to the upper barrel of the hydrant and shall consist of four main parts:

1) A sleeve-insert valve seat, made of E-coated or fusion-bonded epoxy steel. The top of the valve seat shall have a machined slot to accommodate an EPDM quad ring which will provide an impenetrable seal between the seat and the valve. The quad ring shall separate the valve from the insert to prevent the chance of galvanic corrosion. The sleeve shall have a plug in the drain hole located at the bottom of the sleeve.

2) A valve made of brass with machined slots to accommodate a Viton o-ring between the valve and the upper stem.

3) A 304 stainless steel machined upper stem to replace the original upper stem. The brass valve shall be attached to the upper stem in such a manner as to provide free vertical movement along the shaft and be sealed and separated from the stem by a Viton o-ring. The o-ring shall prevent contact between dissimilar metals to eliminate the chance of galvanic corrosion.

4) A 302 stainless steel spring that fits around the upper stem and is of adequate compression strength and length such that sufficient pressure is placed on the valve to provide an impenetrable seal when the hydrant is not in use and yet allow water to flow freely when the hydrant is flowed.

Installation of the DATV shall be made by a technician certified by the DATV manufacturer. The DATV manufacturer or authorized representative shall provide both initial and ongoing refresher training, free of charge to governmental entities utilizing their product.

The DATV shall be shop-installed by the hydrant distributor and be delivered to the project site ready for installation. The hydrant distributor shall order the hydrants without the hydrant parts that are to be replaced by the DATV. The DATV shall carry a minimum 10-year warranty against defects in workmanship and materials. Said warranty shall also guarantee that its installation inside the hydrant will not cause failure of any of the original fire hydrant parts while the hydrant is under warranty, provided that: (a) the hydrant and DATV are installed and maintained in accordance with the corresponding manufacturers' recommendations; (b) the installer of the DATV was certified for such installation by the DATV manufacturer; and (c) that analysis of the failure clearly establishes that installation of the DATV as the primary cause of the failure.

Installation of the DATV shall not alter the standard warranty offered by the hydrant manufacturer, except that such warranty shall not cover the DATV itself. The DATV shall not interfere with the breakaway functionality of the fire hydrant.

Drain Outlet: Upper valve plate, seat ring and drain ring or shoe bushing shall be bronze, to form an all bronze drain way. The drain valve shall be provided to drain the hydrant properly by opening as soon as the main valve is closed.

Inlet Connections: Shall be mechanical joint, with accessories, gland, bolts, gaskets, and a 6-inch diameter inlet connection. Main valve facing against seats shall be synthetic rubber. Top of the stem or bonnet shall be equipped with O-ring seal. Hydrant shall be oil or grease lubricated.

Outlet and Pumper Nozzles: There shall be two hose outlets with 2 1/2-inch nozzles with National Standard hose coupling screw threads. The outlet nozzles shall be of the caulked type or

mechanically connected into the barrel with an O-ring seal and a non-corrosive locking pin to lock the nozzle to the barrel.

Pumper Nozzle shall have an inner diameter of 4-inches with threads conforming to the City of El Paso Standards.

Nozzle caps shall have one 1-inch square nut, gaskets, and non-kinking chains. The operating nut and nozzle cap nuts shall be one 1-inch square at the base and tapered to 7/8-inch square at the end and not less than 1-inch deep. Nozzle caps to be provided with rubber gaskets.

Hydrant Operator: Shall be 1-inch square at the base and tapered to 7/8-inch at the end and not less than 1-inch deep. Attachment of the operator nut shall not, in any way hinder operating the hydrant with the wrench. The hydrant operator shall open by turning left (counterclockwise).

Hydrants shall be designed with O-ring seals to prevent water from damaging the operating threads.

Tamper Proof Cover: The hydrant shall be equipped with a tamper proof cover, with drainage holes, that deters unauthorized operation of the hydrant. The tamper proof cover shall provide adequate wrench clearance and shall have a minimum inside diameter of 2-1/4". The height of the cover shall range from 2-1/4" to 2-1/2", measured from the base at the bonnet to the top of the collar.

Painting: Barrels above ground shall be prime coated and painted with two coats of paint, color shall be "aluminum" as approved by the Water Utility.

Protective Coating: All interior ferrous surfaces of shoe exposed to flow shall be epoxy coated to a minimum dry thickness of 4 mils. Epoxy coating shall be factory applied by an electrostatic or thermosetting process in accordance with manufacturer's printed instructions. Epoxy materials shall be 100 percent powder epoxy or liquid epoxy conforming to AWWA C-550 and to the current requirements of the Food and Drug Administration and the EPA for potable water.

E. INSTALLATION: Hydrants shall be installed in locations as shown on the Drawings or in standard locations approved by the Water Utility. Installation shall conform to typical details of the Water Utility. Paint damaged during installation shall be touched up. Hydrants shall be disinfected with the connecting piping in accordance with SECTION 267.9 - Cleaning, Disinfection, Testing of Water Mains. All hydrants shall be furnished and left in good working order with control valve open.

6.7 DISINFECTION AND TESTING

A. SCOPE: After completion of all pipe line section, the following procedure will be used to clean, sterilize and pressure test the pipeline. The pipeline shall be filled and flushed until all evidence of dirt or debris has been washed from the pipeline. The line shall then be refilled if necessary, introducing the chlorinating material. Each valved section shall then be brought up to test pressure and the leakage test performed. After all sections have been accepted, all valves shall be cleaned and the line left full of sterilizing water.

B. QUALITY ASSURANCE: The Contractor shall take special care to keep the interior of the pipe clean during storing, handling, and laying operations in order to reduce the need for flushing to an absolute minimum. In addition, all open ends shall be tightly covered whenever unattended to prevent small animals and dirt from entering the pipeline after it is in place.

C. STANDARDS: Disinfecting and Testing of Water Mains shall comply with applicable requirements of the following:

AWWA B-300 Standard for Hypochlorites
AWWA B-301 Standard for Liquid Chlorine
AWWA C-651 Standard for Disinfecting Water Mains

D. MATERIALS: Water required for filling, flushing and testing the line will be furnished at the Contractor's expense, at such points along the pipe line as water is available from the existing distribution or supply systems. Wasting of water will not be condoned and such actions may require the Owner to make appropriate charges for such water.

The Contractor shall make provisions to provide the water, by tank truck or other means, to the points necessary to produce specified test pressure.

Chlorinating Material: Shall be either liquid chlorine conforming to AWWA B-301 or hypochlorite conforming to AWWA B-300.

E. STERILIZATION: Before acceptance for operation, each unit of completed water system shall be sterilized as specified below or as prescribed by AWWA Standard C-651. As per C-651, two consecutive sets of acceptable samples, taken at least 24-hours apart, shall be collected from the new main. The unit to be sterilized shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The Contractor shall provide all chlorination material for sterilization at his cost. The chlorinating material shall provide a dosage of not less than 50 parts per million and shall be introduce into the water line in an approved manner. The treated water shall be retained in the pipe long enough to destroy all nonspore-forming bacteria. Except where a shorter period is approved, the retention time shall be at least 25 hours and shall produce not less than 10 p.p.m. of chlorine at the extreme end of the line at the end of the retention period. All valves on the lines being sterilized shall be opened and closed several times during the contact period.

F. HYDROSTATIC PRESSURE AND LEAKAGE TESTING: The pipe system shall be subjected to a hydrostatic pressure and leakage test and all valves and hydrants shall be checked for proper operation and pressure. After completion of each valved section and following the filling and disinfection of the section, the system shall be subjected to this test. The meter, pressure gauges, pump, small piping, hose connections and all labor necessary for conducting the test, shall be furnished by the Contractor.

After the section of pipeline has been filled, water shall be pumped into the section and the pressure raised to 150 pounds per square inch. This test pressure shall be maintained for a period of at least two (2) hours. The water required to maintain this pressure shall be delivered into the pipe through the meter. The amount of water through the meter during the two-hour test period will be the total leakage. Should this leakage exceed the allowable amount, as specified herein, the Contractor shall make such repairs as may be required until the actual leakage, as determined by succeeding tests, is no greater than the allowable as determined by the following formula:

$$L = S \times D \times \frac{\sqrt{P}}{133{,}200}$$

except that L = 0 in above ground systems and otherwise

L = Allowable Leakage in gallons/hour

S = Length of pipe tested in feet

D = Nominal diameter of pipe in inches.

P = Average test pressure during the test, in pounds per square inch, gage; determined by computing the weighted average of actual pressures on various portions of the section.

After all sections of the pipeline have been tested, as described above, all valves shall be closed and the line left filled with the water to be used for disinfection and testing.

END OF SECTION

7.0 SANITARY SEWER SYSTEM

7.1 SEWER SERVICE CONNECTIONS

A. SCOPE: Furnish labor, materials, equipment, and incidentals to install sewer service lines as indicated on the plans, in accordance with EPWU Standard Details.

B. MATERIALS: Fittings, service risers, and laterals shall be as specified for the material type utilized. Where additional service connections are required on an existing main line, an approved service saddle compatible to the size and type of both the collection line and service lateral shall be installed.

All sanitary sewer services shall be of materials conforming to the requirements of the City of El Paso's Plumbing Code and all amendments thereto.

Where PVC saddles with rubber seals and stainless steel bands are used, the saddles shall be encased with Class B (2500 psi) concrete in accordance with EPWU Standard Details to protect the steel bands from corrosion and to add stability.

C. TEE AND RISER: Where designated on the plans or directed by the Engineer in the field, Contractor shall install tee or wye fittings for future house service connections. Fittings shall be bell-type and shall be sealed on the branch outlet with an approved plug which can be easily removed for service riser or lateral line installation.

Where ground water is encountered, the Contractor shall install the tee and a sufficient service line RISER, thereby raising the final bell above the ground water level. In deep trenches, the RISER shall be extended to the depth of the intersecting service line, or to within 6 feet of the surface, whichever is designated by the plans or appropriate for field conditions.

Contractor shall install a maximum of four (4) service connections at manholes located at the ends of street cul-de-sacs. Additional services shall connect to the main line at a minimum spacing 24 inches.

D. SERVICE LINE LATERALS: Where required by the Contract drawings and specifications, the Contractor shall extend lateral service lines for future or existing customer service connections. Unless otherwise specified, the minimum diameter of the lateral service lines shall be 4-inches. Although the maintenance of service laterals is the responsibility of private property owners, including the portion within public right-of-way, as established by Public Service Board Rules and Regulations, the Contractor shall be responsible for the integrity of the installation or re-connection of all such service lines during the warranty period. All sanitary sewer services shall be of materials conforming to the requirements of the City of El Paso's Plumbing Code and all amendments thereto.

Unless otherwise specified or shown in the drawings, service lines shall be installed and extended 6-inches beyond existing or proposed improvements such as pavement, curb and gutter, sidewalk, etc. Service lines shall be installed at a minimum slope of 2 percent with a minimum cover at the terminus of 18-inches for standard subdivisions having curb and gutter for drainage. For subdivisions with flat terrain and on-site ponding (no curb and gutter), minimum cover shall be 3.5 feet, unless otherwise directed by the Engineer. Prior to installation, Utility personnel will curb mark the locations of proposed service tees for the Contractor. Service lines and/or tees shall be laid such that the branch makes an angle of 45E with the vertical on the side of the main facing the lot to be served.

Service pipe shall be uniformly supported on bedding having a density of not less than 90 percent of maximum density per ASTM D-1557. Backfill on service lines shall be carefully placed and compacted per the requirements of SECTION 4.5 of these Specifications. The terminus of the service line shall be plugged with an approved universal end cap compatible with the pipe size and material.

All service risers and lateral extensions shall be installed by a qualified licensed plumber who shall be bonded and approved by the City Public Inspection Department. Contractor shall provide evidence to the Engineer that the Plumber is licensed and insured in accordance with the requirements of the City of El Paso.

E. LOCATION MARKING AND RECORDING: The Contractor shall maintain as-built records of the horizontal and vertical location of installed sewer service lines. In unpaved areas without curb, the plugged ends of risers or laterals shall be marked using a 1" by 2" by 24" wooden stake set vertically at the plugged terminus, and a sufficient length of plastic metallic marking tape extended vertically from the terminus to within 6 inches of ground surface. An electronic marker disk may be used in lieu of metallic tape. Utility personnel will mark locations of the installed service line or riser ends by chipping an arrowhead mark on top of the curb directly over the service plug.

7.2 MANHOLE STRUCTURES

A. SCOPE: Contractor shall furnish all labor, materials, equipment, and incidentals necessary to provide all manholes as required.

Manholes for the various sized lines shall be Standard Type "A" (48" inside diameter), Type "B" (72" inside diameter), or Drop Manhole constructed at the locations designated, and in accordance with Utility Standard Details, and as otherwise indicated in the project drawings.

Manholes shall be constructed pre-cast concrete sections, as herein specified.

B. QUALITY ASSURANCE: All manholes shall be free of visible leakage. Each structure shall be tested for leaks and inspected, and all leaks shall be repaired in a manner subject to Engineer's approval.

C. SUBMITTALS: Complete manufacturer's shop drawings on the manhole section(s), to include the joints, shall be submitted for approval. If the shop drawings do not meet specifications and secure the El Paso Water Utilities Engineer's approval, the vendor shall revise their shop drawings to meet specifications and receive Engineer's approval. Manufacturer's specification data and recommendations shall be submitted on the lifters and joint material.

Compliance with ASTM C-478 and these Specifications shall also be submitted. Failure to provide either the detailed shop drawings, specification data and recommendation on lifters and joint material, or the letter certifying that all material provided shall meet specifications shall be grounds for rejection of the material.

D. STANDARDS: Manhole structures shall comply with applicable requirements of the following:

ASTM A-48	Specification for Gray Iron Castings
ASTM A-82	Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A-185	Specification for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
ASTM A-615	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C-32	Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C-33	Specification for Concrete Aggregates
ASTM C-144	Specification for Aggregate for Masonry Mortar
ASTM C-150	Specification for Portland Cement
ASTM C-309	Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C-478	Specification for Pre-cast Reinforced Concrete Manhole Sections
ASTM C-923	Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes
ASTM D-1557	Test Methods for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in (457-mm) Drop

E. MATERIALS: Frame and Cover: The manhole frame and cover shall be of cast iron of the weight, dimensions, and pattern indicated by the Utility Standard Details. The casting shall be made from superior quality, gray cast iron conforming to the requirements of ASTM A-48. No holes shall be in the cover, but edge notches for embedded rings shall be used for lifting. "SEWER" or a suitable designation is to be on the cover. Mating surfaces shall be machined to assure a snug fit of the cover and frame.

Manhole Rings: Manhole rings used for a maximum 2-foot final grade shall conform to the applicable requirements of ASTM Specifications C-32, Grade MS.

Cement: Cement shall be Portland Cement conforming to ASTM Specifications C-150, Type V.

Mortar Sand: Mortar sand shall conform to ASTM Specifications C-144.

Concrete Aggregates: Concrete aggregates shall conform to ASTM Specifications C-33 except that the requirement for gradation shall not apply to concrete manhole conical and riser sections.

Steel Reinforcement: Billet-steel bars shall conform to ASTM Specifications A-615 and welded steel wire fabric shall conform to ASTM Specifications A-82 or to ASTM Specifications A-185.

Water: Water shall be clean, clear, free from oil, acid or organic matter and injurious amounts of alkali, salts or other chemicals or deleterious materials.

Mortar: Mortar shall be composed of 1 part Portland Cement Type V and 3 parts mortar sand mixed in an approved manner with water to form a workable mixture.

F. PRE-CAST CONCRETE MANHOLES: General: The manhole riser and conical section shall be designed for sewer and water installations in the diameters specified or shown. All manhole sections shall have a 5-inch wall thickness with tongue and groove, unless otherwise specified. Rings shall be available in various lengths from one foot to four feet. The conical sections shall be concentric and adapted to the ring at one end and to El Paso Water Utilities standard cast iron frame at the other. The base ring shall have a flat bottom joint. Steps or rungs are not required. Manufacturing of manhole section(s) shall comply with ASTM C-478 and any additional specifications listed here forth:

Concrete: Concrete to have a minimum 28 days compressive strength of 4000 psi. Water cement ratio shall be 0.5 or less by weight or not more than 5.5 gallons per sack.

Aggregates: All aggregates fine and coarse other than lightweight aggregate shall conform to specifications outlined by ASTM C-33. Aggregates shall be free of deleterious substances causing reactivity with oxidized hydrogen sulfide. Both types of aggregates shall be graded in order to produce a homogeneous concrete mix. All materials are to be accurately weighed at a central batching facility for mixing.

Cement: All cement shall be Portland Cement conforming to ASTM C-150, Type I or II for sewer applications. Cement content shall be sufficient to produce a minimum strength of 4,000 PSI, or other design strengths required.

Placing: All concrete shall be handled from the mixer or transport vehicle to the place of final deposit in a continuous manner, as rapidly as practicable, and without segregation or loss of ingredients, until (the approved unit operation) is completed. Concrete shall be placed in layers not over two feet deep. Each layer shall be compacted by mechanical internal or external vibrating equipment. Duration of the vibration cycle shall be limited to the time necessary to produce satisfactory consolidation without causing objectionable segregation.

Quality Assurance: The Engineer reserves the right to inspect the manufacturing process at any time to make tests on materials used, and to have cores cut out of the completed manholes for compressive strength testing and placement of reinforcement.

Curing: For purposes of early re-use of forms, the concrete may be heated in the mold after the initial set has taken place. The temperature shall not exceed 160 degrees and shall be raised from normal ambient temperature at a rate not to exceed 40 degrees per hour. The cured unit shall not be removed from forms until sufficient strength is obtained for the unit to withstand any structural strain that may be subjected during the form stripping operation. After the stripping of forms, further curing by means of water spraying or a membrane curing compound may be used and shall be of a clear or white type, conforming to ASTM C-309-58.

Steel Reinforcement: Reinforcing steel shall be as outlined in ASTM C-478 and any additional specifications herein. The minimum steel area of 0.12 square inches shall apply to both risers and cone sections and the maximum center to center spacing of 6 inches shall apply as well. Placing of reinforcing steel for one line circumferential reinforcement shall be on the tension side of the wall (the inner half part of the wall with a minimum 1-inch cover) for two lines circular reinforcement, refer to ASTM C-478. All reinforcing shall be sufficiently tied to withstand any displacement during the pouring operation.

Joint Reinforcement: Both tongue and groove shall contain a #4 re-bar.

