LONE PINE STATE PARK
WATER SYSTEM
IMPROVEMENTS

FWP PROJECT # 7176312

SPECIFICATIONS

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MONTANA FWP
LONE PINE STATE PARK
PUBLIC WATER SUPPLY UPGRADES
SPECIFICATIONS
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Division 1
General Requirements

DIVISION 1 – GENERAL REQUIREMENTS

SECTION 01400

CONTRACTOR QUALITY CONTROL AND OWNER QUALITY ASSURANCE

PART 1: GENERAL

1.1 DESCRIPTION

A. This section describes the Contractor quality control testing requirements and Owner's quality assurance program.

1.2 References

A. The following ASTM publication is a part of this specification.

ASTM E 329 Evaluation of Testing and Inspection Agencies as Used in Construction

PART 2: PRODUCT — NOT USED

PART 3: EXECUTION

3.1 GENERAL

A. Be responsible for quality control tests and inspections to control contractor production and construction processes. Include in the Contractor quality control system an internal organization, plans, and procedures to produce the specified end product. Assure the system covers all construction operations, both on-site and off-site, and is keyed to the construction sequence. Quality control testing frequency is at Engineer/Owner discretion, except where tests are specifically required in the technical specifications for individual products.

B. Sampling and testing to assure specification conformance are performed by the Testing Firm hired by the contractor at discretion of owner/engineer as quality assurance testing.

C. The Owner may select a testing agency to perform quality assurance testing. (ASTM E329 is referenced as a guide to the selection of a qualified testing agency.)

D. Quality assurance testing is performed following the standards in the technical specifications for individual products.

3.2 CONTRACTOR COOPERATION WITH QUALITY ASSURANCE AGENCY

A. Assure the Owner's personnel and quality assurance agency have access to all work areas at all times work is in progress. Provide any special facilities or equipment to access work areas at Contractor expense.

B. Notify the Engineer of the work ready for quality assurance testing. Establish and update as the construction schedule to provide the Engineer estimated sampling/testing dates and times.

PART 4: MEASUREMENT AND PAYMENT

4.1 PAYMENT FOR TESTING

A. Pay for all quality control testing as outlined in Subsection 3.1 above. Mix designs for Portland Cement Concrete and Flowable Fill, mix designs for Asphalt Concrete, backfill compaction testing and gradation testing, and all initial aggregate quality tests are quality control tests and are at Contractor expense. Contractor is also responsible for all concrete strength testing per the Concrete section of this specifications. Testing costs are incidental to the work and to be included in the unit price bid for the respective item.

4.2 RETESTING

A. Quality assurance re-testing due to failing initial tests will be performed by the Owner or the Owner's quality assurance testing agency, and the re-test costs deducted from the contract amount for the affected bid item.

END OF SECTION

SECTION 01500

CONSTRUCTION AND TEMPORARY FACILITIES

PART 1: GENERAL

1.1 CONSTRUCTION FACILITIES

A. Furnish temporary services and utilities, including use fees and operation costs for: potable and non-potable water; lighting and power; and, materials storage.

B. Furnish personnel support facilities including: sanitary facilities; drinking water; first aid supplies and facilities; and, trash removal.

C. Do not park vehicles or equipment or store materials on private property without written permission from the property owner under Section 01010.1.4.B.

1.2 SECURITY

A. Provide fencing, barricades, warning signs, and lights to secure all work areas, equipment, and materials.

1.3 DUST CONTROL

1.4 Be responsible for dust control, providing all equipment and personnel for the work. Furnish Engineer name(s) and telephone number(s) of the person(s) responsible for dust control during evenings and weekends. If this person cannot be contacted, Owner may at Contractor expense, perform the work or contract the work out.

1.5 HAUL ROUTES

A. Obtain Owner approval of haul routes.

PART 2: PRODUCTS — NOT USED

PART 3: EXECUTION — NOT USED

PART 4: MEASUREMENT AND PAYMENT

4.1 PAYMENT

A. All items in Part 1 are incidental to the work and no separate payment is made for these items.

END OF SECTION

SECTION 01570

CONSTRUCTION TRAFFIC CONTROL

PART 1: GENERAL

1.1 DESCRIPTION

A. This work is the furnishing of labor, materials and equipment for installing, maintaining and operating traffic control devices to insure the safety of the general public and project personnel.

1.2 REQUIREMENTS

A. Perform work under this section meeting Manual of Uniform Traffic Control Services (MUTCD) and contract requirements.

1.3 NOTIFICATIONS

A. Coordinate all construction activities to reduce traffic conflicts at the work site, off-site events or other construction projects.

B. Furnish the Engineer, for Owner review, the construction traffic control plan at least one week before construction begins or before changes in segments or phases of the work on the project. The Owner will review and approve the Traffic Control Plan considering known off-site activities and may require modification to the plan or construction timing to coordinate events. Work shall not commence until said plan is approved.

C. For project sites involving a through street, provide the Engineer with a news release. Include in the news release, as a minimum, the work activity and duration. Once approved, furnish the news release to the local media at least three days before starting work. Notify all landowners or residents adjacent to the work of the type and duration of the construction.

PART 2: PRODUCT

2.1 TRAFFIC CONTROL DEVICES

A. Assure all signs and barricades are reflectorized. Assure all night time traffic control devices meet MUTCD lighting requirements.

B. Use traffic control devices meeting the "Manual of Uniform Traffic Control Devices" and the "Traffic Control Devices Handbook" requirements, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20492.

C. Assure all traffic control devices are clean, legible, reflective for night-time use, and operable.

PART 3 EXECUTION

3.1 WORK METHODS:

A. Place all traffic control devices as planned before permitting men or equipment on the traveled way. Install signs, cones and barricades in that order.

B. Inspect the work area at least twice each day during construction and maintain records of traffic control devices used and their location.

C. Assure traffic control is appropriate to the work. Assure traffic control devices are appropriate and clean before suspending work for the day.

D. Remove traffic control devices in reverse order of installation at the end of each shift.

E. Remove and store all unnecessary traffic control devices away from traffic's view.

3.2 NONCOMPLIANCE

A. Remove, repair or replace any traffic control device not providing its intended function.

B. Do not begin work until all required traffic control devices are placed.

C. The Engineer will periodically inspect the traffic control and inform the Contractor of any deficiencies.

D. Contractor failure to correct any deficiency in the traffic control within 4 hours of notification is cause to deduct monies from the contract payment on the next progress payment.

E. The Engineer may direct correcting traffic control deficiencies immediately. Failure to immediately correct the deficiency is cause for the Engineer to correct the deficiency at Contractor expense.

3.3 FLAGGING

A. Furnish competent and properly equipped flag persons as described in the booklet "Instructions for Flag persons" furnished by the Montana Department of Transportation.

PART 4: MEASUREMENT AND PAYMENT

4.1 PAYMENT

A. Separate measurement for each traffic control device is not made unless the on-site field traffic plan requirements differ materially from the original traffic control plan in the contract. Measurement and payment for the Contractor's off-

site traffic control plan and the designed on-site traffic control plan is on a lump sum basis. The lump sum payment is full reimbursement for all costs of furnishing, installing, maintaining, replacing and operating the construction traffic control systems throughout the work period. The construction traffic control system includes but is not limited to, signs, barricades, pavement markings, watering, flag persons and pilot cars.

B. Progress payments are in proportion to total construction completed.

C. If changes in the approved Traffic Control Plan are directed by the Engineer, additional payment or reduction in payment is made for the additional or deleted items as agreed to between the Contractor and the Engineer.

END OF SECTION

SECTION 01580

TEMPORARY WATER SUPPLY

PART 1: GENERAL

1.1 DESCRIPTION

A. Provide temporary water service to all residential and commercial service connections interrupted by water system replacement projects. The Contractor shall verify with the Engineer and Owner at least 72 hours (excluding weekends and holidays) prior to the suspension of service the areas where consumers will require a temporary water supply. Temporary water service shall not include temporary service for commercial fire protection unless specifically indicated on the drawings.

B. The Contractor also shall not disrupt service to commercial and residential users for more than 8 hours at a time unless:

1. The Contractor obtains an authorization from the property owners at least 7 days prior to the interruption of service.

2. The Contractor submits a comprehensive work plan to the Engineer for approval that details the planned methodology to be used to ensure the commercial and residential connections are covered to the satisfaction of the water users at those locations.

1.2 STANDARD DRAWINGS

A. The Owner may have atlas maps showing the water system in the work zones. It shall be the Contractor's responsibility to determine the extent of water system to be taken out of service to perform the work and the subsequent configuration of the temporary water system to provide service to all affected water customers.

1.3 SUBMITTALS

A. Contractor shall submit a shop drawing including all materials proposed to be used for temporary water. Additionally, a temporary water plan shall be submitted for each zone prior to starting the layout of the temporary water system. This submittal shall include as a minimum, connection points, hydrants and/or valves to be operated by the Owner, layout for connection to each service, and the location of all street crossings. Depending on the circumstances of the zone,

additional information may be required by the Engineer.

B. Contractor shall notify the Fire Department at least 48 hours in advance whenever the fire supply to any commercial buildings is interrupted.

C. The Contractor submits a comprehensive work plan to the Engineer for approval that details the planned methodology to be used to ensure the commercial facility is not out water for more than the time detailed in the above letter.

1.4 APPLICABLE LAWAS AND REGULATIONS

A. Contractor shall comply with all applicable laws and regulations.

PART 2: PRODUCTS

2.1 TEMPRARY WATER PIPING

A. The water piping of temporary hoses, piping, etc. shall be a 160 psi rating, NSF approved hose, flexible polyethylene pipe, or PVC pipe. All pipe used for the temporary water system must have a visible NSF approval stamp by the manufacturer. A short section of high pressure flexible rubber hose may be used for the connection to each residence. The temporary system must be leak proof.

2.2 SHUT OFF VALVE

A. The distribution pipe shall have a manual shut-off valve at each service tee. Shut-off valves shall be NSF approved valves.

2.3 BACKFLOW PREVENTER

A. The backflow prevention assembly shall be approved by the Engineer and the Owner during the submittal process. Backflow prevention devices shall be designed in accordance with the current AWWA Standard for Double Check Valve Backflow-Prevention Assembly.

B. Each backflow preventer shall be properly supported to protect the assembly and the attached piping from breakage.

C. The first time a backflow prevention assembly is set up on a project it shall be tested to verify its integrity. If the project is suspended over the winter, all backflow preventers shall be re-tested in the spring. All costs associated with this testing shall be the responsibility of the Contractor.

D. Each backflow prevention assembly shall be tested upon relocation. The cost for all subsequent tests shall be the responsibility of the Contractor.

PART 3: EXECUTION

3.1 GENERAL

A. Following the Engineer's and Owner's review and approval of any proposed shutdown request, the Contractor shall be required to give a minimum 24 hour advance notice (excluding weekends and holidays) to all residential consumers whose service will be temporarily affected, by means of individual notices delivered to each consumer. If the notices are not issued or the temporary service is not ready to be put in use, the Owner shall be free to exercise their authority in not closing down the existing valves and water main system.

B. The Contractor must have available all the necessary materials to complete the restoration of water to each of residential service within eight (8) hours after the suspension begins or before 5:00 p.m., whichever comes first. House-to-house or building-to-building connections will not be allowed unless approved by the Owner.

C. Special arrangements shall be made by the Contractor to provide temporary water service for all commercial services regardless of the length of time the water main is out of service. The Contractor shall supply all hoses, fittings, etc., for providing temporary water service at his expense. Copper piping or other "non-taste" inducing pipe shall be necessary if the commercial consumer serves food or water products as part of the business.

D. Fire protection is not included unless specifically shown by the Engineer. The Fire Department may require the Contractor to provide personnel for continuous "fire watch" at assisted living facilities where residents may require assistance in the event of a fire.

3.2 LOCATING CURB STOPS

A. The Contractor shall be solely responsible for all activities related to locating, exposing and operating curb stop valves to the individual properties. Existing conditions shall be identified and noted by the Contractor. Any existing condition that is suspected to indicate a defect of the curb stop valve, box, or service shall be reported immediately to the Engineer.

3.3 LAWN WATERING CONNECTIONS

A. Each house connection shall be equipped with a tee connection for lawn watering. The tee shall be NSF approved and shall be equipped with an NSF approved vacuum breaker and shut off valve. The connection to each customer shall require a short section of high pressure flexible rubber hose at the connection point.

3.4 TEMPORARY WATER SYSTEM SIZING

A. All pipe sizes shall be adequate to meet ordinary water supply demands of the consumers. The Contractor shall upsize the service at no additional cost if the home or business can show reasonable cause as to service deficiency.

3.5 TEMPORARY WATER SYSTEM DISINFECTION

A. All temporary water systems shall be assembled, flushed, and disinfected in place and approved by the Engineer and Owner before being placed into service. The disinfection procedures shall be equal to the procedures required for the new water main.

B. Temporary hoses, piping, fittings, etc. to be flushed and disinfected in accordance with the State of Montana Department of Environmental Quality standards, and the standards of this specification prior to being put into service.

3.6 CONNECTION TO BUILDINGS

A. Once the temporary water system has been assembled, pressure tested and disinfected, the Contractor will make the final connection to the building. The Contractor should expect to find the existing plumbing on some services to have been in service for several years. The Contractor shall use an ordinary degree of care while working on these services. Also, there may not be any convenient point of temporary connection on some services. In this case, temporary fittings must be provided to achieve the connection. This work will be incidental to the temporary water work. Any damage to the existing residential plumbing shall be repaired at Contractor's expense.

3.7 CROSSING ROADS, ALLEYS AND DRIVEWAYS

A. The Contractor will be required to protect the pipe at road crossings, alleyways, or residential driveways. The method of pipe protection shall be approved by the Engineer prior to placement.

B. The Contractor will be required to install the temporary water supply at street crossings in a shallow trench or other methods acceptable to the Engineer. The Engineer may not allow new asphalt to be cut for temporary water trenches in which case the temporary water main is to be relocated or other crossing methods are to be used. Aerial crossings of the temporary water lines at street crossings will not be allowed. Temporary water supply pipes shall not be installed in storm drain pipes. Mounding millings or cold mix over a temporary water pipe that has been trenched into existing asphalt pavement will be allowed under the following conditions:

1. The maximum height shall be 2-1/2 inches.
2. Provisions are made to avoid impact loads on the temporary water pipe.
3. Signs are erected indicating a bump ahead at 500 feet and 100 feet from the bump and at the bump in both directions.

C. The asphalt crossings shall be cut straight and vertical shall have uniform width and shall be cut perpendicular to the centerline of the street. Restoration shall match the appropriate surface restoration detail and shall be a minimum of 2 feet wide and shall be compacted with a small mechanical compactor. There will be no payment for any street cuts or asphalt restoration under this item, this being incidental to the work. Exceptions to this requirement shall be made only on a case by case basis following the Contractor's proposal and subsequent review and approval by the Owner and Engineer.

3.8 RECONNECTION TO NEW WATER SYSTEM

A. After services are connected or reconnected and prior to flushing, testing and chlorinating the new main, the water service piping shall be thoroughly backflushed from the residence to the new main. Should any service include a backflow prevention device, Contractor shall temporarily remove such device or provide other means to backflush the service. The corporation stop for the reconnected services shall not be left open to the new main until the Bac-T test for the new main has been completed and is acceptable.

PART 4: MEASUREMENT AND PAYMENT

4. 1 GENERAL

A. The cost of the temporary water system is to be included in the bid cost of the public water system improvements.

END OF SECTION

Division 2
Site Work

MPW

Section 02100
Site Preparation

SITE PREPARATION

SECTION 02113 Adjusting Inlets, Water Valve Boxes, Water Services, and Fire Hydrants to Grade

SECTION 02113

ADJUSTING LAMPHOLES, INLETS, WATER VALVE BOXES, WATER SERVICES, AND FIRE HYDRANTS TO GRADE

PART 1: GENERAL

1.1 DESCRIPTION

A. This section consists of locating and adjusting to grade existing manholes, lampholes, inlets, water valve boxes or services, and fire hydrants as shown in the contract documents, staked in the field or as required in the Special Provisions.

1.2 STANDARD DRAWINGS

A. Standard drawings included in Appendix A of this specification book which are applicable to this section are as follows:

Standard Drawing No. 02213-2 Water Valve Adjustment Detail

PART 2: PRODUCTS

2.1 GENERAL

A. Provide all materials including concrete, brick and mortar, complying with the specification section for the particular material involved, or if the material is not covered in these specifications, the material used for adjusting shall be equal, and comparable to that in the existing structure. If extensions for water valve boxes or services and fire hydrants are required beyond the length found to exist, provide items comparable to those in the existing structure.

PART 3: EXECUTION

3.1 GENERAL

A. Bring to required grade all existing manholes, inlets, lampholes and water valve boxes by either lowering or raising in accordance with the details shown in the contract documents. Do not lower manholes, lampholes or inlets by removal of portions of the cones or barrel sections. Accomplish downward adjustments by replacement of existing sections with shorter sections. Assure that all structures have a minimum of one 2-inch (5cm) concrete adjusting ring and a maximum of

12 inches (30cm) of rings under the casting. Do not use brick and/or mortar for adjustment of castings.

B. On manholes requiring steps, assure that maximum spacing between steps is 16 inches (40cm) and that 10 inches (25cm) is the maximum distance from the top of the manhole cone section to the first step.

C. Excavate water valve boxes and services to readily determine whether height adjustment can be made without substituting a longer section. Adjust water valve boxes and services laterally so the valve stems can be operated by the extension. Adjust water services by raising or lowering the curb key stop and extension box.

D. Adjust manholes, lampholes and water valve boxes to final grade before placing the final pavement surface. If required, make preliminary adjustment to allow placement of base courses and paving adjacent to the manhole, lamphole or water valve.

E. Provide backfill material conforming to the requirements of Section 02235, 1 inch (25 cm) Minus Crushed Base Course, and compacted to at least 95 percent of the maximum dry density as determined by AASHTO T99 or ASTM D698.

F. If required, make minor adjustments 5 feet (1.5 meters) to 10 feet (3.0 meters) in the horizontal location of existing fire hydrants to insure that they are the required minimum distance behind the back of curb. At the time of construction staking, any hydrants which require horizontal adjustment will be located by the Engineer and the adjusted location will be staked by the Engineer.

G. Make any minor adjustments required as dimensioned in the contract documents to the height of existing fire hydrants to insure that they are at a reasonable height above the back of curb. At the time of construction staking, any hydrants which require vertical adjustment will be located by the Engineer and the adjusted height will be staked by the Engineer. Accomplish extension of fire hydrant height only by the use of standard extension spools provided by the hydrant manufacturer.

H. Before final acceptance, clean all manholes, lampholes, inlets and water valve boxes/services. Assure that all water valve boxes, services and fire hydrants are operational.

I. All requirements of this section shall apply to new, as well as to existing, manholes, lampholes, valve boxes, water services and fire hydrants.

PART 4: MEASUREMENT AND PAYMENT

4. 1 GENERAL

A. Payment indicated to be included within bid amounts for project for complete compensation for all labor, equipment, materials and incidentals required for the completion of the work.

END OF SECTION

Section - 02200
Earthwork

EARTHWORK

SECTION 02221 Trench Excavation and Backfill for Pipelines and Appurtenance Structures

SECTION 02221

TRENCH EXCAVATION AND BACKFILL FOR PIPELINES & APPURTENANT STRUCTURES

PART 1: GENERAL

1.1 DESCRIPTION

A. This work is the excavation, trenching and backfilling for pipelines and appurtenances. It includes all clearing, grubbing, site preparation, removal and disposal of debris from the excavation, handling and storing materials for fill and backfill, all bracing, shoring and trench protection, construction dewatering, all backfill, subgrade preparation , final grading, site dressing and cleanup.

1.2 REFERENCES

A. The current publications listed below form a part of this specification.

AASHTO T99	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5-lb (2.5kg) Rammer and 12-inch (305mm) Drop
ASTM D698	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5-lb (2.5kg) Rammer and 12-inch (305mm) Drop
AASHTO T191 (ASTM D1556)	Density of Soil In-Place by the Sand-Cone Method
AASHTO T310 (ASTM D6938)	In-Place density and water content of the soil and soil aggregate by Nuclear Method (Shallow Depth)
AASHTO T11 (ASTM C117)	Materials Finer Than 0.075mm (No. 200) Sieve in Mineral Aggregates by Washing
AASHTO T27 (ASTM C136)	Sieve Analysis of Fine and Coarse Aggregate
AASHTO T89	Determining the Liquid Limit of Soils
AASHTO T90	Determining the Plastic Limit and Plasticity Index of Soils
ASTM D4318	Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils

1.3 STANDARD DRAWINGS

A. Standard Drawings applicable to this section are as follows:

1. Standard Drawing No. 02221-1 - Typical Utility Trench Detail

1.4 TESTING

A. Field Density Testing

1. Meet the quality control and quality assurance testing requirements in Section 01400, Contractor Quality Control and Owner Quality Assurance.