Lifters: Lifters shall be designed to handle the imposed weights, and shall be placed per manufacturer's requirements.

Joint Material: All joints to be sealed using Ram-Nek joint sealer. Joint sealer to be provided in sufficient quantities by the vendor as part of the manhole section(s). Size shall be per manufacturer's recommendations.

G. CAST-IN-PLACE CONCRETE MANHOLES: In special circumstances, cast-in-place concrete manholes shall be constructed as shown in the plans, and provided the wall thickness is not less than 6", the concrete is of good quality and well vibrated, and the method of construction materials and type of forms to be used are approved by the El Paso Water Utilities.

H. MANHOLE CONNECTORS: At manholes, a water-tight resilient connection shall be made between the wall and the pipe. This shall be accomplished by use of an engineering approved manhole waterstop adaptor such as Indiana Seal Manhole Adaptor, Kor-N-Seal, or approved equal, meeting the requirements of ASTM C-923. The connector must be compatible to both the type of pipe wall and manhole wall, and shall be installed in strict accordance with the recommendations of the connector manufacturer.

I. INSTALLATION: The manholes shall be constructed at the location shown on the plans or as directed by the Engineer and in accordance with the details shown on the plans and as specified herein. After the excavation has been completed, the concrete base or bottom shall be poured.

When the concrete has sufficiently set, the riser work may proceed. After the manhole rise has been completed, the invert shall be neatly formed in the bottom of the manhole with concrete. The invert shall have a true curve of as large a radius as the size of the manhole will permit and shall be given a smooth trowel finish.

The subgrade under pre-cast manhole bases shall be compacted to 95% density in accordance with ASTM D-1557. Compaction limits shall be one foot beyond the perimeter of the concrete base and shall be a minimum of one foot in depth.

Drop connections shall be constructed as shown on the drawings.

All manholes that are in ground water shall be externally coated with a bituminous coating such as Coal Tar Epoxy. Interior coating of manholes shall be required only when specified in the construction plans. The coating shall be an epoxy resin-type material such as Plascite 7122 or approved equal.

7.3 INSPECTION AND TESTING

A. SCOPE: Test all piping as specified herein unless authorized by the Engineer.

B. STANDARDS: Inspection and testing sewer lines and manholes shall adhere to requirements of the following:

ASTM C-828	Recommended Practice for Low-Pressure Air Test of Vitrified Clay Pipe Lines (4-12 Inches)
ASTM C-1103	Standard Practice for Joint Testing of Installed Pre-Cast Concrete Pipe Sewer Lines
ASTM D-3034	Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM F-679	Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
UNI-BELL-6	Standards and Practices for Low-Pressure Air Testing of Installed Sewer Pipe
UNI-BELL-9	Polyvinyl Chloride (PVC) Large Diameter Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter (Nominal Pipe Sizes 18-48 Inch)

C. MANUFACTURED PRODUCTS: Contractor shall provide all testing apparatus including pumps, compressors, hoses, gauges and fittings, mandrels, and other equipment necessary to perform the required tests.

D. TELEVISION INSPECTION: Prior to placing lines into operation, completed sewer lines shall be inspected by Utility personnel with a television camera as a condition of final acceptance of the installation. The Contractor shall thoroughly clean and flush all lines and notify the Utility Engineer that the line is ready for television inspection.

Any defects discovered in the pipe or construction methods shall be corrected by the contractor at no additional cost to the Owner. The Owner will pay for the initial TV inspection. Any additional inspection(s) required due to failure of the initial inspection shall be paid for by the Contractor.

E. LEAKAGE TESTING: General: To ensure the integrity of the pipe and joints, all sewer lines installed under these specifications shall be tested for leakage using the guidelines established by ASTM C-828 and UNI-BELL B6, and the methods and procedures here forth described.

Contractor shall provide all testing apparatus including pumps, compressors, hoses, gauges and fittings and other equipment necessary to perform the required tests. Acceptable equipment shall be as manufactured by Cherne Industries Incorporated or approved equal.

Unless otherwise approved, Contractor shall conduct tests in the presence of the Engineer. The Engineer shall be notified 48 hours in advance of testing. Test results shall be recorded on standard Utility forms, a copy of which is attached in Appendix Section E of these specifications.

Low pressure air testing may be conducted by the Contractor or an independent testing firm, acceptable to the Utility Engineer.

Sewer lines shall be tested after the "pipe zone" backfilling is completed, and prior to construction of finished surfacing. Where house laterals are included as integral part of the project, testing shall be performed on the main and laterals after the risers or laterals have been completed and backfilled.

Pipe shall be thoroughly cleaned prior to conducting leakage tests. Pipelines which exceed the allowable leakage rate shall be repaired and retested at the Contractor's expense.

All persons conducting an Air Test shall understand fully that an Air Test may be dangerous if conducted improperly.

Exfiltration Air Testing: A Low Pressure Air Test shall be the standard method for testing sewer lines.

Pneumatic plugs shall be sealed tested above ground using a random pipe section pressurized to 5 psig. Plugs should remain intact without bracing or movement out of the section.

Test shall proceed as follows:

Seal off each end of the section of pipe to be tested at a manhole connection. Securely brace test plugs.

Introduce air slowly into the test section through the test plug until an internal pressure of 4.0 psi is reached. Allow internal air temperature to stabilize. Adjust the internal air pressure to 3.5 psi, disconnect the air supply and begin the test.

The section shall maintain the test pressure without losing more than 1.0 psi for a length of time as determined by the following table. If the section being tested includes more than one size of pipe, the test time for each size shall be calculated and added to determine the total test time for the section.

Nominal Pipe Size (d), Inches	Time (t), Minutes/100 Ft.
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
30	4.8
36	6.0
42	7.3

Any section losing more than 1.0 psi shall be considered to have failed the test, and shall be repaired and re-tested prior to acceptance.

Infiltration Test: Infiltration testing of sewer lines under groundwater shall be mandatory. This test shall be performed prior to initiating any service connections and after backfilling. At testing time, the level of the groundwater shall be over the entire section of the pipe or near its maximum level.

The allowable infiltration for any portion of the sewer system shall be measured by a weir or current meter placed in the appropriate manhole and shall not exceed 50 gallons per inch of internal pipe diameter per mile per day, including manholes.

Suitable plugs or other facilities shall be provided by the Contractor in order to measure the amount of infiltration. If infiltration is excessive, the Contractor shall immediately proceed to locate the source of leakage. Once located, the source of leakage shall be sealed by grouting, cementing and rebuilding as required, or by methods approved by the Engineer.

Joint Testing: At the direction of the Engineer, individual joint testing of pipe larger than 24 inches in diameter shall be performed in accordance with ASTM C-1103 for special conditions not covered by other test methods.

Inspection of Sewer Manholes: Manholes installed under groundwater shall be visually inspected for infiltration leakage through all joints and the manhole base. All leaks or cracks shall be repaired with an approved hydro-cement grout.

F. DEFLECTION TESTING: General: As a condition for acceptance of the pipeline, a mandrel test (deflection test) shall be performed by the Contractor to verify the roundness and proper installation of the flexible pipeline.

Within 30 days, but not less than seven (7) days after the installation and backfilling of the flexible sewer line, including any service connections, the Contractor shall, in the presence of the Engineer, test deflection of the pipe with a mandrel (GO-NOGO device).

Mandrel Fabrication: Mandrels shall be of high quality fabrication and precision as commercially available by Cherne Industries Incorporated, or approved equal. Mandrels shall be approved by the Engineer and shall be equipped with proven rings and meet the following requirements:

1. Mandrel outside diameter (gauge dimension) shall be fabricated to the following specification:

   Mandrel O.D. = Pipeline Base I.D. - (% deflection limit x Pipeline Base I.D.) in accordance with ASTM D-3034, F-679, or UNI-BELL-9.

2. Mandrel Construction: The mandrel design shall be open thereby preventing debris buildup between channels of adjacent fins. The fin sets shall number at least (9) and be removable from the mandrel core. Gauges of various diameters shall be assembled by substituting fin sets of appropriate dimension. The length of the minimum radius portion of the mandrel shall not be less than one-third of the nominal diameter of the pipe being tested.

Execution: Prior to testing, the pipe shall be flushed and cleaned by the Contractor. Flow shall not be permitted in the pipeline throughout the duration of the deflection test.

The mandrel shall be manually pulled through the pipeline with a suitable rope or cable that is connected to an eyebolt at one end of the gauge. A similar rope or cable shall be attached to the eyebolt at the opposite end of the mandrel and tension shall be applied to it. This will ensure that the mandrel maintains its correct position during testing, while providing easy removal of the mandrel should it become lodged in an excessively deflected pipeline. Winching or other methods of forcing the mandrel through the pipeline shall be unacceptable.

Deflection of a pipeline deflection tested within thirty (30) days of installation shall have a deflection not exceeding 5% of the base inside pipe diameter as established by ASTM Standards D-3034 and F-679 listed in the following table:

Deflection Gauge Dimensions: SDR 35 or RSC 160

Nominal Size	Average I.D.	Base I.D.	5% Deflection Gauge
6"	5.893	5.742	5.46
8"	7.891	7.665	7.28
10"	9.864	9.563	9.08
12"	11.737	11.361	10.79
15"	14.374	13.898	13.20
18"	17.564	16.976	16.13
21"	20.707	20.004	19.00
24"	23.296	22.480	21.36
27"	26.258	25.327	24.06

Pipeline deflection tests performed thirty days (30) beyond the date of installation shall have a deflection not exceeding 7.5% of the nominal inside diameter or as established otherwise by the applicable governing body. Mandrel Gauge shall be adjusted for 7.5% and approved by the Engineer. The Contractor shall make every effort to test for deflection prior to the 30 day expiration.

A permanent record of all testing with locations where excessive pipeline deflections occur shall be kept by the Contractor and forwarded to the Engineer after completion of testing on each line.

The Contractor shall replace all sections of pipe which deflect more than 5% (or 7-1/2%). Pipelines with acceptable ovality shall be laid such that the larger diameter is situated in the vertical direction.

All expenses for re-trenching, backfill, compaction, paving, and related work necessary due to failure to satisfy deflection test requirements shall be borne by the Contractor.

END OF SECTION

8.0 CLEAN-UP

After completing each section of water line, the Contractor shall remove all debris, construction materials, and equipment from the site of the work; grade and smooth over the surface on both sides of the line and leave the entire right-of-way in a clean, neat, and serviceable condition.

END OF SECTION

APPENDIX A

AWWA AND ASTM STANDARDS

APPENDIX - SECTION A

AWWA and ASTM STANDARDS

Reference to the standards listed below shall be to the most recent issue, addendum or revision.

AWWA STANDARDS

C105/A21.5	American National Standard for Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
C151/A21.51	American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
C-200	AWWA Standard for Steel Water Pipe - 6 inches and Larger
C-214	AWWA Standard for Tape Coating Systems for the Exterior of Steel Water Pipelines
C-301	AWWA Standard for Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, Pretensioned, for Water and Other Liquids
C-303	AWWA Standard for Reinforced Concrete Pressure Pipe, Steel Cylinder Type, Pretensioned, for Water and Other Liquids
C-304	AWWA Standard for Design of Prestressed Concrete Cylinder Pipe
C-500	AWWA Standard for Metal Seated Gate Valves for Water Supply Service
C-502	AWWA Standard for Dry-Barrel Fire Hydrants
C-504	AWWA Standard for Rubber-Seated Butterfly Valves
C-509	AWWA Standard for Resilient-Seated Gate Valves for Water and Sewerage Systems
C-900	AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution (Includes addendum C900-92)
C-905	AWWA Standard for Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 in. through 36 in.

ASTM STANDARDS

ASTM C-76	Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
ASTM C-700	Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C-828	Recommended Practice for Low-Pressure Air Test of Vitrified Clay Pipe
ASTM D-2321	Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe
ASTM D-2487	Classification of Soils for Engineering Purposes
ASTM D-3034	Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D-3262	Specification for "Fiberglass" (Glass Fiber Reinforced Thermosetting Resin) Sewer Pipe

ASTM D-4254	Test Methods for Minimum Index Density of Soils and Calculation of Relative Density
ASTM D-3034	Specification for Type PSM Poly (Vinyl Chloride)(PVC) Sewer Pipe and Fittings
ASTM F-679	Specification for Poly (Vinyl Chloride)(PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F-789	Specification for Type PS-46 Poly (Vinyl Chloride)(PVC) Plastic Gravity Flow Sewer Pipe and Fittings
ASTM F-794	Specification for Poly (Vinyl Chloride)(PVC) Large Diameter Ribbed Gravity Sewer Pipe and Fittings Based on controlled Inside Diameter
ASTM F-894	Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

NATIONAL ASSOCIATION OF CORROSION ENGINEERS (NACE)

RP01-69(1983)	Recommended Practice, Control of External Corrosion of Underground and Submerged Metallic Piping Systems

APPENDIX B

DESCRIPTION OF EMBEDMENT MATERIALS CLASSIFICATION

APPENDIX - SECTION B

DESCRIPTION OF EMBEDMENT MATERIAL CLASSIFICATIONS

SOIL CLASS	SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION
CLASS I SOILS *	----	Manufactured angular, granular material, ¼ to 3/4 inches (6 to 19 mm) size, including materials having regional significance such as crushed stone or rock, broken coral, crushed slag, cinders, or crushed shells.
CLASS II SOILS **	GW	Well-graded gravels and gravel-sand mixtures, little or no fines. 50% or more retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
	GP	Poorly graded gravels and gravel-sand mixtures, little or no fines. 50% or more retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
	SW	Well-graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
	SP	Poorly graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
CLASS III SOILS ***	GM	Silty gravels, gravel-sand-silt mixtures. 50% or more retained on No. 4 sieve. More than 50% retained on No. 200 sieve.
	GC	Clayey gravels, gravel-sandy-clay mixtures. 50% or more retained on No. 4 sieve. More than 50% retained on No. 200 sieve.
	SM	Silty sands, sand-silt mixtures. More than 50% passes No. 4 sieve. More than 50% retained on No. 200 sieve.
	SC	Clayey sands, sand-clay mixtures. More than 50% passes No. 4 sieve. More than 50% retained on No. 200 sieve.
CLASS IV SOILS	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
	CH	Inorganic clays of high plasticity, fat clays. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
CLASS V SOILS	OL	Organic silts and organic silty clays of low plasticity. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
	OH	Organic clays of medium to high plasticity. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
	PT	Peat, much and other highly organic soils.

* Soils defined as Class I materials are not defined in ASTM D2487.

** In accordance with ASTM D2487, less than 5% pass No. 200 sieve.

*** In accordance with ASTM D2487, more than 12% pass No. 200 sieve. Soils with 5% to 12% pass No 200 sieve fall in borderline classification, *e.g.*, GP-GC.

APPENDIX C

EL PASO WATER UTILITIES
STANDARD BEDDING CLASS SCHEDULE

APPENDIX - SECTION C

EL PASO WATER UTILITIES
STANDARD BEDDING CLASS SCHEDULE [1]

TABLE C-1

CLASS	MATERIAL CLASS	BEDDING SECTION	PIPE TYPE[3]	DEPTH COVER	SOIL CONDITION
A	Native < 12% passing #200 sieve	Shaped Trench	Rigid	3' - 12'	Dry
B	Native < 12% passing #200 sieve	6" Bed Min + (O.D./6)" but not < 4"	Rigid	3' - 18'	Dry & Wet[2]
C	Concrete	(O.D./6)" but not < 4" Ext to Springline	Rigid	> 18'	Dry
E1	Class I ASTM D-2321	4" to 6" Bed - Ext to Top of Pipe Zone	Rigid & Flex	> 3'	Dry
E2	Class II ASTM D-2487	4" to 6" Bed - Ext to Top of Pipe Zone	Flex	> 3'	Dry
E3	Class III ASTM D-2487	4" to 6" Bed - Ext to Top of Pipe Zone	Flex	> 3'	Dry
F	Class I	4" - 6" Bed - Geotech Fabric Bottom of Bed to Top of Pipe Zone	Flex	> 3'	Wet
G	Class II ASTM D-2487	4" Bed - Ext to Top of Pipe Zone	Flex Pressure Pipe	as specified	Dry & Wet[2]

[1] *Refer to Drawing Details Appendix D for correlation to this table.*

[2] *Under special conditions, where trench bottom is unstable, gravel may be added to embedment material.*

[3] *Pipe type shall be classified according to the following, as designated by the Utility:*
***Rigid Pipe** shall denote steel, steel cylinder concrete pipe (SCCP), ductile iron pipe (DIP), reinforced concrete pipe (RCP), and vitrified clay pipe (VCP).*
***Flexible Pipe** shall denote polyvinyl chloride (PVC) sewer pipe, high density polyethylene (HDPE) and fiberglass pipe.*
***Flexible Pressure Pipe** shall denote polyvinyl chloride (PVC) water pipe in accordance with AWWA Standards.*

APPENDIX D

DESIGN STANDARD DETAIL DRAWINGS

APPENDIX SECTION D

DESIGN STANDARD DETAIL DRAWINGS

DETAIL NO.	DESCRIPTION
130	Cover Sheet for 24" X 36" Size Sheet
131	Standard Utility Symbols to be Used in Plans
132	Standard Utility Symbols to be Used in Plans *(cont.)*
133	Standard Utility Symbols to be Used in Plans *(cont.)*
140	Standard Location for Extensions
160	Separation Distance New Water and New Sewer
161	Separation Distance New Water and Existing Sewer
162	Separation Distance Existing Water and New Sewer
170	Standard Trench Cross - Section Terminology
171	Embedment Class A and B for Rigid Pipe
172	Embedment Class C for Rigid Pipe
174	Embedment Class E1 for Rigid Pipe and Flexible Sewer Pipe
175	Embedment Class E2 and E3 for Flexible Sewer Pipe
176	Embedment Class F for Flexible Sewer Pipe
177	Embedment Class G for PVC Pressure Pipe
179	Typical Trench Backfill and Pavement Restoration Under Proposed or Existing Paved Streets
180	Standard Carrier Pipe Installation in Casing Pipe
181	Carrier Pipe Installation with Casing Insulators
182	Concrete Cap (Paved Condition)
183	Concrete Cap (Unpaved Condition)
190	Bridge Pipe Support
191	Bridge Pipe Support
250	Standard Cover for Water Mains
260	Gate Valve Installation
261	Butterfly Valve Manhole
262	Blow-off Valve Assembly
263-1	Air Release Valve Installation Unpaved Condition
263-2	Air Release Valve Installation Paved Condition 16" and Smaller
263-3	Air Release Valve Installation Paved Condition
263-4	Air Release Valve Installation for Valves 2" and Smaller
264-1	6" Pressure Reducing Valve Installation Paved Condition
264-2	6" Pressure Reducing Valve Installation Unpaved Condition
265-1	Pressure Relief Valve (Discharge to Atmosphere)
265-2	Pressure Relief Valve (Back Discharge to Low Side)

APPENDIX SECTION D

DESIGN STANDARD DETAIL DRAWINGS
(continued)

DETAIL NO.	DESCRIPTION
266	Tapping Sleeve and Valve
267	Stabilizer Unit
268	Bonnet Box
269	Bonnet Box Cover and Extension
270	Thrust Blocking
271	Valve Anchor
272	Side Outlet Connection
273	Top Outlet Connection
280-1	Standard Fire Hydrant Installation
280-2	Standard Fire Hydrant Installation (12" Main or Larger)
281	Fire Hydrant Cap
282	Fire Hydrant Locations
283	Fire Hydrant Steamer Nozzle
290-1	Typical 3/4" and 1" Service Line Installation
290-2	Typical 1-1/2" - 2" Service Line Installation
290-3	Typical 3" and Larger Service Line Installation
291	Meter Box Type "A" 3/4" Service Installation
292	Meter Box Type "B" 1" Service Installation
293	Meter Box Type "C" 1-1/2" to 2" Service Installation
294	Meter Box Type "D" 3" and Larger
295	Meter Box Ring
296	Meter Box Cover
297	Frame and Cover for 1-1/2" - 2" Meter Box
298	Fire Meter Service Assembly
370	Standard Manhole Type "A"
371	Standard Manhole Type "A1"
372	Special Manhole Type "A2"
373	Standard Manhole Type "B"
374	Standard Manhole Type "B1"
375	Standard Drop Connection Manhole
376	Pipe Connection to Manhole
377	Sewer Manhole Ring
378	Sewer Manhole Cover
379	Concrete Manhole Cover for 72" I.D.
390	Sewer Service Riser Connection
391	Sewer Service Riser and Service Line Connection
395	End of Sewer Line Cleanout
396	Bonnet Box for Cleanout
397	Bonnet Box Cover & Extension for Cleanout

APPENDIX SECTION D

DESIGN STANDARD DETAIL DRAWINGS
(continued)

DETAIL NO. **DESCRIPTION**

520 ..... Fence Details
521 ..... Rock Wall

THE FOLLOWING DETAILS ARE FOR REFERENCE ONLY AND ARE NOT FOR DISTRIBUTION.

410 ..... Insulating Flange
411 ..... Zinc Grounding Cell
420 ..... Prepacked Zinc Reference Electrode
421 ..... Zinc Grounding Anode
422 ..... Multiple Magnesium Anode Bed Installation
423 ..... Insulating Blanket
424 ..... Tubular Anode
440 ..... Alumino - Thermic Weld
441 ..... Bonding Detail for All Below - Grade Steel and Ductile Iron Pipe
442 ..... Bonded Joint for Steel Cylinder Concrete Pipe
443 ..... Bonding for Valves and Flexible Couplings
444 ..... Bonding for Fittings
445 ..... Bond Repair - Steel Cylinder Concrete Pipe
450 ..... Pipe Test Wire Attachments for Steel Cylinder Concrete Pipe
451 ..... Cathodic Test Stations

452-1 ..... Two Wire Test Station
452-2 ..... Wiring Diagram Two Wire Test Boxes
453-1 ..... Insulating Flange Test Station
453-2 ..... Wiring Diagram Insulating Flange Test Stations
454-1 ..... Pipe Casing Test Station
454-2 ..... Wiring Diagram Pipe Casing Test Box
455 ..... Deep Anode System and Rectifier Installation
456 ..... Deep Anode Shunt Box and Wiring Schematic

522 ..... Exterior Hose Station
523 ..... Concrete Pipe Support
524 ..... Wall Bracket
525 ..... Double Hatch Access Cover
526 ..... Typical Riser Diagram
527 ..... Portable Hoist

540-1 ..... Lift Station Building Details
540-2 ..... Lift Station Building Details
540-3 ..... Warning Sign Detail

550 ..... Lift Station Duplex Type Site Layout

APPENDIX SECTION D

DESIGN STANDARD DETAIL DRAWINGS
(continued)

DETAIL NO.	DESCRIPTION
551	Duplex Type Lift Station Plan - Finish Grade
552	Duplex Type Lift Station Plan - Below Grade
553	Duplex Type Lift Station Section
560	Lift Station Rectangular Type Site Layout
561	Rectangular Type Lift Station Plan - Finish Grade
562	Rectangular Type Lift Station Plan - Below Grade
563	Rectangular Type Lift Station Section

APPENDIX E

TRENCH EXCAVATION SYSTEM

APPENDIX
SECTION E

TRENCH EXCAVATION SAFETY SYSTEM

SPECIAL CONDITIONS:

A. The Contractor will be required to install a trench safety system to provide for the safe excavation of all trenches exceeding a depth of five (5) feet as per OSHA standards.

B. It shall be the duty and responsibility of the Contractor and all of its subcontractors to be familiar and comply with all requirements of Public Law 91-596, 29 U.S.C. Secs. 651 et. seq., the Occupational Safety and Health Act of 1970 (OSHA), and all amendments thereto, and to enforce and comply with all of the provisions of this Act. In addition, on projects in which trench excavation will exceed a depth of five feet, the Contractor and all of its subcontractors shall comply with all requirements of 29 C.F.R. Secs., 1926.652 and 1926.653, OSHA Safety and Health Standards, which are more fully described herein.

C. The successful responsible bidder will be required to submit 3 sets of trench excavation plans with a trench safety system to the Owner for review within 15 consecutive days after Award of Contract.

Plans must be designed and sealed by a professional engineer registered in the State of Texas with professional experience in geotechnical engineering. The Contractor is responsible for obtaining borings and soil analysis as required for the design and preparation of the trench excavation plan and trench safety system. The trench excavation plan and the trench safety system is to be designed in conformance with OSHA standards and regulations.

No trenching in excess of five (5) feet below existing grade will be allowed until the trench excavation plan is reviewed and returned to the Contractor. Any changes in the trench excavation plan after initiation of construction will not cause an Extension of Time or Change Order but such changes will require the same review process as the original excavation plan.

The Contractor accepts sole responsibility for compliance with all applicable safety requirements. The review is only for general conformance with OSHA safety standards; and review of the trench excavation plan does not relieve the Contractor of any or all construction means, methods, techniques, and procedures. Any property damage or bodily injury, including death, that arises from use of the trench excavation plan shall remain the sole responsibility and liability of the Contractor.

D. INDEMNIFICATION - The Contractor shall indemnify and hold harmless the Owner, its employees and agents, from any and all damages, costs (including without limitation, legal fees, court costs, and the cost of investigation), judgments or claims, by anyone, including workers or the general public, for injury or death of persons resulting from the collapse or failure of trenches constructed under this contract.

The Contractor acknowledges and agrees that this indemnity provision provides indemnity for the Owner in case that claims are made that the Owner is negligent either by act or omission in providing for trench safety, including, but not limited to inspections, failure to issue stop work orders, and the hiring of the Contractor.

TECHNICAL SPECIFICATIONS:

E. DESCRIPTION: This section shall govern the Trench Safety Systems required for the construction of all trench excavation to be utilized in the project including all additional excavation and backfill necessitated by the safety system. The trench safety systems shall be suitable for construction or pipe-lines, utilities, etc., that are installed below grade and shall be sufficient to fully protect public or private property including other existing utilities and structures below, or above grade. Trench Safety Systems include but are not limited to sloping of side of excavation, sheeting, trench boxes or trench shields, sheet piling, cribbing, bracing, shoring, dewatering, or diversion of water to provide adequate drainage.

The Contractor shall be responsible for the design of systems, and procedures such as the use of sheet piling, shoring, or other means of temporary support to protect existing buildings, streets, highways, water conveying structures, or any other structures. In the case of existing utilities, the contractor may elect to remove the utilities under the stipulated condition that the removal and subsequent replacement of these utilities shall meet with the approval of the Engineer, the Owner, the Utility Owner, and all agencies having jurisdiction of the structure or property. In all cases, the Contractor shall be fully responsible for the protection of public, or private property and for the protection of any person or persons who, as a result of the Contractor's work, may be injured.

F. CONSTRUCTION METHODS: Trench safety systems shall be accomplished in accordance with the detalled specifications set out in the provisions of Excavations, Trenching, and Shoring, Federal Occupational Safety and Health Administration (OSHA) Standards, 29 CFR, Part 1926. Subpart P, as amended including proposed Rules published in the Federal Register (Vol. 54, No. 209) on Tuesday, October 31, 1989. The sections that are incorporated into these specifications by reference include Sections 1926-650 through 1926-652. Legislation that has been enacted by the Texas Legislature (H.B. No. 662 and H.B. No. 665) with regard to Trench Safety Systems, is hereby also incorporated, by reference, into these specifications.

G. SAFETY PROGRAM: The Contractor shall submit a safety program specifically for the construction of trench excavations together with the trench excavation plans for Trench Safety Systems. The trench safety program shall be in accordance with OSHA standards governing the presence and activities of individuals working in and around trench excavation.

Contractors have two generally accepted methods, or combinations thereof, to meet OSHA Standards for Trench Excavations:

1. Utilization of Trench Box.

2. Shoring, Sheeting, and Bracing Methods.

A Contractor electing to utilize a Trench Box must submit physical dimensions, materials, position in the trench, expected loads, and the strength of the box. The Trench Box shall be designed by a Professional Engineer. No claims for delay will be permitted.

Contractor electing to utilize Shoring, Sheeting, and Bracing must submit dimensions and materials of all uprights, stringers, cross-bracing, and spacing required to meet OSHA requirements, all designed by a Professional Engineer. No claims for delay will be permitted.

H. INSPECTION: The Contractor shall provide a qualified person to make daily inspections of the Trench Safety Systems to ensure that the systems meet OSHA requirements. The Contractor shall maintain a permanent record of daily inspections.

If evidence of possible cave-ins, or slides, is apparent, all work in the trench shall cease until the necessary precautions have been taken by the contractor to safeguard personnel entering the trench. It is the sole duty, responsibility, and prerogative of the contractor, not the Owner or the Owner's designated representative, to determine the specific applicability of the designed trench safety systems to each field condition encountered on the project.

I. EMERGENCIES: In an emergency situation which may threaten or affect the safety or welfare of persons or property, the Contractor shall act at his discretion to prevent possible damage, injury, or loss. Any additional compensation or extension of time claimed for such action shall be considered in view of the cause of the emergency and in accordance with the General Conditions.

J. OSHA SAFETY AND HEALTH REGULATIONS PART 1926: *(see attached)*

APPENDIX F

EASEMENT POLICY

EL PASO WATER UTILITIES - PUBLIC SERVICE BOARD

A POLICY FOR DEDICATION OF EASEMENTS FOR WATER AND SANITARY SEWER SERVICES

April 1994

1.1 GENERAL

1.11 Purpose - it is the intent of this policy to establish design criteria and requirements for water and/or sanitary sewer easements necessary for the extension of water and sewer service to new customers or developments.

1.12 Goal - The goal of the policy is to minimize use of easements and when easements are necessary that they be suitable for adequate repair and maintenance activities and that the easements are adequately maintained so as to not be a nuisance or eyesore to the public.

1.2 RIGHT-OF-WAYS AND EASEMENTS

1.21 Right-of-ways - It is the Utility's intent to construct water and sewer mains in dedicated public streets. Dedicated public right-of-ways for utility use will be avoided as they create a maintenance liability to the Utility and a possible eyesore.

1.22 Easements - Water and sanitary sewer mains shall not be constructed in easements except when the Utility specifically requests or authorizes such construction. It is the Utility's intent to obtain an exclusive El Paso Water Utilities' easement for its use and benefit with regards to its water and sanitary sewer mains. The easement will so be designated as "Water and/or Sanitary Sewer Easement", unless sufficient extra width is provided to grant other utilities within the easement and is designated so by naming it a "Utility Easement".

El Paso Water Utilities will accept subsurface easements only, for the purpose of construction, maintenance, repair, replacement and operation of water and sewer mains, together with the right to excavate and perform necessary work upon the surface of the easement in connection with these purposes. Construction and maintenance of the surface shall not be the responsibility of the El Paso Water Utilities, and the right to make improvements on the surface shall be strictly limited in accordance with this policy and the terms of the easement.

To provide for construction, maintenance and operation of water and sewer mains, the easements shall meet the following minimum criteria:

A. Easement Request: Easement requests shall be accompanied by supporting documentation that it is not feasible or practical to design public streets in a

routing that will accommodate the utilities and that easements are necessary. A drainage and grading plan shall be submitted, and is to include the adjoining areas.

B. Easement Submittal: Easements will be accepted by the Utility by plat and a standard Utility Easement document attached with a scaled map. The map shall clearly indicate the easement to be acquired along with a legal description designated by metes and bounds.

C. Easement Exceptions: Requests for exceptions to one or more of the design criteria and policy may be considered on an individual basis. Any individual who requests an exception must demonstrate to the satisfaction of the El Paso Water Utilities-Public Service Board that the exception will not compromise the accessibility to permit construction and maintenance of the water and/or sanitary sewer mains or result in a degradation of service to the customers.

1. The exception must be requested in writing and must be substantiated by documented data. The request for an exception should precede the submission of engineering plans for a proposed project.

2. Any exception granted by the El Paso Water Utilities-Public Service Board is subject to revocation prior to actual installation of the water and/or sanitary sewer mains.

3. Any request for an exception which is not approved by the El Paso Water Utilities-Public Service Board in writing is denied.

D. Liability: Easement grantor shall indemnify, defend, and hold harmless the El Paso Water Utilities-Public Service Board from and against any and all claims, liability, actions, and damages for bodily injury and property damage to third parties or to the El Paso Water Utilities-Public Service Board which may be caused by or arise out of the maintenance and existence of said water and sewer mains in the easement area.

E. Surface Improvements: Proposed surface improvements such as paving, landscaping, other types of low maintenance surfacing shall be reviewed for approval by the Utility.

F. Maintenance: Use of low maintenance surface improvements is required. The owner of the property is responsible for maintenance of the surface and surface maintenance is not the responsibility of the Utility.

G. Structures: No buildings or permanent structures shall be constructed in easements. Accumulation of storage, vehicles, lumber or other materials within the easement is not allowed. Building setback lines are required abutting all easements (5-foot minimum).

H. Fences: Rock or masonry walls or fences may cross easement perpendicular (at 90° ± 5°), but not longitudinal.

I. Width (minimum): All easements are to be reviewed by the Utility on a case by case basis. The width of the easement dependent on the associated depth of the water and sewer mains as follows:

Depth	Easement Width (minimum)
4 to 8-feet	20-feet
8 to 12-feet	30-feet
over 12-feet	* = (special conditions)

* = Wider easements are required for depths greater than 12-feet and pipe diameters 16-inch and greater.

Minimum easement widths will be in accordance with the number of utilities and separation distance as follows:

1. Water and Sewer mains must be 10-feet apart within a 25-foot easement; with the water and sewer mains being 5-feet and 10-feet from the edge of the easement, respectively.

2. Joint use with other utilities (including storm drainage) - Minimum separation distance of 10-feet between water and sewer mains and a 6-foot edge to edge separation to other underground utilities or storm drain, as needed.

3. When water lines and sanitary sewer lines are installed, they shall be installed no closer to each other than nine feet in all directions and parallel lines must be installed in separate trenches.

J. Location in drainage easements: Water and sewer main construction in drainage easements is not desirable to the Utility nor advocated by the City of El Paso. Any occurrence of this type is to be addressed on a case by case basis only. Special attention must be given to prevent inflow of any storm water to the sewer system.

K. Alignment: Easement alignment shall be laid straight and connect two dedicated public streets.

L. Length: The length of the easement normally shall not exceed 300-feet.

M. Accessibility: Utility shall have accessibility to water and sewer mains at all times. A minimum 50-foot turning radius is required for access.

N. Topography: Proper grading shall be provided to allow operation of maintenance vehicles. The maximum surface slope allowed will be 2 percent for natural ground unless adequate soil erosion control measures are acceptable to the Utility. A 5 percent maximum surface slope will be allowed for asphalt paved areas. Split level development is not allowed by the Utility.

O. Maximum Line Slope: The maximum sanitary sewer line slope allowed is 4 percent.

P. Service Connections: Normally, no water or sewer service connections to water or sewer mains in the easements will be allowed. However, when service is desired for more than six separate water meters or six sewer connections to one tract of land not separated by public streets or public alleys and when the actual buildings to be served are more than 100-feet from a public street or alley, service may be obtained at a closer location to the buildings on the customer's property, provided the customer furnishes the Utility a valid easement for the lines necessary to provide service at the desired location, agrees to hold the Utility, its Public Service Board and the City of El Paso harmless from damages which may be caused by the existence of lines in said easement and further provided the customer pay the total cost of the lines required in said easement plus the normal extension charges for lines constructed or to be constructed in the streets adjacent to the property. These type of easements require review for approval by the Utility.

1.3 ATTACHMENTS

1.31 A - 20' Water or Sanitary Sewer Easement/Single Utility (4' - 8' Depth)

1.32 B - 30' Water or Sanitary Sewer Easement/Excavation (8' - 12' Deep)

1.33 C - 25' Water and Sanitary Sewer Easement/Combined Water and Sanitary Sewer Utilities

End of Easement Policy

APPENDIX E

OSHA REGULATIONS

· OSHA REGULATIONS ·

- REGARDING TRENCH SAFETY (FROM FEDERAL REGISTER)

(2) The employer shall ensure that there is in the vicinity of each barge in use at least one U.S. Coast Guard-approved 30-inch lifering with not less than 90 feet of line attached, and at least one portable or permanent ladder which will reach the top of the apron to the surface of the water. If the above equipment is not available at the pier, the employer shall furnish it during the time that he is working the barge.

(3) Employees walking or working on the unguarded decks of barges shall be protected with U.S. Coast Guard-approved work vests or buoyant vests.

(e) *Commercial diving operations.* Commercial diving operations shall be subject to subpart T of part 1910, §§ 1910.401–1910.441, of this chapter.