2. In-place field density tests for quality assurance are at Owner expense meeting AASHTO T191 (ASTM D1556), Sand Cone Method; or by AASHTO T310 (ASTM D6938) Nuclear Densometer Methods. Quality assurance field density testing frequency is at the Engineer's discretion.

3. Re-testing failing areas is at the expense of the Contractor.

4. At the direction of the Engineer, provide necessary equipment and labor to excavate and replace materials for test holes up to 5 feet deep into the compacted backfill to allow testing below the surface of any layers covered without inspection and approval by the Engineer.

B. Laboratory Maximum Density and Optimum Moisture

1. Quality assurance tests will be made by the Engineer for each on-site natural soil or each source of off-site material, including borrow material, to determine the laboratory maximum density values and optimum compaction moisture content according to AASHTO T-99 or ASTM D698.

C. Material Submittals

1. Submit to the Engineer material quality test results including Type 1 Bedding gradation and plasticity index; and Type 2 Bedding gradation.

2. Submit to the Engineer samples of on-site and off-site borrow soils for laboratory moisture-density relationship testing by the Engineer.

3. If applicable, submit a blasting plan to the Engineer.

PART 2: PRODUCTS

2.1 PIPE BEDDING MATERIALS

A. TYPE 1 PIPE BEDDING

1. Type 1 Pipe Bedding includes the material placed from 4 inches (100mm) below the bottom of the pipe, around the pipe, and up to the springline of the pipe.

2. Provide Type 1 Bedding consisting of sand, sandy gravel, or gravel having a maximum 3/4 inch size (19mm) and a maximum plasticity index of 6, determined by AASHTO T89 and T90 or by ASTM D4318.

3. Where trench excavation encounters wet or unstable material, Type 1 Pipe Bedding must be free draining and non-plastic

4. Refer to Standard Drawing 02221-1 and Special Provisions for other requirements.

B. SELECT TYPE 1 BEDDING

1. Select Type 1 Bedding includes the material placed from the springline of the pipe to 6 inches (15cm) over the pipe.

2. Select Type I Bedding shall consist of soil, sand or fine gravel, free from clods, lumps of frozen material, or rock exceeding 1-1/2 inches (38mm) in its greatest dimension.

3. Excavated trench material may be screened or sorted for use as backfill subject to approval of the Engineer.

4. Where trench excavation encounters wet or unstable material, Select Type 1 Bedding must be free draining and non-plastic.

C. TYPE 2 PIPE BEDDING

1. Type 2 Pipe Bedding is used as directed by the Engineer to replace unsuitable material encountered in the trench bottom.

2. Place Type 2 Pipe Bedding from the bottom of the Type 1 Bedding material to the depth required to adequately support the pipe.

3. Type 2 Bedding shall consist of granular material meeting the following gradation.

Sieve Opening	% Passing
3 Inch	100
No. 4	0 - 25
No. 8	0 – 10

D. SEPARATION GEOTEXTILE

1. The plans may require, or the engineer may direct, the use of non-woven geo-textile fabric intended to provide materials separation. The fabric will wrap all or part of the Type 1 Pipe Bedding and Select Type 1 Pipe Bedding to prevent materials migrating into the trench bottom and trench walls as shown on the plans or as directed by the engineer. The fabric shall be AASHTO M288 Class 1, 2, or 3 as specified or determined by the Engineer and shall fully comply with MPW Section 2110.

2.2 TRENCH BACKFILL MATERIALS

A. Materials from Trench Excavation

1. Backfill material obtained from trench excavations must be free of cinders, ash, refuse, organic or frozen material, boulders, or other deleterious materials. Backfill materials and placement are further described in the Execution Section of this specification.

B. Imported Backfill Material

1. Imported backfill material is from borrow source(s) outside the project limits and is used when, in the opinion of the Engineer, an adequate volume of suitable backfill material is not available within the project limits. Imported Backfill Materials must comply with the requirements of Section 2.2.A, MATERIALS FROM TRENCH EXCAVATION.

2.3 FLOWABLE FILL

A. If used, Flowable Fill is to meet the requirements set forth by the engineer.

2.4 DETECTABLE BURIED WARNING TAPE

A. Detectable buried warning tape is to have a minimum 6 inch (15cm) width and 5 mil (0.12mm) thickness and a solid aluminum core running the full length and width of the tape enclosed in a color coded inert plastic jacket, impervious to alkalis, chemical reagents and solvents in the soil. The tape is to meet APWA/ULCC Color Code requirements and is to have a maximum 36 inch(90cm) imprint.

PART 3: EXECUTION

3.1 PROTECTION OF EXISTING PROPERTIES

A. General

1. Take precautions to protect all adjoining private and public property and facilities, including underground and overhead utilities, curbs, sidewalks, driveways, structures, and fences. Restore or replace all disturbed or damaged facilities to its original condition at Contractor's expense.

2. Contact utility owners using the Montana One Call System for utility locates before starting work. Protect the utilities exposed during the work and prevent damaging underground utilities adjacent to excavations. Immediately notify the utility owner of any construction damage. Repairs of damage to marked utilities are at the expense of the Contractor.

3. Re-locate existing water mains, sanitary sewers and storm drains shown on the plans, that conflict with new pipelines or structures as indicated in the contract documents. No separate payment will be made for this work unless shown as a payment item. If the Owner authorizes the relocation of mains or sewers which are not indicated in the bid documents, and the Engineer determines the work was not included in the original contract, payment will be made under the applicable sections of the General Conditions.

4. Cut and replace existing service lines interfering with trenching operations only with the engineer's permission and at the contractor's expense. Show all repaired and/or adjusted water and sewer lines on the As-Built Plans.

5. Protect existing water and sewer mains and water and sewer services from freezing at all times during construction.

B. Privately Owned Utilities

1. If any existing private utility interferes with the work in either alignment or grade, and has to be moved, the work will be performed by the appropriate UTILITY Owner, unless otherwise specified in the contract documents. Such private utilities may include gas mains, underground electrical and telephone cables, telephone poles, light poles, etc.

2. If, however, such private utility relocation is performed by the Contractor, and the relocation is not a separate payment item, payment will be made under the contract provisions covering such conditions covering such changes.

3. Such payment will be made only if the work is determined by the Engineer to be a change from the original contract work scope.

C. Existing Structures

1. Prevent damage to existing buildings or structures in the work area. Repair all construction related damage to the satisfaction of the Owner.

D. Existing Overhead Utilities

1. Use extreme caution to avoid conflict, contact or damage to overhead utilities during the work. Any damage to these lines is the responsibility of the contractor.

E. Exploratory Excavation

1. The location of existing buried public utilities may need to be verified by exploratory excavation before construction.

2. Where authorized by the Engineer, the Contractor will be reimbursed for exploratory excavation work at the unit price bid per hour for a backhoe/excavator with operator and a laborer to assist. Use a backhoe/excavator having at least 60 horsepower (45kw), as rated by the manufacturer.

3. The unit price per hour includes the backhoe/excavator, operator and one laborer based upon the actual time, to the nearest one-half hour, that the equipment and personnel are used in actual excavating and backfilling operations including standby time between excavation and backfilling which allows the Engineer to make the necessary survey of the underground utilities.

4. Exercise care to prevent damaging all utilities and repair any utility damage caused by exploratory excavation.

F. Pavement Removal and Stripping

1. Where trench excavation or appurtenant structure excavation requires removing curb and gutter, concrete sidewalks, asphalt concrete pavement, or Portland cement concrete pavement, cut the concrete or pavement in a straight line parallel to the excavations edge using a spade-bitted air hammer, concrete saw or other suitable equipment to produce a straight, square and clean break. Re-cut edges broken during construction, before concrete or paving

operations.

2. For trenches passing through existing pavement, cut the pavement along a neat vertical line at least 12 inches (30cm) from the trench edge. Where the neat line cut is less than 3 feet (0.9m) from the edge of the existing pavement, remove and replace the entire pavement section between trench and edge of pavement.

3. Dispose of the asphalt concrete and/or Portland cement concrete debris off-site according to applicable state and local regulations.

G. When excavating across existing gravel streets or other developed surfaces, remove the surfacing material full depth and stockpile for inclusion as trench backfill or legally dispose of the surfacing material.

H. When excavating across cultivated or sodded areas, remove topsoil full depth or to a maximum 12 inch (30cm) depth, whichever is less, and stockpile for possible project use.

I. Re-sod or reseed, as specified in the contract documents, all established lawn areas cut by trenching or damaged during the construction, in accordance with Section 2910, and/or 2920, to the satisfaction of the Engineer.

3.2 MAINTENANCE OF FLOWS

A. Maintain the flow of sewers, drains and water courses encountered during construction. Restore culverts, ditches, fences, crosswalks and structures disturbed by construction to their original condition upon completion of the work.

3.3 TRENCH EXCAVATION

A. General

1. Meet current OSHA Safety and Health Standards for all excavation, trenching, shoring, and related work.

2. Excavate at the specified locations for pipeline installations and appurtenant structures.

3. Crossings under sidewalks or curbs may be made by tunneling, if approved by the Engineer. If a portion of a sidewalk or curb is removed, use a concrete saw to make joints, compact the backfill as specified, and replace the removed section with new concrete sidewalk or curb.

4. During excavation, stockpile backfill materials away from the trench banks to assure trench wall stability. Stockpile excavated materials on only one side of the trench without obstructing existing fire hydrants,

valves, manholes and other appurtenances. Assure surface drainage of adjoining areas is unobstructed.

5. Remove and dispose of all excess or unsuitable excavated materials.

6. Prevent surface water from flowing into excavations. Promptly remove all water accumulating in trench excavations. Do not permit water to accumulate in any open trench. Remove and re-lay all pipe out of alignment or grade caused by trench flooding.

7. Grade the trench bottoms to the specified lines and grades. Assure bedding material provides uniform bearing and support for each pipe section along its entire length. Excavate for bell and joints after the trench bedding is graded, limiting the excavation to the required length, depth and width for making the particular type of joint used. Backfill over-excavations with Type 2 Bedding Material.

8. No differentiation between common and rock trench excavation is made, except when listed as separate bid items on the bid proposal or bid form. Excavation includes removing and subsequent handling of all earth, gravel, bedrock or other material encountered regardless of the type, character, composition or condition of the material.

9. The use of trench digging machinery is permitted, except in places where its operation is likely to cause damage to existing structures or features, in which case hand methods are to be employed.