[39 FR 22801, June 24, 1974, as amended at 42 FR 37674, July 22, 1977]

§ 1926.606 Definitions applicable to this subpart.

(a) *Apron*—The area along the waterfront edge of the pier or wharf.

(b) *Bulwark*—The side of a ship above the upper deck.

(c) *Coaming*—The raised frame, as around a hatchway in the deck, to keep out water.

(d) *Jacob's ladder*—A marine ladder of rope or chain with wooden or metal rungs.

(e) *Rail*, for the purpose of § 1926.605, means a light structure serving as a guard at the outer edge of a ship's deck.

Subpart P—Excavations

AUTHORITY: Sec. 107, Contract Worker Hours and Safety Standards Act (Construction Safety Act) (40 U.S.C. 333); Secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12–71 (36 FR 8754), 8–76 (41 FR 25059), or 9–83 (48 FR 35736), as applicable, and 29 CFR part 1911.

SOURCE: 54 FR 45959, Oct. 31, 1989, unless otherwise noted.

§ 1926.650 Scope, application, and definitions applicable to this subpart.

(a) *Scope and application.* This subpart applies to all open excavations made in the earth's surface. Excavations are defined to include trenches.

(b) *Definitions applicable to this subpart.*

Accepted engineering practices means those requirements which are compatible with standards of practice required by a registered professional engineer.

Aluminum Hydraulic Shoring means a pre-engineered shoring system comprised of aluminum hydraulic cylinders (crossbraces) used in conjunction with vertical rails (uprights) or horizontal rails (walers). Such system is designed, specifically to support the sidewalls of an excavation and prevent cave-ins.

Bell-bottom pier hole means a type of shaft or footing excavation, the bottom of which is made larger than the cross section above to form a belled shape.

Benching (Benching system) means a method of protecting employees from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels.

Cave-in means the separation of a mass of soil or rock material from the side of an excavation, or the loss of soil from under a trench shield or support system, and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, bury, or otherwise injure and immobilize a person.

Competent person means one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Cross braces mean the horizontal members of a shoring system installed perpendicular to the sides of the excavation, the ends of which bear against either uprights or wales.

Excavation means any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal.

Faces or *sides* means the vertical or inclined earth surfaces formed as a result of excavation work.

Failure means the breakage, displacement, or permanent deformation of a structural member or connection so as to reduce its structural integrity and its supportive capabilities.

Hazardous atmosphere means an atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

Kickout means the accidental release or failure of a cross brace.

Protective system means a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

Ramp means an inclined walking or working surface that is used to gain access to one point from another, and is constructed from earth or from structural materials such as steel or wood.

Registered Professional Engineer means a person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer, registered in any state is deemed to be a "registered professional engineer" within the meaning of this standard when approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

Sheeting means the members of a shoring system that retain the earth in position and in turn are supported by other members of the shoring system.

Shield (Shield system) means a structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Additionally, shields can be either premanufactured or job-built in accordance with § 1926.652 (c)(3) or (c)(4). Shields used in trenches are usually referred to as "trench boxes" or "trench shields."

Shoring (Shoring system) means a structure such as a metal hydraulic, mechanical or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.

Sides. See "Faces."

Sloping (Sloping system) means a method of protecting employees from cave-ins by excavating to form sides of an excavation that are inclined away from the excavation so as to prevent cave-ins. The angle of incline required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

Stable rock means natural solid mineral material that can be excavated with vertical sides and will remain intact while exposed. Unstable rock is considered to be stable when the rock material on the side or sides of the excavation is secured against caving-in or movement by rock bolts or by another protective system that has been designed by a registered professional engineer.

Structural ramp means a ramp built of steel or wood, usually used for vehicle access. Ramps made of soil or rock are not considered structural ramps.

Support system means a structure such as underpinning, bracing, or shoring, which provides support to an adjacent structure, underground installation, or the sides of an excavation.

Tabulated data means tables and charts approved by a registered professional engineer and used to design and construct a protective system.

Trench (Trench excavation) means a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet (4.6 m). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

Trench box. See "Shield."

Trench shield. See "Shield."

Uprights means the vertical members of a trench shoring system placed in contact with the earth and usually positioned so that individual members do not contact each other. Uprights placed so that individual members are closely spaced, in contact with or

interconnected to each other, are often called "sheeting."

Wales means horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system or earth.

§ 1926.651 Specific excavation requirements.

(a) *Surface encumbrances.* All surface encumbrances that are located so as to create a hazard to employees shall be removed or supported, as necessary, to safeguard employees.

(b) *Underground installations.* (1) The estimated location of utility installations, such as sewer, telephone, fuel, electric, water lines, or any other underground installations that reasonably may be expected to be encountered during excavation work, shall be determined prior to opening an excavation.

(2) Utility companies or owners shall be contacted within established or customary local response times, advised of the proposed work, and asked to establish the location of the utility underground installations prior to the start of actual excavation. When utility companies or owners cannot respond to a request to locate underground utility installations within 24 hours (unless a longer period is required by state or local law), or cannot establish the exact location of these installations, the employer may proceed, provided the employer does so with caution, and provided detection equipment or other acceptable means to locate utility installations are used.

(3) When excavation operations approach the estimated location of underground installations, the exact location of the installations shall be determined by safe and acceptable means.

(4) While the excavation is open, underground installations shall be protected, supported or removed as necessary to safeguard employees.

(c) *Access and egress*—(1) *Structural ramps.* (i) Structural ramps that are used solely by employees as a means of access or egress from excavations shall be designed by a competent person. Structural ramps used for access or egress of equipment shall be designed by a competent person qualified in structural design, and shall be constructed in accordance with the design.

(ii) Ramps and runways constructed of two or more structural members shall have the structural members connected together to prevent displacement.

(iii) Structural members used for ramps and runways shall be of uniform thickness.

(iv) Cleats or other appropriate means used to connect runway structural members shall be attached to the bottom of the runway or shall be attached in a manner to prevent tripping.

(v) Structural ramps used in lieu of steps shall be provided with cleats or other surface treatments on the top surface to prevent slipping.

(2) *Means of egress from trench excavations.* A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are 4 feet (1.22 m) or more in depth so as to require no more than 25 feet (7.62 m) of lateral travel for employees.

(d) *Exposure to vehicular traffic.* Employees exposed to public vehicular traffic shall be provided with, and shall wear, warning vests or other suitable garments marked with or made of reflectorized or high-visibility material.

(e) *Exposure to falling loads.* No employee shall be permitted underneath loads handled by lifting or digging equipment. Employees shall be required to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials. Operators may remain in the cabs of vehicles being loaded or unloaded when the vehicles are equipped, in accordance with § 1926.601(b)(6), to provide adequate protection for the operator during loading and unloading operations.

(f) *Warning system for mobile equipment.* When mobile equipment is operated adjacent to an excavation, or when such equipment is required to approach the edge of an excavation, and the operator does not have a clear and direct view of the edge of the excavation, a warning system shall be utilized such as barricades, hand or mechanical signals, or stop logs. If possible, the grade should be away from the excavation.

(g) *Hazardous atmospheres*—(1) *Testing and controls.* In addition to the requirements set forth in subparts D and E of this part (29 CFR 1926.50–1926.107) to prevent exposure to harmful levels of atmospheric contaminants and to assure acceptable atmospheric conditions, the following requirements shall apply:

(i) Where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist, such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby, the atmospheres in the excavation shall be tested before employees enter excavations greater than 4 feet (1.22 m) in depth.

(ii) Adequate precautions shall be taken to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen and other hazardous atmospheres. These precautions include providing proper respiratory protection or ventilation in accordance with subparts D and E of this part respectively.

(iii) Adequate precaution shall be taken such as providing ventilation, to prevent employee exposure to an atmosphere containing a concentration of a flammable gas in excess of 20 percent of the lower flammable limit of the gas.

(iv) When controls are used that are intended to reduce the level of atmospheric contaminants to acceptable levels, testing shall be conducted as often as necessary to ensure that the atmosphere remains safe.

(2) *Emergency rescue equipment.* (i) Emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher, shall be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation. This equipment shall be attended when in use.

(ii) Employees entering bell-bottom pier holes, or other similar deep and confined footing excavations, shall wear a harness with a life-line securely attached to it. The lifeline shall be separate from any line used to handle materials, and shall be individually attended at all times while the employee wearing the lifeline is in the excavation.

(h) *Protection from hazards associated with water accumulation.* (1) Employees shall not work in excavations in which there is accumulated water, or in excavations in which water is accumulating, unless adequate precautions have been taken to protect employees against the hazards posed by water accumulation. The precautions necessary to protect employees adequately vary with each situation, but could include special support or shield systems to protect from cave-ins, water removal to control the level of accumulating water, or use of a safety harness and lifeline.

(2) If water is controlled or prevented from accumulating by the use of water removal equipment, the water removal equipment and operations shall be monitored by a competent person to ensure proper operation.

(3) If excavation work interrupts the natural drainage of surface water (such as streams), diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering the excavation and to provide adequate drainage of the area adjacent to the excavation. Excavations subject to runoff from heavy rains will require an inspection by a competent person and compliance with paragraphs (h)(1) and (h)(2) of this section.

(i) *Stability of adjacent structures.* (1) Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning shall be provided to ensure the stability of such structures for the protection of employees.

(2) Excavation below the level of the base or footing of any foundation or retaining wall that could be reasonably expected to pose a hazard to employees shall not be permitted except when:

(i) A support system, such as underpinning, is provided to ensure the safety of employees and the stability of the structure; or

(ii) The excavation is in stable rock; or

(iii) A registered professional engineer has approved the determination that the structure is sufficently removed from the excavation so as to be

unaffected by the excavation activity; or

(iv) A registered professional engineer has approved the determination that such excavation work will not pose a hazard to employees.

(3) Sidewalks, pavements, and appurtenant structure shall not be undermined unless a support system or another method of protection is provided to protect employees from the possible collapse of such structures.

(j) *Protection of employees from loose rock or soil.* (1) Adequate protection shall be provided to protect employees from loose rock or soil that could pose a hazard by falling or rolling from an excavation face. Such protection shall consist of scaling to remove loose material; installation of protective barricades at intervals as necessary on the face to stop and contain falling material; or other means that provide equivalent protection.

(2) Employees shall be protected from excavated or other materials or equipment that could pose a hazard by falling or rolling into excavations. Protection shall be provided by placing and keeping such materials or equipment at least 2 feet (.61 m) from the edge of excavations, or by the use of retaining devices that are sufficient to prevent materials or equipment from falling or rolling into excavations, or by a combination of both if necessary.

(k) *Inspections.* (1) Daily inspections of excavations, the adjacent areas, and protective systems shall be made by a competent person for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions. An inspection shall be conducted by the competent person prior to the start of work and as needed throughout the shift. Inspections shall also be made after every rainstorm or other hazard increasing occurrence. These inspections are only required when employee exposure can be reasonably anticipated.

(2) Where the competent person finds evidence of a situation that could result in a possible cave-in, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions, exposed employees shall be removed from the hazardous area until the necessary precautions have been taken to ensure their safety.

(l) Walkways shall be provided where employees or equipment are required or permitted to cross over excavations. Guardrails which comply with §1926.502(b) shall be provided where walkways are 6 feet (1.8 m) or more above lower levels.

[54 FR 45959, Oct. 31, 1989, as amended by 59 FR 40730, Aug. 9, 1994]

§ 1926.652 Requirements for protective systems.

(a) *Protection of employees in excavations.* (1) Each employee in an excavation shall be protected from cave-ins by an adequate protective system designed in accordance with paragraph (b) or (c) of this section except when:

(i) Excavations are made entirely in stable rock; or

(ii) Excavations are less than 5 feet (1.52m) in depth and examination of the ground by a competent person provides no indication of a potential cave-in.

(2) Protective systems shall have the capacity to resist without failure all loads that are intended or could reasonably be expected to be applied or transmitted to the system.

(b) *Design of sloping and benching systems.* The slopes and configurations of sloping and benching systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (b)(1); or, in the alternative, paragraph (b)(2); or, in the alternative, paragraph (b)(3), or, in the alternative, paragraph (b)(4), as follows:

(1) *Option (1)—Allowable configurations and slopes.* (i) Excavations shall be sloped at an angle not steeper than one and one-half horizontal to one vertical (34 degrees measured from the horizontal), unless the employer uses one of the other options listed below.

(ii) Slopes specified in paragraph (b)(1)(i) of this section, shall be excavated to form configurations that are in accordance with the slopes shown for Type C soil in Appendix B to this subpart.

(2) *Option (2)—Determination of slopes and configurations using Appendices A and B.* Maximum allowable slopes, and allowable configurations for sloping

and benching systems, shall be determined in accordance with the conditions and requirements set forth in appendices A and B to this subpart.

(3) *Option (3)—Designs using other tabulated data.* (i) Designs of sloping or benching systems shall be selected from and be in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data shall be in written form and shall include all of the following:

(A) Identification of the parameters that affect the selection of a sloping or benching system drawn from such data;

(B) Identification of the limits of use of the data, to include the magnitude and configuration of slopes determined to be safe;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.

(4) *Option (4)—Design by a registered professional engineer.* (i) Sloping and benching systems not utilizing Option (1) or Option (2) or Option (3) under paragraph (b) of this section shall be approved by a registered professional engineer.

(ii) Designs shall be in written form and shall include at least the following:

(A) The magnitude of the slopes that were determined to be safe for the particular project;

(B) The configurations that were determined to be safe for the particular project; and

(C) The identity of the registered professional engineer approving the design.

(iii) At least one copy of the design shall be maintained at the jobsite while the slope is being constructed. After that time the design need not be at the jobsite, but a copy shall be made available to the Secretary upon request.

(c) *Design of support systems, shield systems, and other protective systems.* Designs of support systems shield systems, and other protective systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (c)(1); or, in the alternative, paragraph (c)(2); or, in the alternative, paragraph (c)(3); or, in the alternative, paragraph (c)(4) as follows:

(1) *Option (1)—Designs using appendices A, C and D.* Designs for timber shoring in trenches shall be determined in accordance with the conditions and requirements set forth in appendices A and C to this subpart. Designs for aluminum hydraulic shoring shall be in accordance with paragraph (c)(2) of this section, but if manufacturer's tabulated data cannot be utilized, designs shall be in accordance with appendix D.

(2) *Option (2)—Designs Using Manufacturer's Tabulated Data.* (i) Design of support systems, shield systems, or other protective systems that are drawn from manufacturer's tabulated data shall be in accordance with all specifications, recommendations, and limitations issued or made by the manufacturer.

(ii) Deviation from the specifications, recommendations, and limitations issued or made by the manufacturer shall only be allowed after the manufacturer issues specific written approval.

(iii) Manufacturer's specifications, recommendations, and limitations, and manufacturer's approval to deviate from the specifications, recommendations, and limitations shall be in written form at the jobsite during construction of the protective system. After that time this data may be stored off the jobsite, but a copy shall be made available to the Secretary upon request.

(3) *Option (3)—Designs using other tabulated data.* (i) Designs of support systems, shield systems, or other protective systems shall be selected from and be in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data shall be in written form and include all of the following:

(A) Identification of the parameters that affect the selection of a protective system drawn from such data;

(B) Identification of the limits of use of the data;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data, which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.

(4) *Option (4)—Design by a registered professional engineer.* (i) Support systems, shield systems, and other protective systems not utilizing Option 1, Option 2 or Option 3, above, shall be approved by a registered professional engineer.

(ii) Designs shall be in written form and shall include the following:

(A) A plan indicating the sizes, types, and configurations of the materials to be used in the protective system; and

(B) The identity of the registered professional engineer approving the design.

(iii) At least one copy of the design shall be maintained at the jobsite during construction of the protective system. After that time, the design may be stored off the jobsite, but a copy of the design shall be made available to the Secretary upon request.

(d) *Materials and equipment.* (1) Materials and equipment used for protective systems shall be free from damage or defects that might impair their proper function.

(2) Manufactured materials and equipment used for protective systems shall be used and maintained in a manner that is consistent with the recommendations of the manufacturer, and in a manner that will prevent employee exposure to hazards.

(3) When material or equipment that is used for protective systems is damaged, a competent person shall examine the material or equipment and evaluate its suitability for continued use. If the competent person cannot assure the material or equipment is able to support the intended loads or is otherwise suitable for safe use, then such material or equipment shall be removed from service, and shall be evaluated and approved by a registered professional engineer before being returned to service.

(e) *Installation and removal of support*—(1) *General.* (i) Members of support systems shall be securely connected together to prevent sliding, falling, kickouts, or other predictable failure.

(ii) Support systems shall be installed and removed in a manner that protects employees from cave-ins, structural collapses, or from being struck by members of the support system.

(iii) Individual members of support systems shall not be subjected to loads exceeding those which those members were designed to withstand.

(iv) Before temporary removal of individual members begins, additional precautions shall be taken to ensure the safety of employees, such as installing other structural members to carry the loads imposed on the support system.

(v) Removal shall begin at, and progress from, the bottom of the excavation. Members shall be released slowly so as to note any indication of possible failure of the remaining members of the structure or possible cave-in of the sides of the excavation.

(vi) Backfilling shall progress together with the removal of support systems from excavations.

(2) *Additional requirements for support systems for trench excavations.* (i) Excavation of material to a level no greater than 2 feet (.61 m) below the bottom of the members of a support system shall be permitted, but only if the system is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the support system.

(ii) Installation of a support system shall be closely coordinated with the excavation of trenches.

(f) *Sloping and benching systems.* Employees shall not be permitted to work on the faces of sloped or benched excavations at levels above other employees except when employees at the lower levels are adequately protected from

the hazard of falling, rolling, or sliding material or equipment.

(g) *Shield systems*—(1) *General.* (i) Shield systems shall not be subjected to loads exceeding those which the system was designed to withstand.

(ii) Shields shall be installed in a manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads.

(iii) Employees shall be protected from the hazard of cave-ins when entering or exiting the areas protected by shields.

(iv) Employees shall not be allowed in shields when shields are being installed, removed, or moved vertically.

(2) *Additional requirement for shield systems used in trench excavations.* Excavations of earth material to a level not greater than 2 feet (.61 m) below the bottom of a shield shall be permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the shield.

APPENDIX A TO SUBPART P—SOIL CLASSIFICATION

(a) *Scope and application*—(1) *Scope.* This appendix describes a method of classifying soil and rock deposits based on site and environmental conditions, and on the structure and composition of the earth deposits. The appendix contains definitions, sets forth requirements, and describes acceptable visual and manual tests for use in classifying soils.