B. Trench Dimensions

1. Excavate to the trench dimensions specified below.

2. Width

   a. Excavate to provide room to install and join the pipe as specified. The minimum trench width is to be coordinated for concrete work to be performed and is the responsibility of the contractor. Maximum trench width may be specified in the contract documents.

3. Depth

   a. Excavate the trench as required for the invert grade of the footing elements. If bedrock, boulders or large stones are encountered at the bottom of the trench, verify with engineer if additional bedding is needed.

C. Soft or Unsuitable Trench Subgrade

1. When soft or unstable material is encountered at the trench subgrade which will not uniformly support the foundation element, excavate the material to the depth directed by the Engineer and backfill to trench subgrade elevation with material as directed by the engineer and plans.

D. Blasting

1. Obtain Engineer approval to blast for excavation. If approved, the Engineer will establish the time limits blasting will be permitted.

2. Use utmost care to protect life and property during blasting. Use only a licensed blaster with experience in the type of blasting required for the work.

3. Safely and securely store all blasting materials meeting local laws and ordinances and clearly mark all storage places "Dangerous Explosives". Do not leave any explosives where they could endanger persons or property.

4. Blasting Rock in Trenches

   a. When blasting rock in trenches, cover the blasting area with earth backfill or approved blasting mats. Before blasting, station workers and provide danger signals to warn people and stop vehicles.

   b. Assume responsibility for all damage to property and injury to persons resulting from blasting or accidental explosions during the work.

   c. Furnish the following information to the Owner and Engineer at least 48 hours before the commencement of blasting operations: Name of the contractor's powder man, powder man's experience, type of shot, type of explosives and detonator being used, proof of insurance covering liability for such operation, traffic control plans and planned procedures for protecting the public.

5. Assure blasting plan meets federal, state and local ordinances. Obtain all required permits before blasting starts.

E. Pavement Damage Cause by Equipment

1. Equip all track mounted equipment operated on pavement surfacing with pads to prevent pavement damage.

2. Restore all pavement damaged by construction to its original condition.

F. Shoring, Bracing and Sheeting

1. Provide all shoring, bracing and tight sheeting required to prevent caving and protect workers, meeting current Occupational Safety and Health Act Requirements, and to protect adjacent property and structures. The cost of this work is included in the cost for trench excavation.

G. Excavation for Appurtenances and Foundations

1. Make excavations for manholes, hydrants, structures and other appurtenances of the size and depth to permit compacting of backfill on all sides to the specified density. The requirements for removing water and other applicable portions of these specifications apply to excavation for appurtenances.

3.4 DEWATERING

A. Remove all ground water encountered in trench excavations. Do not place pipe, bedding or backfill materials below the groundwater elevation established by dewatering operations. The cost of dewatering operations is considered a part of the excavation cost.

3.5 EXCAVATION STABILITY AND SAFETY

A. The stability of construction excavations and associated worker safety, including slope geometry and shoring/bracing considerations, are the responsibility of the Contractor. Meet current OSHA regulations. This may require design of temporary slopes and/or shoring by a licensed professional engineer.

3.6 TRENCH FILLING AND BACKFILLING

A. General

1. Backfill all trenches as specified immediately after grade, alignment and pipe jointing has been inspected and approved by the Engineer. Conduct any pipe testing as specified in the respective water distribution, sewerage/drainage sections. Correct all defects discovered by tests prior to backfilling.

B. Pipe Bedding Placement

1. Type 1 Bedding.

a. Place Type 1 Pipe Bedding material 4 inches (10cm) under the pipe, around the pipe, and up to the springline of the pipe. Place in maximum lifts of 6 inches (15cm), using hand operated or other compaction methods without damaging or disturbing the pipe. Thoroughly compact each layer. Use special care to assure compaction under the pipe haunches.

b. Place backfill material in equal lifts on both sides of the pipe for the full trench width. Take care to prevent migration of Type 1 Bedding into surrounding soils during placement and compaction

2. Select Type 1 Bedding.

a. Place Select Type 1 Bedding material from the springline to 6 inches (15cm) over the pipe. Where wet or unstable material exists, assure the material is free draining and non-plastic.

b. Place in maximum lifts of 6 inches (15cm) using hand or other compaction methods without damaging or disturbing the pipe. Thoroughly compact each layer.

c. Place backfill in equal lifts on both sides of the pipe for the full trench width. Take care to prevent migration of Select Type 1 Bedding into surrounding soils during placement and compaction.

3. Type 2 Pipe Bedding.

a. Use Type 2 Pipe Bedding described in PRODUCTS SECTION as specified or as directed by the Engineer to replace unsuitable material encountered in the trench bottom, placing it from the bottom of the Type 1 Bedding material to the depth required to adequately support the pipe.

4. SEPARATION GEOTEXTILE

a. Place Separation Geotextile where shown on the plans or where directed by the Engineer.

C. Trench Backfill

1. After the pipe bedding materials are placed and compacted as specified, backfill the trench. Use backfill material free of cinders, ash, refuse,

organic or frozen material, boulders, or other deleterious materials. From the top of the Select Type 1 Pipe Bedding to 6 inches (15cm) below the ground surface, or to the subgrade elevation, material containing rock up to 8 inches (20cm) in the greatest dimension may be used.

2. Trench backfill from the top of the pipe bedding to ground surface or to the street subgrade is separated into three classifications.

   a. Type A Trench Backfill is compacted backfill typically used in streets or paved areas.

   b. Type B Trench Backfill is typically used for unpaved alleys, cultivated areas, borrow pits, unimproved streets or other un-surfaced areas, and other areas where compaction is less critical.

   c. Type C Trench Backfill is typically used in open and unimproved areas outside of the public right-of-way.

3. Meet the backfill and compaction requirements for all of the backfill types described in the contract documents.

4. Watering

   a. Apply uncontaminated water, when required, at the locations and in the amounts required to compact the backfill material to the specified requirements. Maintain an adequate water supply during the work. Assure the equipment used for watering is of the capacity and design to provide uniform water application.

   b. Apply water during the work to control dust and to maintain all embankment and base courses in a damp condition in accordance with these contract documents.

   c. Water required for compacting trench backfill may be obtained from the municipal system if approved by the Owner, or from other sources.

5. Remove, replace, and re-compact backfill in trenches where settlement has occurred as directed by the Engineer at the contractor's expense.

6. Trench backfill types are designated as follows:

   a. Type A Trench Backfill. Place trench backfill in maximum 8 inch compacted lifts within 3 percent of optimum moisture content, and compact to at least 95 percent of maximum dry density determined by AASHTO T99 or by ASTM D698.

b. Type B Trench Backfill. Place backfill in maximum 8 inch (205mm) lifts, within 3 percent of optimum moisture content, and compact to at least 90 percent of maximum dry density, as determined by AASHTO T99 or by ASTM D698.

c. Type C Trench Backfill. Place and compact Type C Trench Backfill in maximum 12 inch lifts at densities equal to or greater than the densities of adjoining undisturbed soil. Mound earth over the trench top, if so directed by the Engineer.

d. Flowable Fill. Place flowable fill as trench backfill as shown in the contract documents or as directed by the Engineer. Flowable fill may also be used as a construction expedient, substituting for any type of trench backfill, subject to approval by the Engineer and at the expense of the Contractor.

D. Replacement of Unsuitable Backfill Material

1. Remove and dispose of excavated soils that are saturated, contain deleterious materials or have characteristics that, in the opinion of the Engineer, render the soils unsuitable as backfill.

2. Replace unsuitable soils with material obtained from trench excavations within the project limits at the expense of the Contractor. If suitable replacement material is not available within project limits, obtain material from an approved borrow source, to be paid for as Imported Backfill Material.

3. Place and compact all imported material according to the applicable backfill specification requirements.

E. Backfill of Appurtances

1. Place and compact backfill for appurtenances to finished grade around manholes, inlets, valve boxes and other underground items without disturbing appurtenance alignments.

2. Meet the backfill material, placement, and compaction requirements specified for the adjoining trench.

F. Detectable Buried Warning Tape

1. The use of warning tape is optional and if used must not be relied on as the primary locating device. Provide warning tape as described in PRODUCTS Section 2.3. Bury tape a maximum 18 inches (45cm) below finish surface grade.

3.7 SURVEY MARKERS AND MONUMENTS

A. Protect all survey markers and monuments. Protection includes marking with flagged high lath and supervising work near markers and monuments. Do not disturb monuments without prior approval from the Engineer.

B. Replace all Contractor disturbed or destroyed survey markers or monuments, not approved during construction, using a licensed land surveyor. See Section 01050 for details on survey marker protection/disturbance.

3.8 CLEANUP

A. As work progresses, remove debris and complete to finish grade each portion of the work. Once the work is complete, clear debris and finish the entire site to smooth, uniform slopes presenting a neat and workmanlike appearance. Remove and dispose of all rocks brought to the surface during excavation or backfilling.

3.9 TIME AND DISTANCE OF OPEN TRENCHES

A. Perform the work so that trenches will remain open the minimum time required to accomplish the work.

B. Do not begin trench excavating until appropriate compaction equipment is at the excavation site.

C. The maximum permissible distance between backfilling/ compaction operations and the end of newly installed pipe is 200 feet (60m) in existing streets (and/or alleys) and 500 feet (150m) in all other areas.

D. The maximum distance between the newly installed pipe and the excavator is to be 100 feet (30m) in existing streets (and/or alleys) and 200 feet (60m) in all other areas.

E. For each work group consisting of a trench excavator, a pipe laying crew, and a backfilling/compacting crew, the maximum allowable open ditch at any time is 300 feet (90m) in existing streets (and/or alleys) and 700 feet (210m) in all other areas.

F. The maximum distance behind the end of the new pipe is 1,500 feet (460m) for gravel surfacing replacement, base placement or pavement replacement.

PART 4: MEASUREMENT AND PAYMENT

4. 1 GENERAL

A. The following items constitute pay items for the work covered under this section. Payment for these items is full compensation for providing all materials, tools, labor and equipment necessary to complete the item and all incidental work related thereto, whether specifically mentioned herein or not.

4. 2 TRENCH EXCAVATION AND BACKFILL

A. No separate measurement and payment is made for TRENCH EXCAVATION AND BACKFILL. Include all costs for this item in the unit price bid.

B. The upper limit of the TRENCH EXCAVATION AND BACKFILL item is defined as the top of subgrade. Details of the various types of surface restoration are found in the contract documents.