(2) *Application.* This appendix applies when a sloping or benching system is designed in accordance with the requirements set forth in §1926.652(b)(2) as a method of protection for employees from cave-ins. This appendix also applies when timber shoring for excavations is designed as a method of protection from cave-ins in accordance with appendix C to subpart P of part 1926, and when aluminum hydraulic shoring is designed in accordance with appendix D. This Appendix also applies if other protective systems are designed and selected for use from data prepared in accordance with the requirements set forth in §1926.652(c), and the use of the data is predicated on the use of the soil classification system set forth in this appendix.

(b) *Definitions.* The definitions and examples given below are based on, in whole or in part, the following: American Society for Testing Materials (ASTM) Standards D653–85 and D2488; The Unified Soils Classification System, The U.S. Department of Agriculture (USDA) Textural Classification Scheme; and The National Bureau of Standards Report BSS–121.

Cemented soil means a soil in which the particles are held together by a chemical agent, such as calcium carbonate, such that a hand-size sample cannot be crushed into powder or individual soil particles by finger pressure.

Cohesive soil means clay (fine grained soil), or soil with a high clay content, which has cohesive strength. Cohesive soil does not crumble, can be excavated with vertical sideslopes, and is plastic when moist. Cohesive soil is hard to break up when dry, and exhibits significant cohesion when submerged. Cohesive soils include clayey silt, sandy clay, silty clay, clay and organic clay.

Dry soil means soil that does not exhibit visible signs of moisture content.

Fissured means a soil material that has a tendency to break along definite planes of fracture with little resistance, or a material that exhibits open cracks, such as tension cracks, in an exposed surface.

Granular soil means gravel, sand, or silt, (coarse grained soil) with little or no clay content. Granular soil has no cohesive strength. Some moist granular soils exhibit apparent cohesion. Granular soil cannot be molded when moist and crumbles easily when dry.

Layered system means two or more distinctly different soil or rock types arranged in layers. Micaceous seams or weakened planes in rock or shale are considered layered.

Moist soil means a condition in which a soil looks and feels damp. Moist cohesive soil can easily be shaped into a ball and rolled into small diameter threads before crumbling. Moist granular soil that contains some cohesive material will exhibit signs of cohesion between particles.

Plastic means a property of a soil which allows the soil to be deformed or molded without cracking, or appreciable volume change.

Saturated soil means a soil in which the voids are filled with water. Saturation does not require flow. Saturation, or near saturation, is necessary for the proper use of instruments such as a pocket penetrometer or sheer vane.

Soil classification system means, for the purpose of this subpart, a method of categorizing soil and rock deposits in a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing order of stability. The categories are determined based on an analysis of the properties and performance characteristics of the deposits and the environmental conditions of exposure.

Stable rock means natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

Submerged soil means soil which is underwater or is free seeping.

Type A means cohesive soils with an unconfined compressive strength of 1.5 ton per square foot (tsf) (144 kPa) or greater. Examples of cohesive soils are: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. Cemented soils such as caliche and hardpan are also considered Type A. However, no soil is Type A if:

(i) The soil is fissured; or

(ii) The soil is subject to vibration from heavy traffic, pile driving, or similar effects; or

(iii) The soil has been previously disturbed; or

(iv) The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater; or

(v) The material is subject to other factors that would require it to be classified as a less stable material.

Type B means:

(i) Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa); or

(ii) Granular cohesionless soils including: angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam.

(iii) Previously disturbed soils except those which would otherwise be classed as Type C soil.

(iv) Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or

(v) Dry rock that is not stable; or

(vi) Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.

Type C means:

(i) Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less; or

(ii) Granular soils including gravel, sand, and loamy sand; or

(iii) Submerged soil or soil from which water is freely seeping; or

(iv) Submerged rock that is not stable, or

(v) Material in a sloped, layered system where the layers dip into the excavation or a slope of four horizontal to one vertical (4H:1V) or steeper.

Unconfined compressive strength means the load per unit area at which a soil will fail in compression. It can be determined by laboratory testing, or estimated in the field using a pocket penetrometer, by thumb penetration tests, and other methods.

Wet soil means soil that contains significantly more moisture than moist soil, but in such a range of values that cohesive material will slump or begin to flow when vibrated. Granular material that would exhibit cohesive properties when moist will lose those cohesive properties when wet.

(c) *Requirements*—(1) *Classification of soil and rock deposits.* Each soil and rock deposit shall be classified by a competent person as Stable Rock, Type A, Type B, or Type C in accordance with the definitions set forth in paragraph (b) of this appendix.

(2) *Basis of classification.* The classification of the deposits shall be made based on the results of at least one visual and at least one manual analysis. Such analyses shall be conducted by a competent person using tests described in paragraph (d) below, or in other recognized methods of soil classification and testing such as those adopted by the America Society for Testing Materials, or the U.S. Department of Agriculture textural classification system.

(3) *Visual and manual analyses.* The visual and manual analyses, such as those noted as being acceptable in paragraph (d) of this appendix, shall be designed and conducted to provide sufficient quantitative and qualitative information as may be necessary to identify properly the properties, factors, and conditions affecting the classification of the deposits.

(4) *Layered systems.* In a layered system, the system shall be classified in accordance with its weakest layer. However, each layer may be classified individually where a more stable layer lies under a less stable layer.

(5) *Reclassification.* If, after classifying a deposit, the properties, factors, or conditions affecting its classification change in any way, the changes shall be evaluated by a competent person. The deposit shall be reclassified as necessary to reflect the changed circumstances.

(d) *Acceptable visual and manual tests.*—(1) *Visual tests.* Visual analysis is conducted to determine qualitative information regarding the excavation site in general, the soil adjacent to the excavation, the soil forming the sides of the open excavation, and the soil taken as samples from excavated material.

(i) Observe samples of soil that are excavated and soil in the sides of the excavation. Estimate the range of particle sizes and the relative amounts of the particle sizes. Soil that is primarily composed of fine-grained material is cohesive material. Soil composed primarily of coarse-grained sand or gravel is granular material.

(ii) Observe soil as it is excavated. Soil that remains in clumps when excavated is cohesive. Soil that breaks up easily and does not stay in clumps is granular.

(iii) Observe the side of the opened excavation and the surface area adjacent to the excavation. Crack-like openings such as tension cracks could indicate fissured material. If chunks of soil spall off a vertical side, the soil could be fissured. Small spalls are evidence of moving ground and are indications of potentially hazardous situations.

(iv) Observe the area adjacent to the excavation and the excavation itself for evidence of existing utility and other underground structures, and to identify previously disturbed soil.

(v) Observe the opened side of the excavation to identify layered systems. Examine layered systems to identify if the layers slope toward the excavation. Estimate the degree of slope of the layers.

(vi) Observe the area adjacent to the excavation and the sides of the opened excavation for evidence of surface water, water seeping from the sides of the excavation, or the location of the level of the water table.

(vii) Observe the area adjacent to the excavation and the area within the excavation for sources of vibration that may affect the stability of the excavation face.

(2) *Manual tests.* Manual analysis of soil samples is conducted to determine quantitative as well as qualitative properties of soil and to provide more information in order to classify soil properly.

(i) *Plasticity.* Mold a moist or wet sample of soil into a ball and attempt to roll it into threads as thin as ⅛-inch in diameter. Cohesive material can be successfully rolled into threads without crumbling. For example, if at least a two inch (50 mm) length of ⅛-inch thread can be held on one end without tearing, the soil is cohesive.

(ii) *Dry strength.* If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it is granular (any combination of gravel, sand, or silt). If the soil is dry and falls into clumps which break up into smaller clumps, but the smaller clumps can only be broken up with difficulty, it may be clay in any combination with gravel, sand or silt. If the dry soil breaks into clumps which do not break up into small clumps and which can only be broken with difficulty, and there is no visual indication the soil is fissured, the soil may be considered unfissured.

(iii) *Thumb penetration.* The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils. (This test is based on the thumb penetration test described in American Society for Testing and Materials (ASTM) Standard designation D2488—"Standard Recommended Practice for Description of Soils (Visual—Manual Procedure).") Type A soils with an unconfined compressive strength of 1.5 tsf can be readily indented by the thumb; however, they can be penetrated by the thumb only with very great effort. Type C soils with an unconfined compressive strength of 0.5 tsf can be easily penetrated several inches by the thumb, and can be molded by light finger pressure. This test should be conducted on an undisturbed soil sample, such as a large clump of spoil, as soon as practicable after excavation to keep to a miminum the effects of exposure to drying influences. If the excavation is later exposed to wetting influences (rain, flooding), the classification of the soil must be changed accordingly.

(iv) *Other strength tests.* Estimates of unconfined compressive strength of soils can also be obtained by use of a pocket penetrometer or by using a hand-operated shearvane.

(v) *Drying test.* The basic purpose of the drying test is to differentiate between cohesive material with fissures, unfissured cohesive material, and granular material. The procedure for the drying test involves drying a sample of soil that is approximately one inch thick (2.54 cm) and six inches (15.24 cm) in diameter until it is thoroughly dry:

(A) If the sample develops cracks as it dries, significant fissures are indicated.

(B) Samples that dry without cracking are to be broken by hand. If considerable force is necessary to break a sample, the soil has significant cohesive material content. The soil can be classified as a unfissured cohesive material and the unconfined compressive strength should be determined.

(C) If a sample breaks easily by hand, it is either a fissured cohesive material or a granular material. To distinguish between the two, pulverize the dried clumps of the sample by hand or by stepping on them. If the clumps do not pulverize easily, the material is cohesive with fissures. If they pulverize easily into very small fragments, the material is granular.

APPENDIX B TO SUBPART P—SLOPING AND BENCHING

(a) *Scope and application.* This appendix contains specifications for sloping and benching when used as methods of protecting employees working in excavations from cave-ins. The requirements of this appendix apply when the design of sloping and benching protective systems is to be performed in accordance with the requirements set forth in §1926.652(b)(2).

(b) *Definitions.*

Actual slope means the slope to which an excavation face is excavated.

Distress means that the soil is in a condition where a cave-in is imminent or is likely to occur. Distress is evidenced by such phenomena as the development of fissures in the face of or adjacent to an open excavation; the subsidence of the edge of an excavation; the slumping of material from the face or the bulging or heaving of material from the bottom of an excavation; the spalling of material from the face of an excavation; and ravelling, i.e., small amounts of material such as pebbles or little clumps of material suddenly separating from the face of an excavation and trickling or rolling down into the excavation.

Maximum allowable slope means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H:V).

Short term exposure means a period of time less than or equal to 24 hours that an excavation is open.

(c) *Requirements*—(1) *Soil classification.* Soil and rock deposits shall be classified in accordance with appendix A to subpart P of part 1926.

(2) *Maximum allowable slope.* The maximum allowable slope for a soil or rock deposit shall be determined from Table B–1 of this appendix.

(3) *Actual slope.* (i) The actual slope shall not be steeper than the maximum allowable slope.

(ii) The actual slope shall be less steep than the maximum allowable slope, when there are signs of distress. If that situation occurs, the slope shall be cut back to an actual slope which is at least ½ horizontal to one vertical (½H:1V) less steep than the maximum allowable slope.

(iii) When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person shall determine the degree to which the actual slope must be reduced below the maximum allowable slope, and shall assure that such reduction is achieved. Surcharge loads from adjacent structures shall be evaluated in accordance with §1926.651(i).

(4) *Configurations.* Configurations of sloping and benching systems shall be in accordance with Figure B–1.

TABLE B–1

MAXIMUM ALLOWABLE SLOPES

SOIL OR ROCK TYPE	MAXIMUM ALLOWABLE SLOPES (H:V)[1] FOR EXCAVATIONS LESS THAN 20 FEET DEEP [3]
STABLE ROCK TYPE A [2] TYPE B TYPE C	VERTICAL (90°) 3/4 : 1 (53°) 1:1 (45°) 1½: 1 (34°)

NOTES:

1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.
2. A short-term maximum allowable slope of 1/2H:1V (63°) is allowed in excavations in Type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth shall be 3/4H:1V (53°).
3. Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

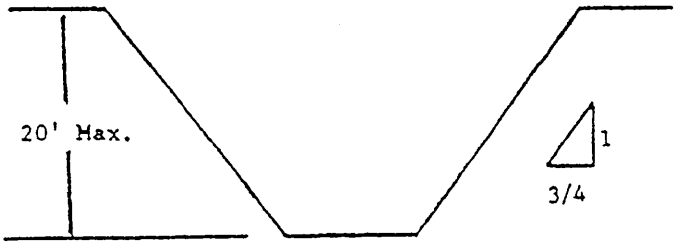
Figure B–1

Slope Configurations

(All slopes stated below are in the horizontal to vertical ratio)

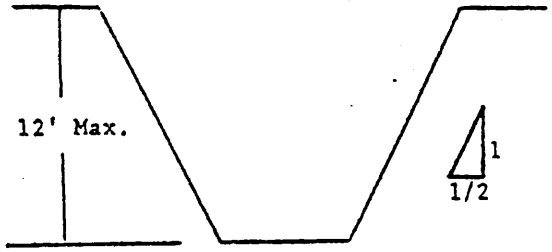
B–1.1 Excavations made in Type A soil.

1. All simple slope excavation 20 feet or less in depth shall have a maximum allowable slope of ¾:1.



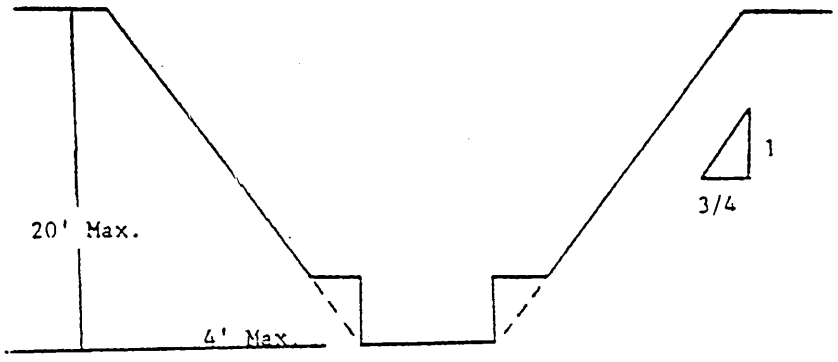
SIMPLE SLOPE—GENERAL

Exception: Simple slope excavations which are open 24 hours or less (short term) and which are 12 feet or less in depth shall have a maximum allowable slope of ½:1.

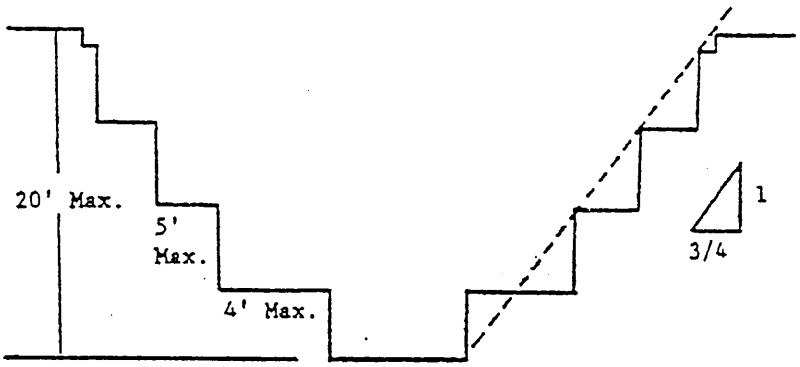


SIMPLE SLOPE—SHORT TERM

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of ¾ to 1 and maximum bench dimensions as follows:

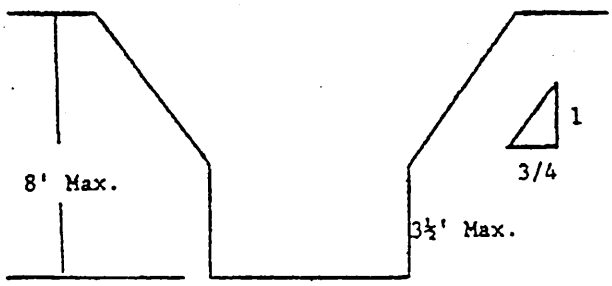


SIMPLE BENCH



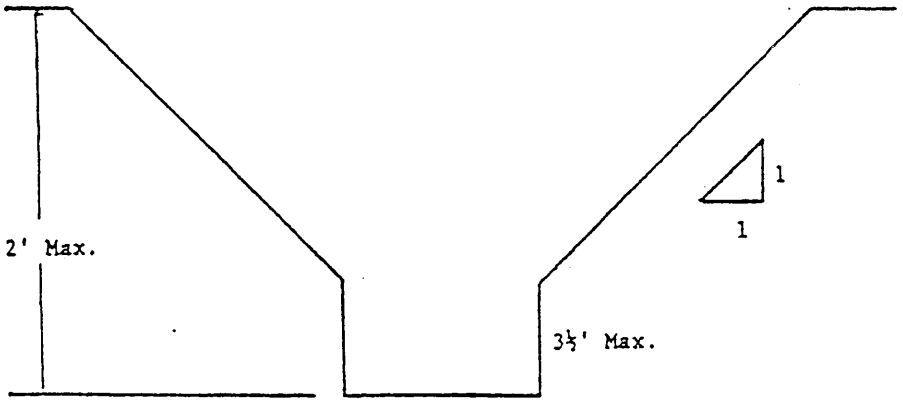
MULTIPLE BENCH

3. All excavations 8 feet or less in depth which have unsupported vertically sided lower portions shall have a maximum vertical side of 3½ feet.



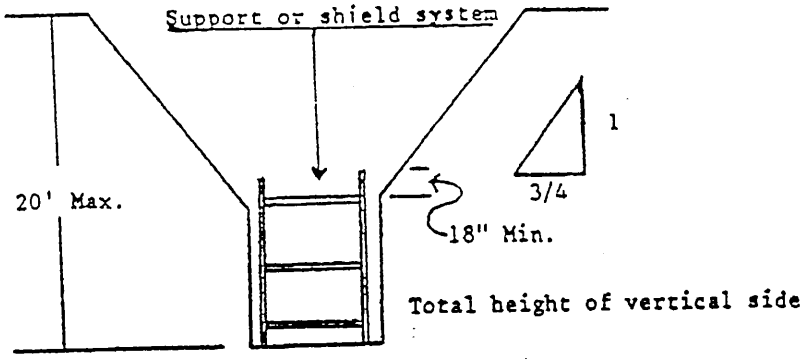
UNSUPPORTED VERTICALLY SIDED LOWER PORTION—MAXIMUM 8 FEET IN DEPTH

All excavations more than 8 feet but not more than 12 feet in depth which unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and a maximum vertical side of 3½ feet.



UNSUPPORTED VERTICALLY SIDED LOWER PORTION—MAXIMUM 12 FEET IN DEPTH

All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of ¾:1. The support or shield system must extend at least 18 inches above the top of the vertical side.

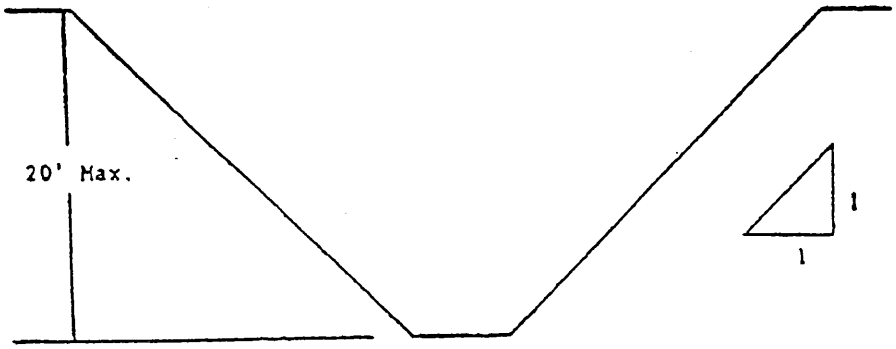


SUPPORTED OR SHIELDED VERTICALLY SIDED LOWER PORTION

4. All other simple slope, compound slope, and vertically sided lower portion excavations shall be in accordance with the other options permitted under § 1926.652(b).

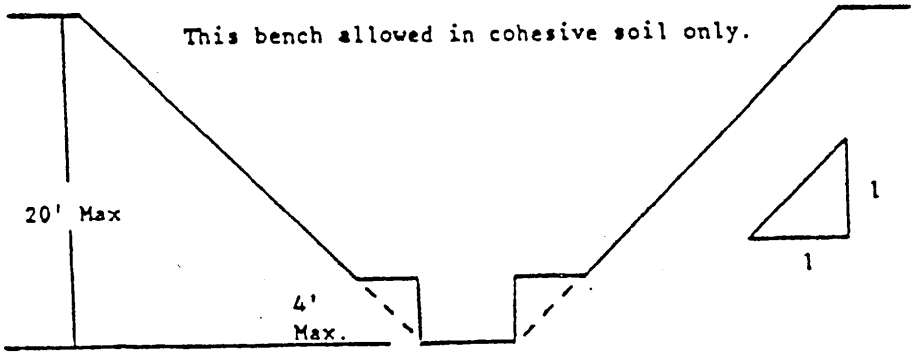
B-1.2 Excavations Made in Type B Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1.

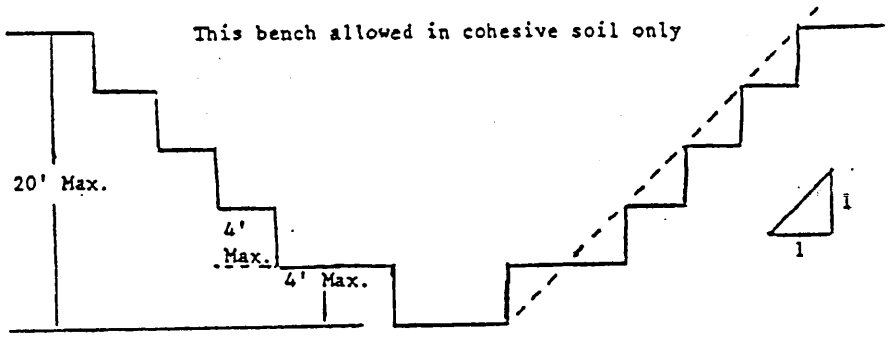


SIMPLE SLOPE

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1 and maximum bench dimensions as follows:

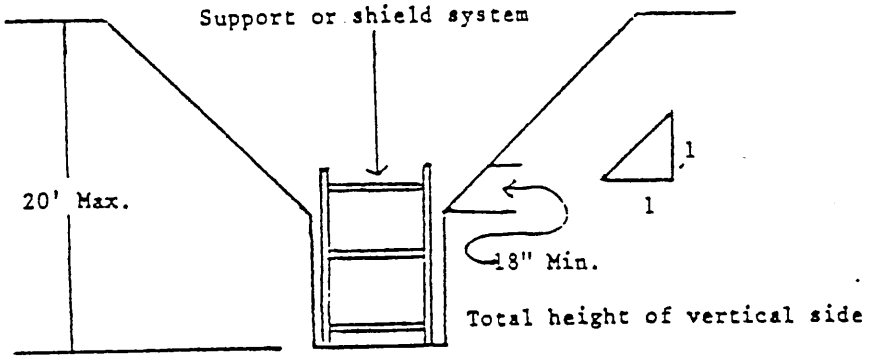


SINGLE BENCH



MULTIPLE BENCH

3. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1:1.

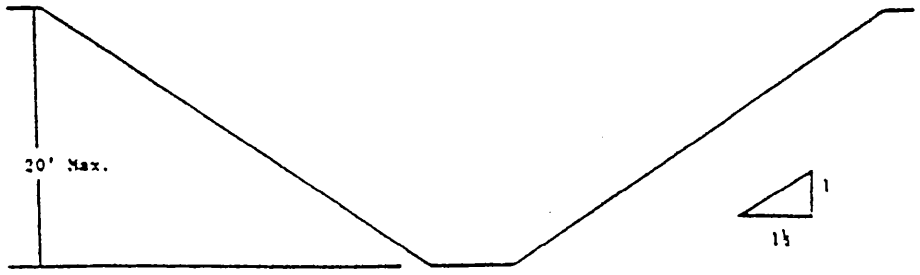


VERTICALLY SIDED LOWER PORTION

4. All other sloped excavations shall be in accordance with the other options permitted in §1926.652(b).

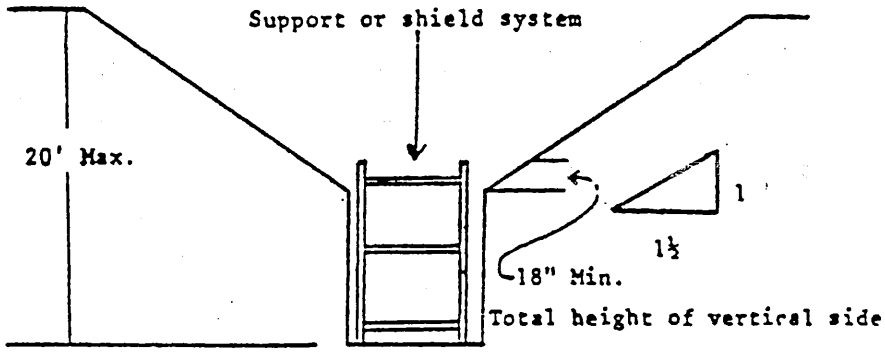
B-1.3 Excavations Made in Type C Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1½:1.



SIMPLE SLOPE

2. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1½:1.

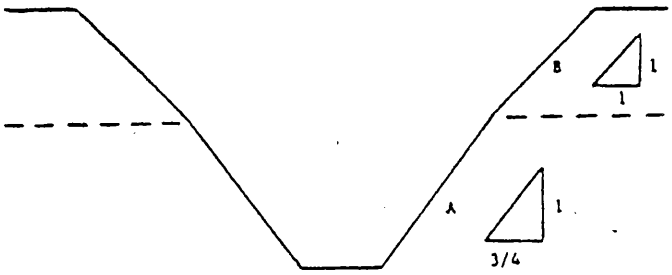


VERTICAL SIDED LOWER PORTION

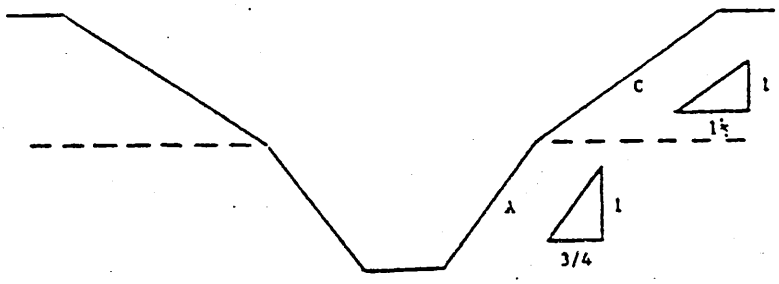
3. All other sloped excavations shall be in accordance with the other options permitted in §1926.652(b).

B-1.4 Excavations Made in Layered Soils

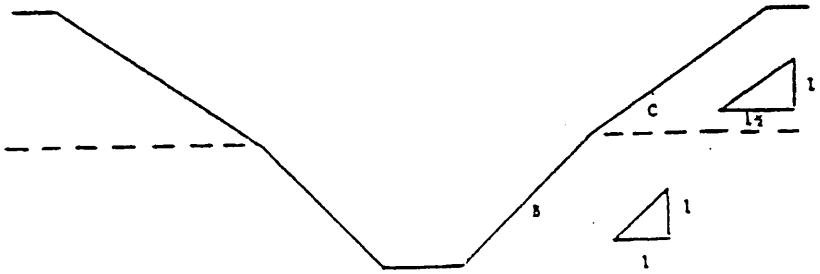
1. All excavations 20 feet or less in depth made in layered soils shall have a maximum allowable slope for each layer as set forth below.



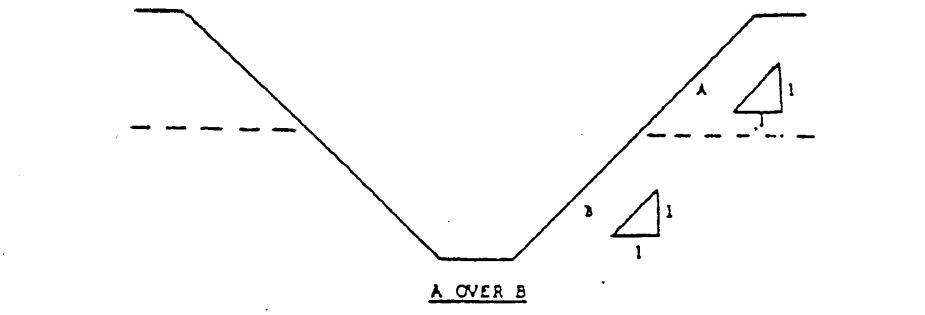
B OVER A



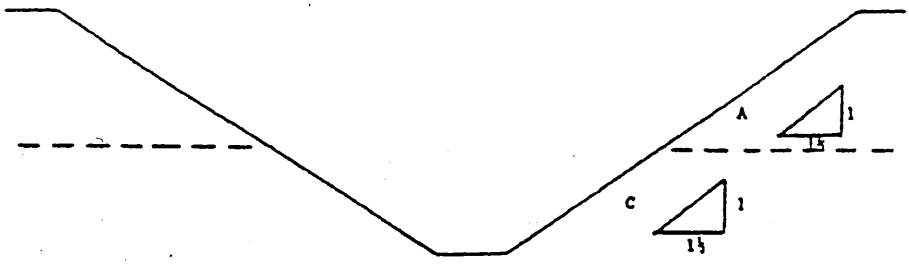
C OVER A



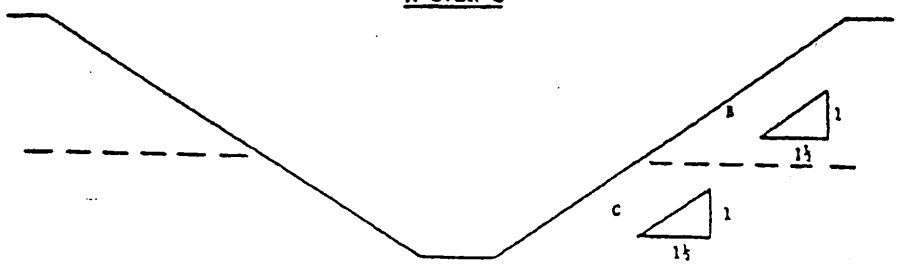
C OVER B



A OVER B



A OVER C



B OVER C

2. All other sloped excavations shall be in accordance with the other options permitted in §1926.652(b).

APPENDIX C TO SUBPART P—TIMBER SHORING FOR TRENCHES

(a) *Scope.* This appendix contains information that can be used timber shoring is provided as a method of protection from cave-ins in trenches that do not exceed 20 feet (6.1 m) in depth. This appendix must be used when design of timber shoring protective systems is to be performed in accordance with §1926.652(c)(1). Other timber shoring configurations; other systems of support such as hydraulic and pneumatic systems; and other protective systems such as sloping, benching, shielding, and freezing systems must be designed in accordance with the requirements set forth in §1926.652(b) and §1926.652(c).

(b) *Soil Classification.* In order to use the data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil classification method set forth in appendix A of subpart P of this part.

(c) *Presentation of Information.* Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables C-1.1, C-1.2, and C-1.3, and Tables C-2.1, C-2.2 and C-2.3 following paragraph (g) of the appendix. Each table presents the minimum sizes of timber members to use in a shoring system, and each table contains data only for the particular soil

type in which the excavation or portion of the excavation is made. The data are arranged to allow the user the flexibility to select from among several acceptable configurations of members based on varying the horizontal spacing of the crossbraces. Stable rock is exempt from shoring requirements and therefore, no data are presented for this condition.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix, and on the tables themselves.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous notations regarding Tables C-1.1 through C-1.3 and Tables C-2.1 through C-2.3 are presented in paragraph (g) of this Appendix.

(d) *Basis and limitations of the data.*—(1) *Dimensions of timber members.* (i) The sizes of the timber members listed in Tables C-1.1 through C-1.3 are taken from the National Bureau of Standards (NBS) report, "Recommended Technical Provisions for Construction Practice in Shoring and Sloping of Trenches and Excavations." In addition, where NBS did not recommend specific sizes of members, member sizes are based on an analysis of the sizes required for use by existing codes and on empirical practice.

(ii) The required dimensions of the members listed in Tables C-1.1 through C-1.3 refer to actual dimensions and not nominal dimensions of the timber. Employers wanting to use nominal size shoring are directed to Tables C-2.1 through C-2.3, or have this choice under §1926.652(c)(3), and are referred to The Corps of Engineers, The Bureau of Reclamation or data from other acceptable sources.

(2) *Limitation of application.* (i) It is not intended that the timber shoring specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be designed as specified in §1926.652(c).

(ii) When any of the following conditions are present, the members specified in the tables are not considered adequate. Either an alternate timber shoring system must be designed or another type of protective system designed in accordance with §1926.652.

(A) When loads imposed by structures or by stored material adjacent to the trench weigh in excess of the load imposed by a two-foot soil surcharge. The term "adjacent" as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.

(B) When vertical loads imposed on cross braces exceed a 240-pound gravity load distributed on a one-foot section of the center of the crossbrace.

(C) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(D) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) *Use of Tables.* The members of the shoring system that are to be selected using this information are the cross braces, the uprights, and the wales, where wales are required. Minimum sizes of members are specified for use in different types of soil. There are six tables of information, two for each soil type. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is then made. The selection is based on the depth and width of the trench where the members are to be installed and, in most instances, the selection is also based on the horizontal spacing of the crossbraces. Instances where a choice of horizontal spacing of crossbracing is available, the horizontal spacing of the crossbraces must be chosen by the user before the size of any member can be determined. When the soil type, the width and depth of the trench, and the horizontal spacing of the crossbraces are known, the size and vertical spacing of the crossbraces, the size and vertical spacing of the wales, and the size and horizontal spacing of the uprights can be read from the appropriate table.

(f) *Examples to Illustrate the Use of Tables C-1.1 through C-1.3.*

(1) *Example 1.*

A trench dug in Type A soil is 13 feet deep and five feet wide.

From *Table C-1.1*, for acceptable arrangements of timber can be used.

Arrangement #1

Space 4x4 crossbraces at six feet horizontally and four feet vertically.

Wales are not required.

Space 3x8 uprights at six feet horizontally. This arrangement is commonly called "skip shoring."

Arrangement #2

Space 4x6 crossbraces at eight feet horizontally and four feet vertically.

Space 8x8 wales at four feet vertically.
Space 2x6 uprights at four feet horizontally.

Arrangement #3

Space 6x6 crossbraces at 10 feet horizontally and four feet vertically.
Space 8x10 wales at four feet vertically.
Space 2x6 uprights at five feet horizontally.

Arrangement #4

Space 6x6 crossbraces at 12 feet horizontally and four feet vertically.
Space 10x10 wales at four feet vertically.
Spaces 3x8 uprights at six feet horizontally.

(2) *Example 2.*

A trench dug in Type B soil in 13 feet deep and five feet wide. From Table C-1.2 three acceptable arrangements of members are listed.

Arrangement #1

Space 6x6 crossbraces at six feet horizontally and five feet vertically.
Space 8x8 wales at five feet vertically.
Space 2x6 uprights at two feet horizontally.

Arrangement #2

Space 6x8 crossbraces at eight feet horizontally and five feet vertically.
Space 10x10 wales at five feet vertically.
Space 2x6 uprights at two feet horizontally.

Arrangement #3

Space 8x8 crossbraces at 10 feet horizontally and five feet vertically.
Space 10x12 wales at five feet vertically.
Space 2x6 uprights at two feet vertically.

(3) *Example 3.*

A trench dug in Type C soil is 13 feet deep and five feet wide.

From Table C-1.3 two acceptable arrangements of members can be used.

Arrangement #1

Space 8x8 crossbraces at six feet horizontally and five feet vertically.
Space 10x12 wales at five feet vertically.
Position 2x6 uprights as closely together as possible.
If water must be retained use special tongue and groove uprights to form tight sheeting.

Arrangement #2

Space 8x10 crossbraces at eight feet horizontally and five feet vertically.
Space 12x12 wales at five feet vertically.
Position 2x6 uprights in a close sheeting configuration unless water pressure must be resisted. Tight sheeting must be used where water must be retained.

(4) *Example 4.*

A trench dug in Type C soil is 20 feet deep and 11 feet wide. The size and spacing of members for the section of trench that is over 15 feet in depth is determined using Table C-1.3. Only one arrangement of members is provided.