4. 3 TYPE 1 AND SELECT TYPE 1 PIPE BEDDING

A. Include approved material for Type 1 and Select Type 1 Pipe Bedding in the pipe installation price. No measurement or additional payment is made for furnishing or placing Type 1 and Select Type 1 Pipe Bedding materials.

4. 4 TYPE 2 PIPE BEDDING

A. Approved material for Type 2 Pipe Bedding to replace soft or unsuitable material, is measured in cubic yards (cubic meters) of material furnished, in-place, for the depth directed.

B. Payment for Type 2 Pipe Bedding is made at the contract unit price bid per cubic yard (cubic meter), which includes furnishing, placing and compacting the Type 2 Bedding material as specified and all other work necessary or incidental for completion of the item.

C. Payment quantity is based upon an excavation width of 2.0 feet (0.6m) plus the outside pipe diameter with a minimum payment width of 3.5 feet (1.1m).

D. If Type 2 Bedding is placed without the engineer's authorization, the Type 2 Bedding is a construction expedient solely for the contractor's convenience and no payment for Type 2 Bedding is made.

E. Payment will be made under: Type 2 Pipe Bedding - Per Cubic Yard (Cubic Meter).

4. 5 IMPORTED BACKFILL MATERIAL

A. When satisfactory backfill material is not available within the project limits, backfill material imported from borrow sources outside the limits of the project site are measured in cubic yards of material furnished, in place (compacted), for the depth directed by the Engineer.

B. No separate measurement and payment is made for this item all costs for this item are to be included in the unit price bid.

4. 6 EXPLORATORY EXCAVATION

A. Measurement of this item is made for the actual time, to the nearest one-half hour, for which the equipment and personnel are used and authorized by the Engineer for actual exploratory excavation and backfilling operations, including standby time between excavation and backfilling, to allow the Engineer to survey the underground utility.

B. Payment is made at the contract unit price bid per hour, which includes providing the equipment on-site, with operator and fuel. Where exploratory excavation is outside of planned excavation limits, payment also includes any time required for compaction of the backfill, if necessary.

C. Surfacing repair will be paid separately, if required.

D. Payment will be made under: Exploratory Excavation - Per Hour.

4. 7 GEOTEXTILE FABRIC

A. Measurement and payment for geotextile fabric shall be by the linear foot of trench if required and approved by engineer.

B. Payment for this item is full compensation for providing all materials, tools, labor and equipment necessary to complete the item and all incidental work related thereto, whether specifically mentioned herein or not.

END OF SECTION

Sections - 2600
Water Distributions

WATER DISTRIBUTION

SECTION 02660 Water Distribution

SECTION 02660

WATER DISTRIBUTION

PART 1: GENERAL

1.1 DESCRIPTION

A. Furnish all water main pipe and fittings meeting the Contract documents or specified as follows.

B. Furnish and install valves and fire hydrants for water mains, together with related appurtenances.

C. Construct water services, including water service piping, tapping mains, corporation stops, curb stops and related items.

1.2 CERTIFICATION BY MANUFACTURER:

A. Furnish a manufacturer's certification covering all pipe and fittings furnished, certifying that the pipe and fittings meet applicable specifications.

1.3 REFERENCES

ANSI B16.1	Tapping Sleeves
ASTM B88-62	Copper Pipe
ASTM PE3406-3408	Polyethylene Pressure Pipe
AWWA B300	Hypochlorite for Disinfecting
AWWA B301	Liquid Chlorine for Disinfecting
AWWA C104	Ductile Iron Cement-Mortar Lining
AWWA C110	Ductile Iron Fittings
AWWA C111	Ductile Iron Joints
AWWA C151	Ductile Iron Pipe
AWWA C153	Ductile Iron Compact Fittings
AWWA C301	Concrete Cylinder Pipe
AWWA C500	Gate Valves
AWWA C502	Fire Hydrants
AWWA C504	Butterfly Valves
AWWA C509	Gate Valves
AWWA C651	Disinfecting Water Mains
AWWA C900	PVC Water Main Pipe

1.4 STANDARD DRAWINGS:

A. Standard Drawings in Appendix A applicable to this section are as follows:

Standard Drawing No. 02660-1	Thrust Blocking for Water Main Fittings
Standard Drawing No. 02660-2	Water and Sewer Main Separation
Standard Drawing No. 02660-3	Thrust Blocking for Water Main Valves
Standard Drawing No. 02660-4	Fire Hydrant Setting
Standard Drawing No. 02660-5	Hydrant Location Detail
Standard Drawing No. 02660-6	Water Service Line
Standard Drawing No. 02660-7	Blowoff Valve

PART 2: PRODUCTS

2.1 GENERAL

A. Furnish Water Main pipe and fittings as specified in the Contract Documents and meeting the material and testing requirements of this Section. Furnish fittings and service line piping of the same material and design as the water main pipe unless specified otherwise. Pipe strength classifications are shown on plan drawings and/or are listed in the Contract Documents.

B. References made to ASTM, ANSI, AWWA, USASI or AASHTO designations are the latest revision at the time of call for bids.

2.2 PIPE MATERIALS

A. General

1. Furnish the pipe specified in the contract documents meeting the materials and testing requirements as outlined in this section.

2. Assure all pipe is clearly marked showing type, class and/or thickness. Lettering must be legible and permanent under normal handling and storage conditions.

B. Ductile Iron Pipe

1. Furnish Class 51 wall thickness meeting AWWA C151, American National Standard for Ductile Iron Pipe.

2. Use underground pipe and fittings having mechanical or push-on joints meeting AWWA C 111.

3. Assure the pipe interior is cement mortar lined meeting AWWA C104 requirements. Assure the outside pipe surface for underground service is bituminous coal tar base coated 1 mil thick.

4. Fittings

   a. Furnish fittings meeting one of the following;

      1) Class 250 fittings meeting AWWA C110, latest edition, Gray-Iron and Ductile Iron Fittings For Water And Other Liquids

      2) Compact fittings meeting AWWA C153.

5. Joints

   a. Assure joints are mechanical or push-on joints meeting AWWA C111. Assure the fitting interior is cement mortar lined meeting AWWA C104. Assure the fitting exterior is bituminous tar coated 1 mil thick. Use compact fittings having a rated working pressure of 350 psi (2410 kPa) following manufacturer recommended laying lengths.

6. Couplings

   a. Use pipe couplings meeting one of the following:

      1) Cast type with cast iron or ductile iron sleeves and malleable or ductile iron flanges.

      2) Gray iron or ductile iron, mechanical joint solid sleeves, with a minimum 12 inch length (30 cm).

      3) Limit use of the first type to a maximum 16 inch (40 cm) diameter. Use the manufacturers' standard gasket for use in potable water systems. Use stainless steel bolts and nuts. Coating to be "manufacturers' standard".

C. Polyvinyl Chloride (PVC) Pressure Pipe

1. Furnish PVC water main pipe meeting AWWA C900 requirements, made to ductile iron O.D.'s for "Push-On" joints. Assure pipe joints are bell and spigot having an elastomeric gasket. Use DR 25 Class 165 pipe.

D. Concrete Cylinder Pipe

1. Furnish prestressed, reinforced concrete water pipe, steel cylinder type meeting AWWA C301 and having rubber gasketed bell and spigot joints. Furnish the pipe class, marking, lengths, etc. specified in the Contract Documents.

E. Water Service Pipe

1. Use copper or polyethylene pipe in water service line construction as specified in the contract documents and meeting the following specifications.

a. Furnish service pipe of the size or sizes specified. Service lines are considered 2-inch (51mm) size and under. Service lines over 2-inch (51 mm) size are considered as water mains and are specified under the applicable sections.

b. Furnish and install the service pipe from the main to the property line installing a curb stop and curb box at the property line. Meet the water service installation requirements of Standard Drawing 02660-6.

c. Copper Service Pipe

1) Use copper, type K, meeting Federal Specification WW-T-799 or ASTM B88-62.

d. Polyethylene Service Pipe

1) Use pipe meeting AWWA SpecificationC901, "Polyethylene (PE) Pressure Pipe, Tubing and Fittings, 1/2 inch through 3 inch for Water" and ASTM PE3406-3408. PE pipe to be pressure tubing meeting Table 6 requirements of said specification. Use class 200 with a DR of 7 Polyethylene pipe.

2.3 TAPPING SLEEVES AND VALVES:

A. Use tapping sleeves meeting either:

1. Gray iron or ductile iron, split-sleeve, mechanical joint type with end and side gaskets,

2. Split-body type with circular gasket forming a seal around the circumference of the outlet.

3. Assure both types have a class 125, ANSI B16.1 outlet flange, are rated for a minimum 150 psi (1030 kPa) working pressure and contain a threaded test plug on the neck or body of the tapping sleeve. Assure gaskets are manufacturers' standard for use in potable water systems. Use stainless steel bolts and nuts. Assure mechanical joint type is fusion-bonded, 12-mil thickness, and epoxy coated. Limit the use of mechanical joint type to metal pipe. Assure tapping valves meet the applicable requirements for gate valves, as outlined in this section, with flanged inlets compatible with the flange of the tapping sleeve and mechanical joint outlet.

2.4 CORPORATION STOPS

A. Furnish brass corporation stops with inlet end to meet tapping requirements and flared outlet for copper tubing or pressure coupling for polyethylene tubing.

2.5 SERVICE CLAMPS

A. Furnish flat, double strap, bronze metal service clamps with Neoprene gaskets and corporation stop threads. Assure service clamps for PVC provide full support around the pipe circumference with a bearing area of the width along the axis of the pipe so the pipe is not distorted when the clamp is tightened.

2.6 CURB STOPS

A. Furnish curb stops with bronze plug, tee head key with Minneapolis pattern and screw box mount.

2.7 CURB BOXES

A. Furnish extension type curb boxes having a 6- 1/2 foot (2 meters) extended length.

2.8 VALVES

A. Gate Valves

1. Furnish iron body gate valves, resilient seat or double disc gate valves with non-rising stems with design, construction and pressure rating meeting AWWA C500 or AWWA C509 requirements and the following.

2. Assure stem seals are double "O" ring seals capable of replacing the seal above the stem collar with the valve under pressure in full open position.

3. Furnish gate valves for underground installation equipped with a 2-inch (31 mm) square operating nut for key operation. All valves to open counterclockwise. Valves to be equipped with push-on joints or mechanical joints for pipe connections.

B. Butterfly Valves

1. Furnish Class 150, rubber seated, butterfly valves for water distribution systems meeting AWWA C504 requirements. Valves to be equipped with mechanical joint ends and lubricated screw type operators designed for underground service.

2. Rubber valve seats to be replaceable without disassembling the valve and not interrupted by the shafting. Rubber seats may be retained on the disc edge by stainless steel clamping instead of bonding to the valve body. Assure shaft packing is the self-adjusting, permanent type.

3. Assure underground service operators are permanently lubricated, screw type, totally enclosed and watertight constructed. Assure overload protection is incorporated in the operator allowing 450 foot-pounds (610 j) input torque at full-open and full-closed positions without damaging the operator or valve. Provide a 2-inch (51mm) square operating nut and valve box for operating the valve. Valves to open counter clockwise. Furnish performance certification, leakage and hydrostatic tests as specified in AWWA C504. Assure valve manufacturer has at least five years experience manufacturing waterworks and distribution valves.

2.9 VALVE BOXES

A. Furnish cast iron valve boxes, 5-1/4-inch (13 cm) diameter, adjustable valve boxes with the required base for the valve size used. Assure valve boxes are screw type and of the specified length for the pipe bury. Assure the valve box cast iron cover has an arrow indicating the opening direction and stamped with the word "Water".

2.10 FIRE HYDRANTS

A. Furnish fire hydrants meeting AWWA C502; "Standard Specifications for Fire Hydrants for Ordinary Water Works Service", and the Contract requirements.

B. Furnish hydrants with 5-1/4-inch (13 cm) valve openings, 6-inch (15 cm) mechanical joint, flanged or push-on inlet, one pumper connection and two, 2-1/2-

inch (63 cm) hose connections. Assure hose nozzle threads meet ASA Specification B26 for National Standard Fire Hose Coupling Screw Threads, 7 1/2 threads per inch. Assure pumper nozzle size and threads match owners existing pattern. Furnish National Standard operating nut. Furnish hydrants opening counter clockwise and having an arrow on the hydrant top designating the opening direction.

C. Furnish "Compression" type hydrants with safety flange and safety stem coupling above the ground line permitting repair without shutting off the water. Assure hydrants are of the dry top design with two or more "O" rings sealing the water from the operating mechanism. Assure the operating mechanism is automatically lubricated from a sealed, self-contained lubricating reservoir.

D. Paint the hydrant portion above the ground line meeting the owner's standards. Furnish hydrants for 6.5 foot (2 meters) bury.

2.11 SPECIAL FITTINGS

A. Furnish special fittings meeting the Contract Documents. The Engineer will specify gasket materials for contaminated soil or special groundwater situations.

2.12 POLYETHYLENE ENCASEMENT

A. Furnish polyethylene encasement in accordance with AWWA C105, "Polyethylene Encasement for Fray and Ductile Cast – Iron Pipe for Water and other Liquids".

PART 3: EXECUTION

3.1 TRENCH EXCAVATION AND BACKFILL FOR WATER MAINS

A. This work includes all excavation, backfilling, disposal of surplus and unsuitable material, and all other work incidental to trench construction, including excavation for valves, fittings, hydrants, thrust blocks or other pipeline structures and not classified as "Structural Excavation."

B. Perform this work in accordance with Section 02221: TRENCH EXCAVATION AND BACKFILL FOR PIPELINES & APPURTENANT STRUCTURES.

3.2 PIPE INSTALLATION FOR WATER MAINS

A. General

1. Install pipe following the manufacturer's specifications and instructions. Provide all tools and equipment required to install each type of pipe used.

2. The Contractor is responsible for all contractor furnished material. Replace all defective material or material damaged by handling after delivery by the manufacturer. This includes the furnishing of all materials and labor required to replace installed material discovered damaged or defective before final acceptance of the work, or during the guarantee period.

3. Store all material safely and to prevent damage. Keep pipe interior and other accessories free from dirt and foreign matter at all times.

4. Deliver and distribute all Contractor furnished pipe at the site. Load and unload pipe, fittings, specials, valves and accessories to prevent damage. Do not permit pipe handled on skidways to skid or roll against pipe already on the ground.

5. When distributing material at the work site, lay each piece adjacent to its installation point. Repair or replace all damaged pipe at Contractor's expense on the jobsite.

B. Dewatering of Trench

1. Remove all water in the trench during pipe laying and maintain a dry trench until the pipe ends are sealed. Do not permit the pipe to float. Do not allow any trench water to enter the pipe at any time.

C. Laying of Pipe

1. Inspect the pipe and pipe coating for damage or defects before installation. Lay pipe without damaging the pipe coating. Repair all pipe coating damage following the manufacturer's instructions before laying the pipe. When using belt slings to lower the pipe into the trench, remove the slings without damaging the pipe coating.

2. Lay pipe to the specified lines and grades with fittings and valves at the required locations. Plumb all valve stems.

3. Grade and alignment on un-graded streets will be provided using hubs set parallel to the pipe line, and on graded streets from established points on

the existing curbs or sidewalks, when directed by the Engineer. Excavate pipe trenches to the lines and grades given or to the standard cover depth specified. Transfer lines and grades to the pipe from hubs or from existing concrete curbs or sidewalks as an incidental part of this work.

4. Use implements, tools and facilities satisfactory to the Engineer for the safe and convenient prosecution of the work. Carefully lower all pipe, fittings and valves into the trench using a derrick, rope or other tools or equipment, without damaging pipe materials and protective coatings and linings. Do not drop or dump materials into the trench.

5. Take every precaution to prevent foreign material from entering the pipe as it is placed in the line. During laying operations, do not permit debris, tools, clothing or other materials to be placed in the pipe. At times when pipe laying is not in progress, close the open ends of the pipe using a watertight plug or other approved methods to prevent material entering the pipe.

6. Place pipe bedding in the bottom of the trench meeting Section 02221; TRENCH EXCAVATION AND BACKFILL FOR PIPELINES & APPURTENANT STRUCTURES. Voids may be left in the bedding material to remove pipe slings and for pipe bells to allow support along the full length of the pipe barrel.

7. Long radius curves, either horizontal or vertical, may be laid with standard pipe with deflections at the joints where approved. If the pipe is shown curved on the plans and no special fittings are shown, assume that the curves can be made by deflection of the joints with standard lengths of pipe. If shorter lengths are required, the plan will indicate maximum lengths that can be used.

8. The Engineer will determine the method of deflection or curving where required but not specified. No additional payment will be made for laying pipe on planned curves, nor for field changes involving standard pipe lengths deflected at the joints.

9. Do not exceed the applicable material and joint specifications of AWWA or the pipe manufacturer's recommendations at pipe joints for various types of pipe. When rubber gasketed pipe is laid on a curve, joint the pipe in a straight alignment and then deflect to the curved alignment. Excavate trenches to accommodate deflections and curves.

10. Construct reaction or thrust blocks at all tees, plugs, valves, reducers, caps and at bends deflecting 22-1/2 degrees or more. Construct thrust blocks at tapping sleeves where the outlet diameter exceeds one-half the diameter of

the main being tapped. Limit using metal rods or straps for thrust restraint to those specified on the plans, or where the use of concrete thrust blocks would be impractical. Do not use metal rods or straps without the Engineer's approval. Construct reaction blocks from concrete having a minimum compressive strength of 2,000 pounds per square inch (14,000 kPa) at 28 days. Place blocking between undisturbed ground and the fitting to be anchored, as shown on Standard Drawing 02660-1. Place the blocking so that the pipe and fitting joints are accessible for repair.

11. Cut pipe for inserting valves, fittings or closure pieces in a neat and workmanlike manner without damaging the pipe or coating and leaving a smooth end at right angles to the pipe axis. Do not cut pipe using an oxyacetylene torch.

D. Pipe Jointing

1. Rubber Gasket, "Push-On" Joints

a. Follow the manufacturer's recommendations for jointing of pipe and fittings with a rubber gasket, "push-on" type. Wipe the rubber gasket and gasket seat inside the bell clean with a cloth. Wipe the plain end of the adjoining pipe clean, lubricate and insert into the bell to make contact with the gasket. Force the plain end "home" using a crow bar, fork tool, or jack assembly.

2. Mechanical Joints

a. Thoroughly brush the bell and the outside of the spigot of the mechanical joint fitting with a wire brush to remove all loose rust or other foreign material just before assembly. Brush the cleaned surfaces with soapy water just before slipping the gasket over the spigot end and into the bell.

b. Center the spigot end of the pipe or fitting in the bell before jointing is begun. Once the gasket is in place, bring the gland up toward the pipe flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. Partially tighten the bolts, alternately around the socket, maintaining approximately equal tension until the final tension is reached.

c. Use the following bolt torque range for the joints:

Bolt Size Inch	(millimeters)	Range of Torque Ft.-Lb.	(joules)
5/8	(16)	40 - 60	(54-81)
3/4	(19)	60 – 90	(81-122)
1	(25)	70 – 100	(95-135)
1-1/4	(32)	90 – 120	(122-163)

d. Apply the torque loads with torque measuring or indicating wrenches, or apply using regular socket wrenches, checked with torque wrenches.

e. If the joint is not sealed using the maximum torque indicated above, disassemble and re assemble the joint after thorough cleaning. Do not overstress bolts to provide the seal.

3. Connections to Existing Mains

a. Make all connections to existing water mains in use unless otherwise specified. Furnish the special fittings, as shown on the plans, and all other material required. Make all necessary excavations to assure gradual transition between the new and existing water main, and perform all necessary backfilling.

b. Where the connection of new work to old requires a service interruption and customer notification, the Engineer and the Contractor are to mutually agree upon a date for connections to permit adequate time to assemble labor and materials, and to notify all affected customers. All notifications are the Contractor's responsibility.

3.3 POLYETHYLENE ENCASEMENT

A. Wrap all direct bury cast iron or ductile iron pipe and fittings including hydrants, valve boxes, curb boxes, and all other metal parts and surfaces, in polyethylene encasement.

3.4 TESTING, CLEANING & DISINFECTING WATER MAINS, VALVES & FITTINGS:

A. Hydrostatic and Leakage Testing

1. Perform hydrostatic and leakage testing in accordance with AWWA C600. Once the pipe is laid and backfilled, test for at least 2 hours, all newly laid pipe, or any valved section, to a hydrostatic pressure of at least 1.5 times

the normal operating pressure at the test point or 1.25 times the normal operating pressure at the highest point along the test section.

2. Slowly fill the pipe with water, purging all air, and apply the test pressure using a pump hooked up so that the pressure and leakage can be measured. To purge the pipe of air during the test, it is necessary to tap the pipe at its highest points if permanent air vents, water services, hydrants, etc. are not located at the high points. Use corporation stops for this purpose. Furnish the pump connections, gauges, stops, and all necessary apparatus for testing.