Space 8x10 crossbraces at six feet horizontally and five feet vertically.
Space 12x12 wales at five feet vertically.
Use 3x6 tight sheeting.

Use of Tables C-2.1 through C-2.3 would follow the same procedures.

(g) *Notes for all Tables.*

1. Member sizes at spacings other than indicated are to be determined as specified in §1926.652(c), "Design of Protective Systems."

2. When conditions are saturated or submerged use Tight Sheeting. Tight Sheeting refers to the use of specially-edged timber planks (e.g., tongue and groove) at least three inches thick, steel sheet piling, or similar construction that when driven or placed in position provide a tight wall to resist the lateral pressure of water and to prevent the loss of backfill material. Close Sheeting refers to the placement of planks side-by-side allowing as little space as possible between them.

3. All spacing indicated is measured center to center.

4. Wales to be installed with greater dimension horizontal.

5. If the vertical distance from the center of the lowest crossbrace to the bottom of the trench exceeds two and one-half feet, uprights shall be firmly embedded or a mudsill shall be used. Where uprights are embedded, the vertical distance from the center of the lowest crossbrace to the bottom of the trench shall not exceed 36 inches. When mudsills are used, the vertical distance shall not exceed 42 inches. Mudsills are wales that are installed at the toe of the trench side.

6. Trench jacks may be used in lieu of or in combination with timber crossbraces.

7. Placement of crossbraces. When the vertical spacing of crossbraces is four feet, place the top crossbrace no more than two feet below the top of the trench. When the vertical spacing of crossbraces is five feet, place the top crossbrace no more than 2.5 feet below the top of the trench.

TABLE C-1.1

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE A $P_a = 25 \times H + 72$ psf (2 ft Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS **													
	CROSS BRACES							WALES		UPRIGHTS				
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE	4	5	6	8
5 TO 10	UP TO 6	4X4	4X4	4X6	6X6	6X6	4	Not Req'd	---				2X6	
	UP TO 8	4X4	4X4	4X6	6X6	6X6	4	Not Req'd	---					2X8
	UP TO 10	4X6	4X6	4X6	6X6	6X6	4	8X8	4			2X6		
	UP TO 12	4X6	4X6	6X6	6X6	6X6	4	8X8	4				2X6	
10 TO 15	UP TO 6	4X4	4X4	4X6	6X6	6X6	4	Not Req'd	---				3X8	
	UP TO 8	4X6	4X6	6X6	6X6	6X6	4	8X8	4		2X6			
	UP TO 10	6X6	6X6	6X6	6X8	6X8	4	8X10	4			2X6		
	UP TO 12	6X6	6X6	6X6	6X8	6X8	4	10X10	4				3X8	
15 TO 20	UP TO 6	6X6	6X6	6X6	6X8	6X8	4	6X8	4	3X6				
	UP TO 8	6X6	6X6	6X6	6X8	6X8	4	8X8	4	3X6				
	UP TO 10	8X8	8X8	8X8	8X8	8X10	4	8X10	4	3X6				
	UP TO 12	8X8	8X8	8X8	8X8	8X10	4	10X10	4	3X6				
OVER 20	SEE NOTE 1													

* Mixed oak or equivalent with a bending strength not less than 850 psi.

** Manufactured members of equivalent strength may by substituted for wood.

TABLE C-1.2

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE B $P_a = 45 \times H + 72$ psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS**														
	CROSS BRACES							WALES		UPRIGHTS					
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)					
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE	2	3			
5 TO 10	UP TO 6	4X6	4X6	6X6	6X6	6X6	5	6X8	5			2X6			
	UP TO 8	6X6	6X6	6X6	6X8	6X8	5	8X10	5			2X6			
	UP TO 10	6X6	6X6	6X6	6X8	6X8	5	10X10	5			2X6			
	See Note 1														
10 TO 15	UP TO 6	6X6	6X6	6X6	6X8	6X8	5	8X8	5		2X6				
	UP TO 8	6X8	6X8	6X8	8X8	8X8	5	10X10	5		2X6				
	UP TO 10	8X8	8X8	8X8	8X8	8X10	5	10X12	5		2X6				
	See Note 1														
15 TO 20	UP TO 6	6X8	6X8	6X8	8X8	8X8	5	8X10	5	3X6					
	UP TO 8	8X8	8X8	8X8	8X8	8X10	5	10X12	5	3X6					
	UP TO 10	8X10	8X10	8X10	8X10	10X10	5	12X12	5	3X6					
	See Note 1														
OVER 20	SEE NOTE 1														

* Mixed oak or equivalent with a bending strength not less than 850 psi.
** Manufactured members of equivalent strength may by substituted for wood.

TABLE C-1.3

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE C P_a = 80 X H + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS**														
	CROSS BRACES								UPRIGHTS						
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET) (See Note 2)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE				
5 TO 10	UP TO 6	6X8	6X8	6X8	8X8	8X8	5	8X10	5	2X6				
	UP TO 8	8X8	8X8	8X8	8X8	8X10	5	10X12	5	2X6				
	UP TO 10	8X10	8X10	8X10	8X10	10X10	5	12X12	5	2X6				
	See Note 1													
10 TO 15	UP TO 6	8X8	8X8	8X8	8X8	8X10	5	10X12	5	2X6				
	UP TO 8	8X10	8X10	8X10	8X10	10X10	5	12X12	5	2X6				
	See Note 1													
	See Note 1													
15 TO 20	UP TO 6	8X10	8X10	8X10	8X10	10X10	5	12X12	5	3X6				
	See Note 1													
	See Note 1													
	See Note 1													
OVER 20	SEE NOTE 1													

* Mixed Oak or equivalent with a bending strength not less than 850 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.1

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *
SOIL TYPE A P_a = 25 X H ± 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **													
	CROSS BRACES							WALES		UPRIGHTS				
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE	4	5	6	8
5 TO 10	UP TO 6	4X4	4X4	4X4	4X4	4X6	4	Not Req'd	Not Req'd				4X6	
	UP TO 8	4X4	4X4	4X4	4X6	4X6	4	Not Req'd	Not Req'd					4X8
	UP TO 10	4X6	4X6	4X6	6X6	6X6	4	8X8	4			4X6		
	UP TO 12	4X6	4X6	4X6	6X6	6X6	4	8X8	4				4X6	
10 TO 15	UP TO 6	4X4	4X4	4X4	6X6	6X6	4	Not Req'd	Not Req'd				4X10	
	UP TO 8	4X6	4X6	4X6	6X6	6X6	4	6X8	4		4X6			
	UP TO 10	6X6	6X6	6X6	6X6	6X6	4	8X8	4			4X8		
	UP TO 12	6X6	6X6	6X6	6X6	6X6	4	8X10	4		4X6		4X10	
15 TO 20	UP TO 6	6X6	6X6	6X6	6X6	6X6	4	6X8	4	3X6				
	UP TO 8	6X6	6X6	6X6	6X6	6X6	4	8X8	4	3X6	4X12			
	UP TO 10	6X6	6X6	6X6	6X6	6X8	4	8X10	4	3X6				
	UP TO 12	6X6	6X6	6X6	6X8	6X8	4	8X12	4	3X6	4X12			
OVER 20	SEE NOTE 1													

* Douglas fir or equivalent with a banding strength not less than 1500 psi.
** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.2

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE B P_a = 45 X H + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **													
	CROSS BRACES							WALES		UPRIGHTS				
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE	2	3	4	6
5 TO 10	UP TO 6	4X6	4X6	4X6	6X6	6X6	5	6X8	5			3X12 4X8		4X12
	UP TO 8	4X6	4X6	6X6	6X6	6X6	5	8X8	5		3X8		4X8	
	UP TO 10	4X6	4X6	6X6	6X6	6X8	5	8X10	5			4X8		
	See Note 1													
10 TO 15	UP TO 6	6X6	6X6	6X6	6X8	6X8	5	8X8	5	3X6	4X10			
	UP TO 8	6X8	6X8	6X8	8X8	8X8	5	10X10	5	3X6	4X10			
	UP TO 10	6X8	6X8	8X8	8X8	8X8	5	10X12	5	3X6	4X10			
	See Note 1													
15 TO 20	UP TO 6	6X8	6X8	6X8	6X8	8X8	5	8X10	5	4X6				
	UP TO 8	6X8	6X8	6X8	8X8	8X8	5	10X12	5	4X6				
	UP TO 10	8X8	8X8	8X8	8X8	8X8	5	12X12	5	4X6				
	See Note 1													
OVER 20	SEE NOTE 1													

* Douglas fir or equivalent with a bending strength not less than 1500 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.3

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE C P_a = 80 X H + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **														
	CROSS BRACES						WALES		UPRIGHTS						
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)					
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE					
5 TO 10	UP TO 6	6X6	6X6	6X6	6X6	8X8	5	8X8	5	3X6					
	UP TO 8	6X6	6X6	6X6	8X8	8X8	5	10X10	5	3X6					
	UP TO 10	6X6	6X6	8X8	8X8	8X8	5	10X12	5	3X6					
	See Note 1														
10 TO 15	UP TO 6	6X8	6X8	6X8	8X8	8X8	5	10X10	5	4X6					
	UP TO 8	8X8	8X8	8X8	8X8	8X8	5	12X12	5	4X6					
	See Note 1														
	See Note 1														
15 TO 20	UP TO 6	8X8	8X8	8X8	8X10	8X10	5	10X12	5	4X6					
	See Note 1														
	See Note 1														
	See Note 1														
OVER 20	SEE NOTE 1														

* Douglas fir or equivalent with a bending strength not less than 1500 psi.
** Manufactured members of equivalent strength may be substituted for wood.

APPENDIX D TO SUBPART P—ALUMINUM HYDRAULIC SHORING FOR TRENCHES

(a) *Scope.* This appendix contains information that can be used when aluminum hydraulic shoring is provided as a method of protection against cave-ins in trenches that do not exceed 20 feet (6.1m) in depth. This appendix must be used when design of the aluminum hydraulic protective system cannot be performed in accordance with §1926.652(c)(2).

(b) *Soil Classification.* In order to use data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil classification method set forth in appendix A of subpart P of part 1926.

(c) *Presentation of Information.* Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables D–1.1, D–1.2, D–1.3 and E–1.4. Each table presents the maximum vertical and horizontal spacings that may be used with various aluminum member sizes and various hydraulic cylinder sizes. Each table contains data only for the particular soil type in which the excavation or portion of the excavation is made. Tables D–1.1 and D–1.2 are for vertical shores in Types A and B soil. Tables D–1.3 and D1.4 are for horizontal waler systems in Types B and C soil.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous notations (footnotes) regarding Table D–1.1 through D–1.4 are presented in paragraph (g) of this appendix.

(6) Figures, illustrating typical installations of hydraulic shoring, are included just prior to the Tables. The illustrations page is entitled "Aluminum Hydraulic Shoring; Typical Installations."

(d) *Basis and limitations of the data.*

(1) Vertical shore rails and horizontal wales are those that meet the Section Modulus requirements in the D–1 Tables. Aluminum material is 6061–T6 or material of equivalent strength and properties.

(2) Hydraulic cylinders specifications. (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a minimum safe working capacity of no less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe working capacity of not less than 30,000 pounds axial compressive load at extensions as recommended by product manufacturer.

(3) Limitation of application.

(i) It is not intended that the aluminum hydraulic specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be otherwise designed as specified in §1926.652(c).

(ii) When any of the following conditions are present, the members specified in the Tables are not considered adequate. In this case, an alternative aluminum hydraulic shoring system or other type of protective system must be designed in accordance with §1926.652.

(A) When vertical loads imposed on cross braces exceed a 100 Pound gravity load distributed on a one foot section of the center of the hydraulic cylinder.

(B) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(C) When only the lower portion or a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) *Use of Tables D–1.1, D–1.2, D–1.3 and D–1.4.* The members of the shoring system that are to be selected using this information are the hydraulic cylinders, and either the vertical shores or the horizontal wales. When a waler system is used the vertical timber sheeting to be used is also selected from these tables. The Tables D-1.1 and D-1.2 for vertical shores are used in Type A and B soils that do not require sheeting. Type B soils that may require sheeting, and Type C soils that always require sheeting are found in the horizontal wale Tables D–1.3 and D–1.4. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is made. The selection is based on the depth and width of the trench where the members are to be installed. In these tables the vertical spacing is held constant at four feet on center. The tables show the maximum horizontal spacing of cylinders allowed for each size of wale in the waler system tables, and in the vertical shore tables, the hydraulic cylinder horizontal spacing is the same as the vertical shore spacing.

(f) *Example to Illustrate the Use of the Tables:*

(1) Example 1:

A trench dug in Type A soil is 6 feet deep and 3 feet wide. From Table D–1.1: Find vertical shores and 2 inch diameter cylinders spaced 8 feet on center (o.c.) horizontally and 4 feet on center (o.c.) vertically. (See Figures 1 & 3 for typical installations.)

(2) Example 2:

A trench is dug in Type B soil that does not require sheeting, 13 feet deep and 5 feet wide. From Table D–1.2: Find vertical shores and 2 inch diameter cylinders spaced 6.5 feet o.c. horizontally and 4 feet o.c. vertically. (See Figures 1 & 3 for typical installations.)

(3) A trench is dug in Type B soil that does not require sheeting, but does experience some minor raveling of the trench face. The trench is 16 feet deep and 9 feet wide. From Table D–1.2: Find vertical shores and 2 inch diameter cylinder (with special oversleeves as designated by footnote #2) spaced 5.5 feet o.c. horizontally and 4 feet o.c. vertically, plywood (per footnote (g)(7) to the D–1 Table) should be used behind the shores. (See Figures 2 & 3 for typical installations.)

(4) Example 4: A trench is dug in previously disturbed Type B soil, with characteristics of a Type C soil, and will require sheeting. The trench is 18 feet deep and 12 feet wide. 8 foot horizontal spacing between cylinders is desired for working space. From Table D–1.3: Find horizontal wale with a section modulus of 14.0 spaced at 4 feet o.c. vertically and 3 inch diameter cylinder spaced at 9 feet maximum o.c. horizontally. 3x12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

(5) Example 5: A trench is dug in Type C soil, 9 feet deep and 4 feet wide. Horizontal cylinder spacing in excess of 6 feet is desired for working space. From Table D–1.4: Find horizontal wale with a section modulus of 7.0 and 2 inch diameter cylinders spaced at 6.5 feet o.c. horizontally. Or, find horizontal wale with a 14.0 section modulus and 3 inch diameter cylinder spaced at 10 feet o.c. horizontally. Both wales are spaced 4 feet o.c. vertically. 3x12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

(g) *Footnotes, and general notes, for Tables D–1.1, D–1.2, D–1.3, and D–1.4.*

(1) For applications other than those listed in the tables, refer to §1926.652(c)(2) for use of manufacturer's tabulated data. For trench depths in excess of 20 feet, refer to §1926.652(c)(2) and §1926.652(c)(3).

(2) 2 inch diameter cylinders, at this width, shall have structural steel tube (3.5x3.5x0.1875) oversleeves, or structural oversleeves of manufacturer's specification, extending the full, collapsed length.

(3) Hydraulic cylinders capacities. (i) 2 inch cylinders shall be a minimum 2-inch inside diameter with a safe working capacity of not less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe work capacity of not less than 30,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(4) All spacing indicated is measured center to center.

(5) Vertical shoring rails shall have a minimum section modulus of 0.40 inch.

(6) When vertical shores are used, there must be a minimum of three shores spaced equally, horizontally, in a group.

(7) Plywood shall be 1.125 in. thick softwood or 0.75 inch. thick, 14 ply, arctic white birch (Finland form). Please note that plywood is not intended as a structural member, but only for prevention of local raveling (sloughing of the trench face) between shores.

(8) See appendix C for timber specifications.

(9) Wales are calculated for simple span conditions.

(10) See appendix D, item (d), for basis and limitations of the data.