3. Disassemble and reassemble all joints showing leakage after thorough cleaning. Remove and replace all cracked or defective pipes or fittings discovered in during the pressure test with sound material and repeat the test.

4. Conduct the leakage test concurrently with the pressure test for 2 hours. Leakage is defined as the quantity of water supplied into the pipe, or any valved section thereof, necessary to maintain pressure within 5 PSI of the pressure test after the pipe has been filled with water and purged of air.

5. The pipe installation will be rejected if the leakage exceeds that determined by the following formula:

$$L = \frac{SD(P)^{1/2}}{148{,}000}$$

6. In which L equals the allowable leakage in gallons per hour; S is the length of pipe tested, in feet; D is the nominal diameter of the pipe, in inches; and P is the average test pressure during the leakage test, in pounds per square inch gauge.

7. Should any test of pipe laid disclose leakage exceeding that specified above, locate and repair the defective joints until the leakage is within the specified allowance.

8. Conduct the pressure and leakage tests with the Engineer present.

9. When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gallon per hour per inch of nominal valve size is allowed. Repair all visible leaks regardless of the amount of leakage.

10. Pressure test tapping sleeves after installation and before tapping.

B. Cleaning Water Mains

1. Before chlorination, except when hypochlorite tablets are used, flush the mains thoroughly after the pressure and leakage test are completed.

2. It is understood that such flushing removes only the lighter solids and cannot be relied upon to remove heavy material allowed to get into the main during laying. Use a minimum flushing velocity in the main of 2.5 feet per second (0.7 meters/second). If no hydrant is installed at the end of the main, provide a tap of the size to produce a velocity in the main of at least 2.5 feet per second (0.7 meters/second). Table 2 shows the rates of flow required to produce a velocity of 2.5 feet per second (0.7 meters/second) in various size pipes.

TABLE 1
REQUIRED FLOW AND OPENINGS TO FLUSH PIPELINES[1/]
(40 psi Residual Pressure in Water Main)

Pipe Diam. Inches	Flow Required To Produce 2.5 fps (approx.) Velocity in Main, gpm	Size of Tap (inch) 1(25)1-1/2(38)2(51) number of taps on pipe		Hydrant Outlet Number	Hydrant Outlet Size in. (mm)
2	30	1	1	1	2-1/2 (63)
3	65	1	1	1	2-1/2 (63)
4	85	1	1	1	2-1/2 (63)
6	200	2	2	1	2-1/2 (63)
8	400	2	2	2	2-1/2 (63)
10	800	2	4	2	2-1/2 (63)

1. With a 40 psi (267 kPa) pressure in the main with the hydrant flowing to atmosphere, a 2-1/2-inch (63mm) hydrant outlet will discharge approximately 1000 gpm(3786 epm) and a 4-1/2-inch (114mm) hydrant nozzle will discharge approximately 2500 gpm (9463 epm).

2. Number of taps on pipe based on discharge through 5 feet (1.5 meters)of galvanized iron (GI) pipe with one 90 • elbow.

3. Exercise extreme care and conduct a thorough inspection during the water main laying to prevent and detect small stones, pieces of concrete, particles of material, or other foreign material that may have entered the mains. To remove this material, flush and inspect all hydrants on the lines to assure that the entire valve operating mechanism of each hydrant is in good condition.

4. In 24-inch (61 cm) or larger diameter mains, in addition to flushing, broom-sweep the main, removing all sweepings before chlorinating the main.

C. Disinfecting Water Mains

1. General

a. Disinfect the water mains subject to the Engineer's approval in accordance with AWWA C651, "Disinfecting Water Mains", and these specifications, before placing the main in service. Keep the interior of all pipe, fittings and appurtenances free from dirt, heavy and foreign particles.

2. Forms of Chlorine

a. The forms of chlorine that may be used, subject to the approval of the Engineer, are:

1) Liquid chlorine containing 100 percent available chlorine under pressure in steel containers. Meet AWWA B301 requirements and use only in combination with appropriate gas-flow chlorinators and ejectors.

2) Sodium hypochlorite in liquid form containing approximately 5 to 15 percent available chlorine. Meet AWWA B300 requirements.

3) Calcium hypochlorite in granular form or in 5g tablets containing approximately 65 percent available chlorine by weight. Meet AWWA B300 requirements.

3. Methods of Chlorination

a. Three (3) methods of chlorination may be used. The tablet method gives an average chlorine dose of approximately 25 mg./L; the continuous feed method gives a 24 hour chlorine residual of not less than 10 mg./L; and the slug method provides a three hour exposure of not less than 50 mg./L free chlorine.

1) Tablet Method

a) This method may be used if the pipes and appurtenances are kept clean and dry during construction.

b) During construction, place calcium hypochlorite granules at the upstream end of the first section of pipe, at the upstream end of each branch main, and at 500-foot (150 meter) intervals. Use the quantity of granules shown in Table 2.

c) Warning: Do not use this procedure on solvent welded plastic or on screwed joint steel pipe because of fire or explosion hazard from the reaction of the joint compounds with the calcium hypochlorite.

TABLE 2
OUNCES OF CALCIUM HYPOCHLORITE GRANULES TO BE PLACED AT BEGINNING OF MAIN AND AT EACH 500-FOOT (150 METER) INTERVAL

Pipe Diameter		Calcium Hypochlorite Granules
Inches	(cm)	oz
4	(10)	0.5
6	(15)	1.0
8	(20)	2.0
12	(30)	4.0
16 and larger	(41)	8.0

d) During construction, place 5g calcium hypochlorite tablets in each section of pipe and also place one tablet in each hydrant, hydrant branch and other appurtenance. Use the number of 5g tablets for each pipe section required to provide a minimum chlorine concentration of 25 mg/L. Appendix B provides information on the number of tablets required for commonly used sizes of pipe. Attach tablets to the inside of the pipe using an adhesive such as Permatex No.1 or equal. Assure no adhesive is on the tablet except on the broad side attached to the surface of the pipe. Attach all the tablets at the inside top of the main, with approximately equal numbers of tablets at each end of a given pipe length. If the tablets are attached before the pipe section is placed in the trench, mark their position on the section so it can be readily determined that the pipe is installed with the tablets at the top.

e) When installation has been completed, fill the main with water at a velocity not exceeding 1 fps(0.3 mps). Take precautions to assure that air pockets are eliminated. Leave this water in the pipe for at least 24 hours. If the water temperature is less than 41° F (5°C), leave the water in the pipe for at least 48 hours. Position valves so that the chlorine solution in the main being treated will not flow into water mains in active service.

2) Continuous Feed Method

a) Before chlorinating, fill the main with water to eliminate air pockets and flush as specified above.

b) Use water from the existing distribution system or other approved source of supply to flow at a constant, measured rate into the newly laid water main. At a point not more than 10 feet (3 meters) downstream from the beginning of the new main, assure water entering the new main receives chlorine fed at a minimum 25 mg/L free chlorine. To assure that this concentration is provided, measure the chlorine concentration at regular intervals.

c) Appendix B provides information on the amounts of chlorine compound required for various pipe sizes.

d) During chlorine application, position valves so that the chlorine solution in the main being treated does not flow into water mains in active service. Do not stop chlorine application until the entire main is filled with chlorinated water. Retain the chlorinated water in the main for at least 24 hours, operating all valves and hydrants in the section treated to disinfect the appurtenances. At the end of the 24-hour period, the treated water in all portions of the main must have a minimum free chlorine residual of 10 mg/L free chlorine.

e) The preferred equipment for applying liquid chlorine is a solution feed vacuum operated chlorinator to mix the chlorine gas in solution water, in combination with a booster pump for

injecting the chlorine gas solution water into the main to be disinfected. It is recommended that direct feed chlorinators not be used. Hypochlorite solutions may be applied to the water main with a chemical feed pump designed for feeding chlorine solutions.

f) If approved, an optional continuous feed method utilizing calcium hypochlorite granules may be used. Place the granules in the pipe sections as specified under the Tablet Method.

3) Slug Method

a) Before chlorinating, preliminary flush the main as specified herein.

b) Use water from the existing distribution system or other approved source of supply to flow at a constant measured rate into the newly laid water main.

c) Not more than 10 feet (3 meters) downstream from the beginning of the new main, add chlorine to the water entering the new main at a constant rate that the water will have a minimum 100 mg/L free chlorine. Measure this concentration at regular intervals. Apply the chlorine continuously and for the time required to develop a solid column or "slug" of chlorinated water that will, as it moves through the main, expose all interior surfaces to a 100 mg/L for at least 3 hours.

d) Measure the free chlorine residual in the slug as it moves through the main. If at any time it drops below 50 mg/L stop the flow and relocate the chlorination equipment at the head of the slug, and as flow is resumed, add chlorine to restore the free chlorine in the slug to not less than 100 mg/L.

e) As the chlorinated water flows past fittings and valves, operate related valves and hydrants to disinfect appurtenances and pipe branches.

4. Final Flushing

a. After the retention period, flush the chlorinated water from the main until chlorine measurements show that the concentration in the water leaving the main is no higher than that in the system, or is acceptable for domestic use.

D. Bacteriological Tests

1. After final flushing and before the water main is placed in service, test a sample, or samples, collected from the main(s) for turbidity and organisms. Collect at least one sample from the new main and one from each branch.

2. Redisinfection

a. If the initial disinfection fails to produce approved bacteriological or turbidity samples, re-flush and resample the main. If check samples show bacterial contamination, re-chlorinate the main until approved results are obtained.

3. Swabbing

a. Where connections are made to existing piping and the connections are not disinfected along with the newly installed main, swab or spray the interior of all pipe and fittings used in making the connections with a 1 percent hypochlorite solution before installation.

3.5 WATER AND SEWER MAIN SEPARATION

A. Maintain horizontal and vertical separation between water mains and sewer mains in accordance with Standard Drawing No. 02660-2.

3.6 VALVES

A. Set and joint gate valves and butterfly valves to the pipe as specified for pipe laying and jointing. Set valves with operating nut vertical. Center and plumb valve boxes over the operating nut to prevent shock or stress being transmitted to the valve.

B. Valve Boxes

1. Center and plumb valve boxes over the valve operating nut. Set valve box tops flush with the ground surface or street surfacing.

2. Place bedding gravel around all water main valves and under the valve box bottom to drain any water entering the valve box.