ALUMINUM HYDRAULIC SHORING
TYPICAL INSTALLATIONS

FIGURE NO. 1

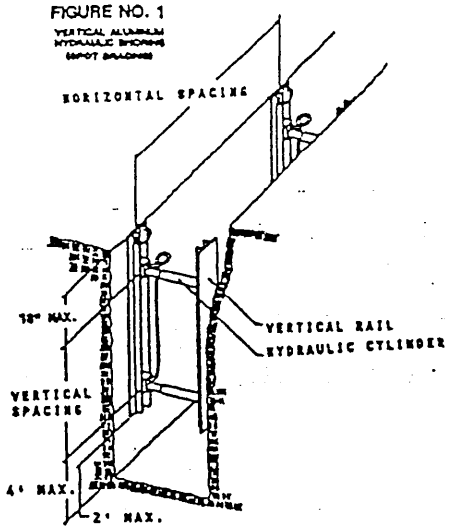


FIGURE NO. 2

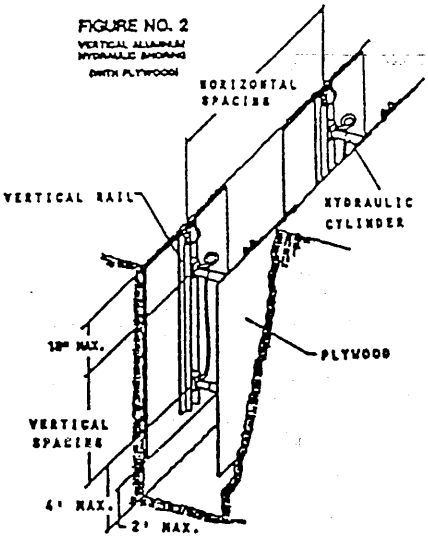


FIGURE NO. 3

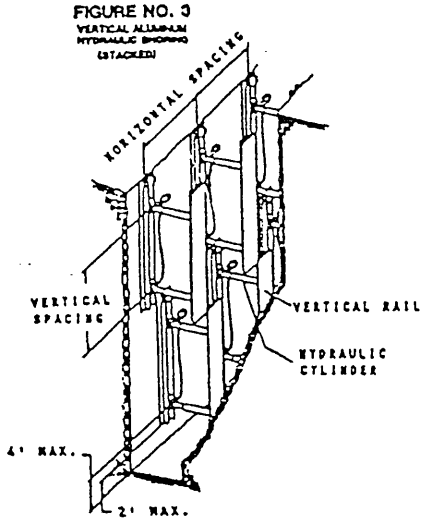


FIGURE NO. 4

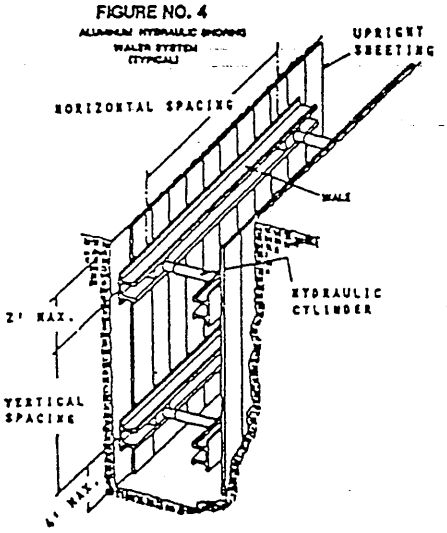


TABLE D - 1.1
ALUMINUM HYDRAULIC SHORING
VERTICAL SHORES
FOR SOIL TYPE A

DEPTH OF TRENCH (FEET)	HYDRAULIC CYLINDERS				
	MAXIMUM HORIZONTAL SPACING (FEET)	MAXIMUM VERTICAL SPACING (FEET)	WIDTH OF TRENCH (FEET)		
			UP TO 8	OVER 8 UP TO 12	OVER 12 UP TO 15
OVER 5 UP TO 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER NOTE (2)	3 INCH DIAMETER
OVER 10 UP TO 15	8				
OVER 15 UP TO 20	7				
OVER 20	NOTE (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Note (1): See Appendix D, Item (g) (1)
Note (2): See Appendix D, Item (g) (2)

TABLE D - 1.2
ALUMINUM HYDRAULIC SHORING
VERTICAL SHORES
FOR SOIL TYPE B

DEPTH OF TRENCH (FEET)	HYDRAULIC CYLINDERS				
	MAXIMUM HORIZONTAL SPACING (FEET)	MAXIMUM VERTICAL SPACING (FEET)	WIDTH OF TRENCH (FEET)		
			UP TO 8	OVER 8 UP TO 12	OVER 12 UP TO 15
OVER 5 UP TO 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER NOTE (2)	3 INCH DIAMETER
OVER 10 UP TO 15	6.5				
OVER 15 UP TO 20	5.5				
OVER 20	NOTE (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Note (1): See Appendix D, Item (g) (1)
Note (2): See Appendix D, Item (g) (2)

TABLE D - 1.3
ALUMINUM HYDRAULIC SHORING
WALER SYSTEMS
FOR SOIL TYPE B

DEPTH OF TRENCH (FEET)	WALES		HYDRAULIC CYLINDERS						TIMBER UPRIGHTS		
			WIDTH OF TRENCH (FEET)						MAX.HORIZ.SPACING (ON CENTER)		
	VERTICAL SPACING (FEET)	* SECTION MODULUS (IN^3)	UP TO 8		OVER 8 UP TO 12		OVER 12 UP TO15		SOLID SHEET	2 FT.	3 FT.
			HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER			
OVER 5 UP TO 10	4	3.5	8.0	2 IN	8.0	2 IN NOTE(2)	8.0	3 IN	—	—	3x12
		7.0	9.0	2 IN	9.0	2 IN NOTE(2)	9.0	3 IN			
		14.0	12.0	3 IN	12.0	3 IN	12.0	3 IN			
OVER 10 UP TO 15	4	3.5	6.0	2 IN	6.0	2 IN NOTE(2)	6.0	3 IN	—	3x12	—
		7.0	8.0	3 IN	8.0	3 IN	8.0	3 IN			
		14.0	10.0	3 IN	10.0	3 IN	10.0	3 IN			
OVER 15 UP TO 20	4	3.5	5.5	2 IN	5.5	2 IN NOTE(2)	5.5	3 IN	3x12	—	—
		7.0	6.0	3 IN	6.0	3 IN	6.0	3 IN			
		14.0	9.0	3 IN	9.0	3 IN	9.0	3 IN			
OVER 20	NOTE (1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Notes (1): See Appendix D, item (g) (1)
Notes (2): See Appendix D, Item (g) (2)
* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

TABLE D - 1.4
ALUMINUM HYDRAULIC SHORING
WALER SYSTEMS
FOR SOIL TYPE C

DEPTH OF TRENCH (FEET)	WALES		HYDRAULIC CYLINDERS						TIMBER UPRIGHTS		
			WIDTH OF TRENCH (FEET)						MAX.HORIZ SPACING (ON CENTER)		
			UP TO 8		OVER 8 UP TO 12		OVER 12 UP TO 15				
	VERTICAL SPACING (FEET)	SECTION MODULUS * (IN^3)	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	SOLID SHEET	2 FT.	3 FT.
OVER 5 UP TO 10	4	3.5	6.0	2 IN	6.0	2 IN NOTE(2)	6.0	3 IN	3x12	—	—
		7.0	6.5	2 IN	6.5	2 IN NOTE(2)	6.5	3 IN			
		14.0	10.0	3 IN	10.0	3 IN	10.0	3 IN			
OVER 10 UP TO 15	4	3.5	4.0	2 IN	4.0	2 IN NOTE(2)	4.0	3 IN	3x12	—	—
		7.0	5.5	3 IN	5.5	3 IN	5.5	3 IN			
		14.0	8.0	3 IN	8.0	3 IN	8.0	3 IN			
OVER 15 UP TO 20	4	3.5	3.5	2 IN	3.5	2 IN NOTE(2)	3.5	3 IN	3x12	—	—
		7.0	5.0	3 IN	5.0	3 IN	5.0	3 IN			
		14.0	6.0	3 IN	6.0	3 IN	6.0	3 IN			
OVER 20	NOTE (1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Notes (1): See Appendix D, item (g) (1)
Notes (2): See Appendix D, Item (g) (2)
* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

APPENDIX E TO SUBPART P—ALTERNATIVES TO TIMBER SHORING

Figure 1. Aluminum Hydraulic Shoring

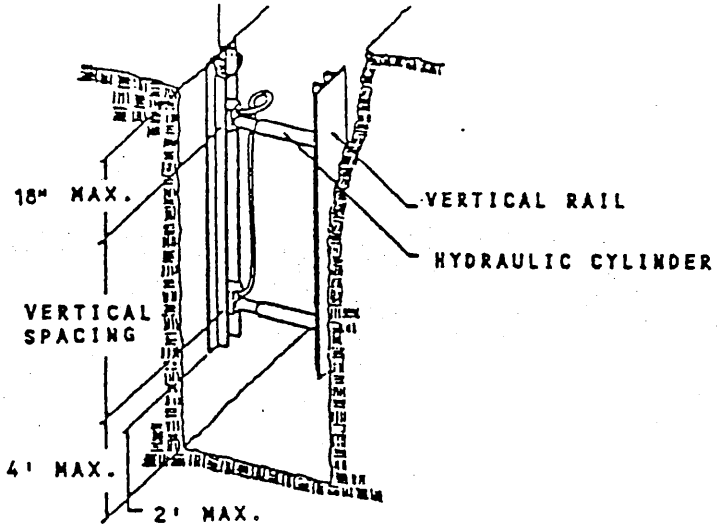


Figure 2. Pneumatic/hydraulic Shoring

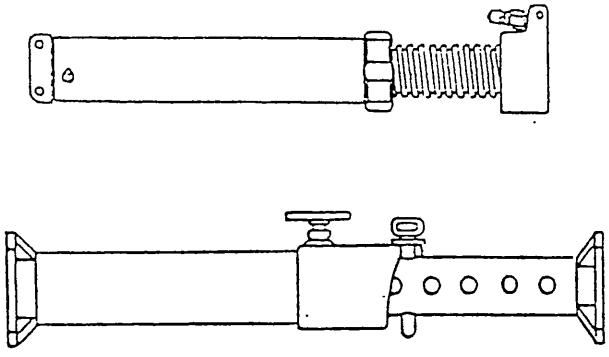


Figure 3. Trench Jacks (Screw Jacks)

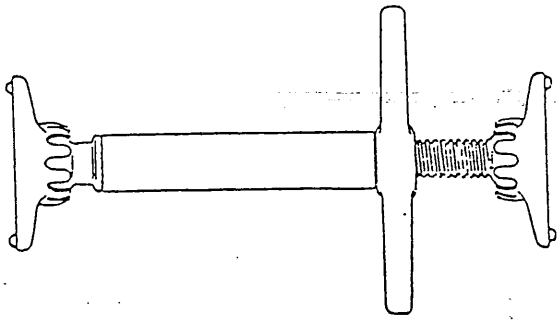
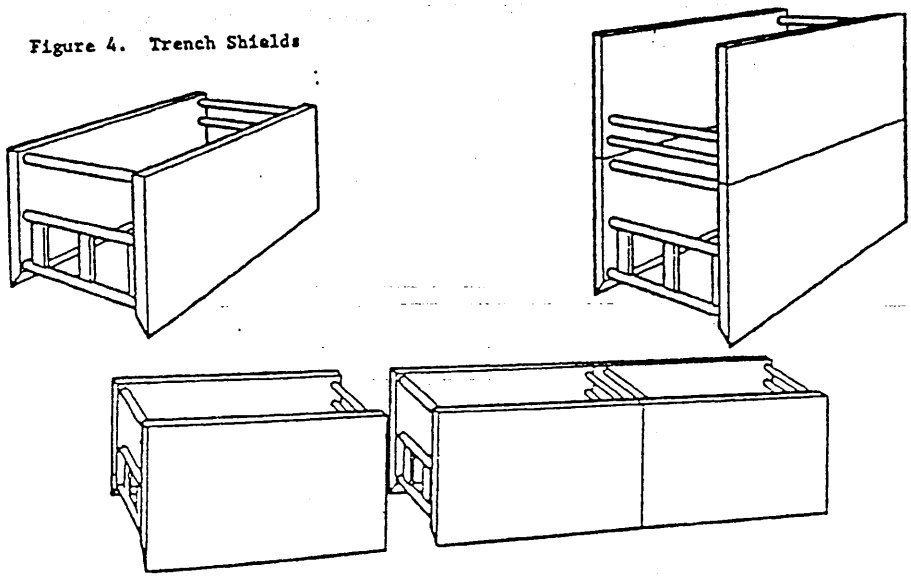


Figure 4. Trench Shields



APPENDIX F TO SUBPART P—SELECTION OF PROTECTIVE SYSTEMS

The following figures are a graphic summary of the requirements contained in subpart P for excavations 20 feet or less in depth. Protective systems for use in excavations more than 20 feet in depth must be designed by a registered professional engineer in accordance with § 1926.652 (b) and (c).

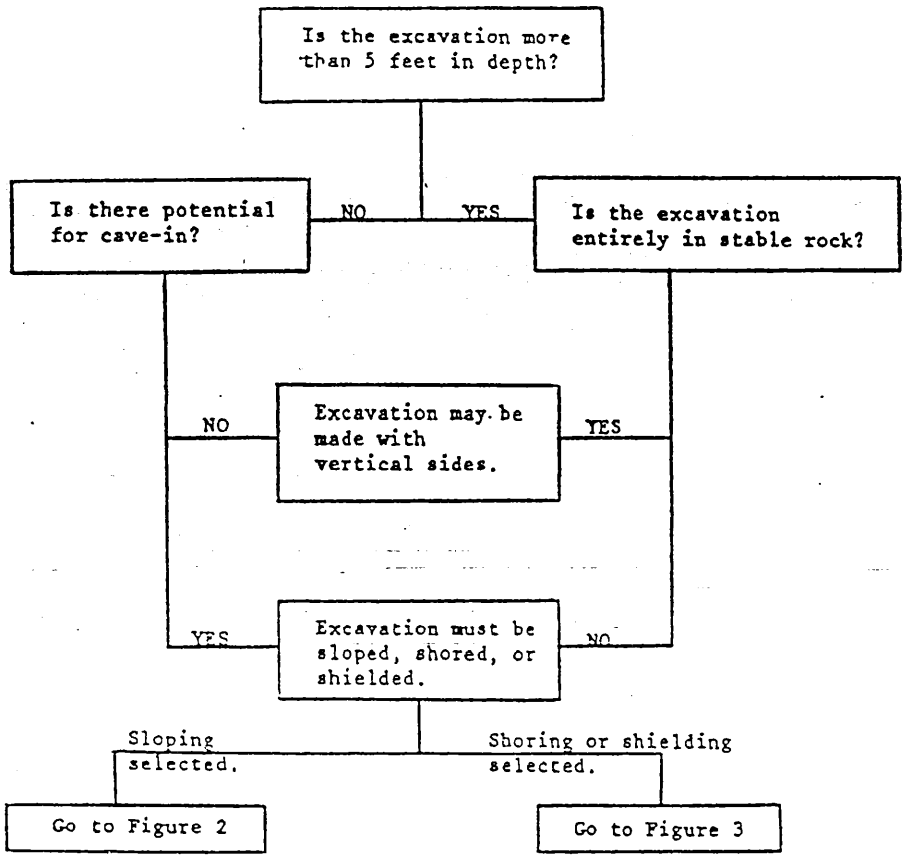


FIGURE 1 - PRELIMINARY DECISIONS

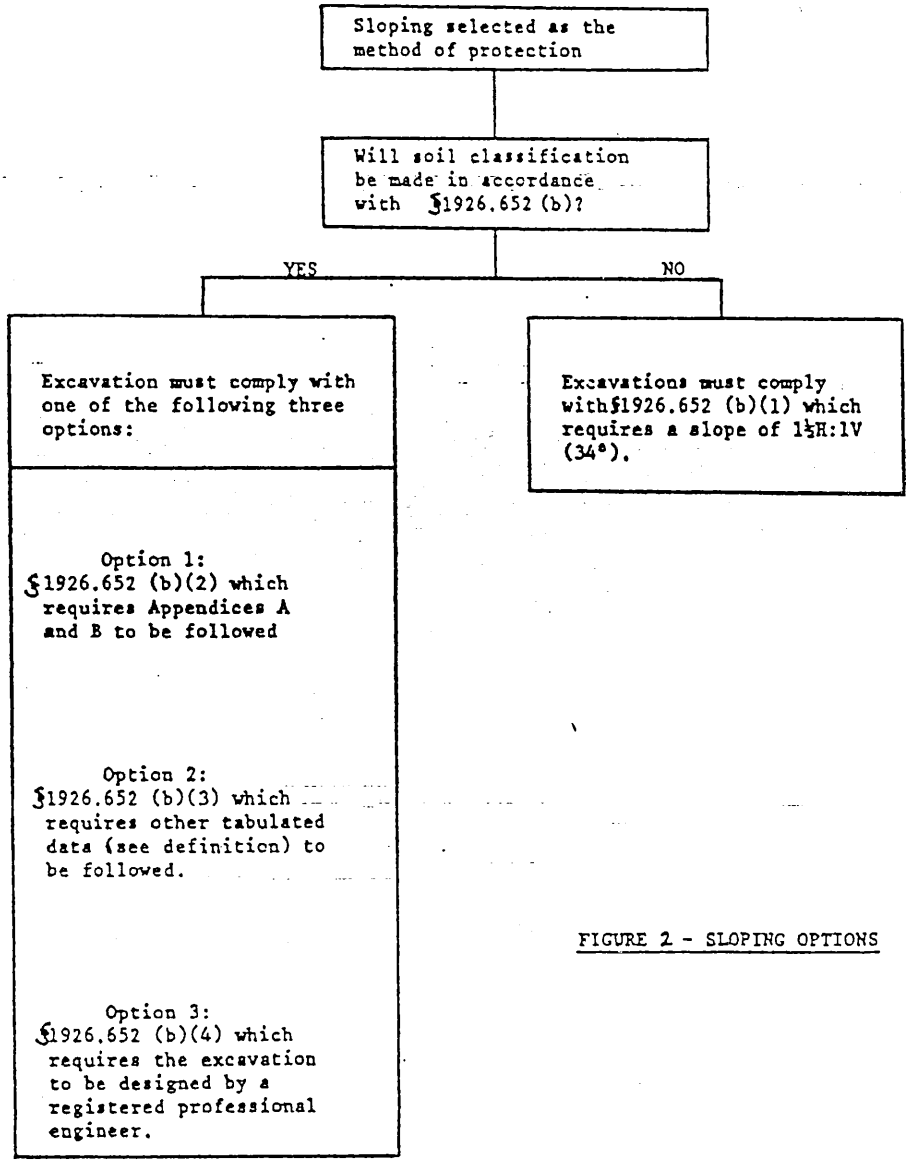


FIGURE 2 - SLOPING OPTIONS

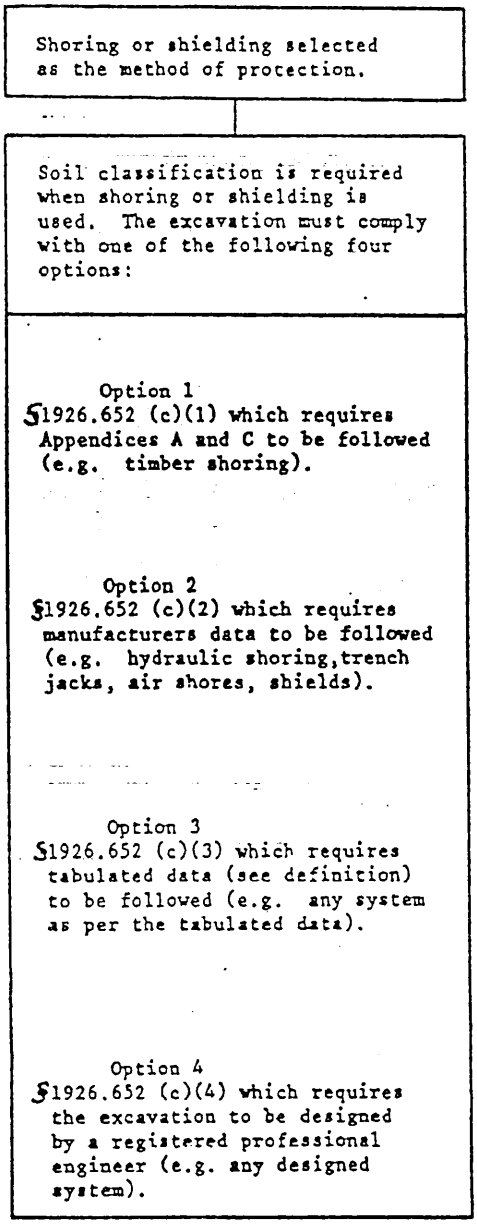


FIGURE 3 - SHORING AND SHIELDING OPTIONS