C. Valve Thrust Blocks

1. When specified, install valves with thrust blocks and anchor rods meeting Standard Drawing 02660-3 requirements.

3.7 FIRE HYDRANTS

A. Set all hydrants plumb with the pumper nozzle facing the street. Set the hydrant with the ground line at the location indicated by the hydrant manufacturer.

B. Provide drainage at the hydrant base by placing clean gravel under and around it. Place gravel at least 1 foot (30 cm) on all sides from the base of the hydrant to at least 6 inches (15 cm) above the drain opening. Brace the hydrant against unexcavated earth at the trench end with concrete backing as detailed on the plans. Furnish hydrants with the specified gate valves. Install hydrants meeting Standard Drawing No.02660-4 or 02660-5 as specified by the Owner.

3.8 SERVICE LINE INSTALLATION

A. Provide all work and materials for the complete service line installation, including trench excavation and backfill; making the water main tap; furnishing and installing the corporation stop, curb stop and box, service clamp where necessary, and service line with fittings to make the connections to the stops. Bend the service line adjacent to the water main into a figure "S" in a horizontal or vertical plane to avoid a rigid connection. Assure all services have a minimum 6-1/2 feet (2 meters) of cover measured as specified in Standard Drawing No. 02660-6.

B. Mark the water service line end at the property line using a steel fence post, 5 feet long (1.5 meters), buried in 3 feet (1 meter) in the ground. Paint the post blue. Where applicable, mark the concrete curb to identify the service locations.

3.9 TAPPING:

A. Tap the newly installed water mains unless specified otherwise. The Owner will tap any existing water mains not installed by the Contractor. If owner tapped, be responsible for scheduling and coordinating with the Owner. The Contractor will be charged a fee for each Owner made tap.

B. Perform tapping using an approved tapping machine using clean, sharp drill taps and/or shell cutters. Do not tap directly into AWWA C900 PVC pipe. 3/4-Inch (19 mm) and 1-inch (25 mm) taps may be made directly into the barrel of ductile

iron pipe without using service saddles. Direct tap into the pipe barrel to the depth exposing a maximum three threads of the corporation stop. Use maximum direct tap sizes of 1-1/2-inch (38 mm) for 6-inch (15 cm) diameter mains and 2-inch (51 mm) for larger mains.

PART 4: MEASUREMENT AND PAYMENT

4.1 GENERAL

A. The following items are pay items for the work covered under this section. Payment for these items is full compensation for providing all materials, tools, labor and equipment necessary to complete the item and all incidental work related thereto, whether specifically mentioned herein or not.

4.2 WATER MAINS

A. Measurement of water mains is made in lineal feet (meters) along the centerline of pipe through all valves, fittings and appurtenances. Payment for water main will be made at the contract unit price bid per lineal foot (meters) of the various sizes called for, which includes furnishing and installing pipe, furnishing and placing Type 1 pipe bedding, trench excavation and backfill, cleaning, testing and disinfecting the water main and all other work necessary or incidental for completion of the item.

4.3 FITTINGS

A. Measurement of water main fittings is by numerical count of the various types and sizes listed in the Contract Documents. Payment for fittings is made at the contract unit price bid for each fitting, and includes furnishing and installing the fittings as required, thrust blocking and any other work necessary or incidental for completion of the item.

4.4 WATER SERVICE CONNECTIONS

A. This item is measured by numerical count of water services of the various sizes listed in the Contract Documents. Payment for water service connections is made at the contract unit price bid per each, which includes furnishing and installing the water service line from the main to the property line, tapping the main, furnishing and installing all fittings, corporation stops, curb stops and boxes and tapping saddles if required, trench excavation, backfill, pipe bedding, shoring, and dewatering, cleanup and all other work necessary or incidental to complete the item.

4.5 WATER SERVICE LINE

A. Payment for water service line is made at the contract unit price bid per each, which includes furnishing and installing the water service line from the main to the property line, trench excavation, backfill, pipe bedding, shoring, and dewatering, cleanup and all other work necessary or incidental to complete the item. No separate measurement and payment is made for trench excavation and backfill for water service lines. Include the cost of this work in the price bid for service lines.

4.6 VALVES

A. Measurement of water valves is made by numerical count of the sizes and types of valves listed in the Contract Documents. Payment for water valves is made at the contract unit price bid each; which includes furnishing and installing the valve
and valve box, all excavation, backfill, and special compaction required for the installation, thrust and anchor blocking (if required), and all other work necessary or incidental for completion of the item.

4.7 FIRE HYDRANTS

A. Measurement of fire hydrant assemblies is by numerical count. Payment is made at the contract unit price bid each; which includes furnishing and installing the fire hydrant and auxiliary gate valve, piping from main waterline to hydrant, all excavation, backfill, and special compaction required for the installation, thrust and anchor blocking, drain gravel, and all other work necessary or incidental for completion of the item.

END OF SECTION

Sections - 2900 Landscaping

LANDSCAPING

SECTION 02910 Seeding

SECTION 02910

SEEDING

PART 1: GENERAL

1.1 DESCRIPTION

A. This section includes ground surface preparation; furnishing and applying fertilizer; and furnishing and planting seed in areas described in the contract documents or directed by the Engineer.

B. Hydraulic seeding is not included in this section. Hydraulic seeding is covered in Section 02920, Hydraulic Seeding.

1.2 SUBMITTALS

A. Submit to the Engineer applicable seed mixture certifications, fertilizer descriptions and mulch certifications. Furnish duplicate signed copies of the vendors statement certifying that each seed lot has been tested by a recognized seed testing laboratory within 6 months of date of delivery. Assure the statement includes: Name and address of laboratory, date of test, lot number for each seed species and the test results including name, percentages of purity and of germination, percentage of weed content for each kind of seed furnished and, for seed mixes, the proportions of each kind of seed.

PART 2: PRODUCTS

2.1 SEED

A. Furnish seed and seed mixture, free of all prohibited noxious weed seed or any other weed seed prohibited by state or local ordinance. Verify all seed mixtures with owner (Montana FWP prior to use on site).

B. Seal and label all seed containers to comply with Montana Seed Law and Regulations or meeting U.S. Department of Agriculture and Regulations under the Federal Seed Act, if shipped in interstate commerce.

C. Do not use wet, moldy, or otherwise damaged seed in the work.

D. Furnish seed mixture of the species described in the contract documents. Furnish seed in standard containers labeled with the seed name, lot number, net weight,

percentages of purity, germination, hard seed, and percentage of maximum weed seed content for each seed species.

2.2 TOPSOIL

A. Use topsoil that is loose, friable, loamy soil, free of excess acid and alkali. Assure topsoil does not contain objectionable amounts of sod, hard lumps, gravel, sub-soil or other undesirable material that would form a poor seedbed. Before striping topsoil, assure it has supported the growth of healthy crops, grass or other vegetable growth.

2.3 LIME

A. Furnish ground limestone or other material deemed suitable by the Engineer containing a minimum 85 percent of total carbonate equivalent ground so that 90 percent will pass through a No. 100 mesh sieve. Coarser material may be acceptable, if the application rates are increased to provide at least the minimum quantities and depth specified using an approved Dolomitic lime or a high magnesium lime containing at least 10 percent magnesium oxide.

2.4 FERTILIZER

A. Furnish standard commercial fertilizers supplied separately or in mixtures containing the specified percentages of total nitrogen, available phosphoric acid, and water soluble potash. Apply fertilizer at the specified rate and depth meeting the applicable State and Federal laws. Furnish fertilizer in standard containers clearly labeled with name, weight, and guaranteed analysis of contents. No cyanamide compounds of hydrated lime are permitted in mixed fertilizers.

B. Fertilizers may be supplied in one of the following forms:

1. A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;

2. A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or

3. A granular or pellet form suitable for application by blower equipment.

2.5 SOILS FOR REPAIRS

A. Use soil for filling and topsoiling repair areas of equal quality to the existing topsoil being repaired. Assure the soil is free of large stones, roots, stumps, or other

materials that interfere with sowing, compacting, and establishing turf. Obtain approval from the Engineer before placing topsoil.

PART 3: EXECUTION

3.1 TOPSOIL

A. Place at least 6 inches (15 cm) of topsoil in all areas to be seeded. Import topsoil if sufficient topsoil is not available from excavated areas of the project.

3.2 ALLOWABLE SEEDING MONTHS

A. Perform seeding when the temperature and moisture are favorable to germination and plant growth. Seed preferably before June 1st and after October 1st of each year. Seeding dates must be approved by the Engineer.

3.3 SEEDBED PREPARATION AND SOWING

A. Clear the areas to be seeded of all debris, vegetation, and other material determined by the Engineer to be detrimental to the preparation of a seedbed. Once the area is cleared, disc, harrow, rake, or work the area by other suitable methods, into a smooth, even seedbed. Assure the prepared seedbed surface is firm enough to prevent seed loss from high winds or normal rainfall. If rolling is required, perform rolling before seeding using a suitable roller, of a weight appropriate to the soil conditions.

B. Sow seed in the areas described in the contract documents at the specified application rates.

C. Sow seed using a force feed drill having a grass seed attachment, except of slopes steeper than three to one or on areas too small to be seeded with a force feed drill. In these areas, seed may be sown by power sprayers, blowers or other effective methods. Use equipment in good working order.

D. Seed Native Grasses/plants per the owner at a depth of one-quarter inch or less and cultipack the seed.

E. Do not sow seed in winds that prevent proper imbedment into the surface.

3.4 FERTILIZER

A. Spread and work fertilizer into the soil during the final seedbed preparation. Apply fertilizer at the rate described in the contract documents.

3.5 CARE OF SEEDED AREAS

A. Keep the seeded area moist until it has germinated and it's continued growth is assured. Prevent erosion during watering. Water is incidental to the item "Seeding".

B. Protect all seeded areas from traffic or pedestrian use with warning barricades or other Engineer approved methods.

C. Maintain the seeded area, performing any required watering and mowing until the seed is firmly established. Prevent weeds and other undesirable vegetation from establishing in the seeded area. Mow weeds and rake and remove the clippings from the areas.

D. Replace any seeded areas failing to germinate which have died or been damaged by construction activities. Replace such areas to meet the contract requirements. The contract warranty period applies to this item.

PART 4: MEASUREMENT AND PAYMENT

4. 1 GENERAL

A. Seeding is measured by the square yard (square meter) and paid for at the unit price bid including topsoil salvage and/or importing, topsoil placement, seedbed preparation, and seeding, complete in place and accepted by the Engineer.

B. Payment indicated to include complete compensation for all labor, equipment, materials and incidentals required for the completion of the work.

END OF SECTION

Division 3
Concrete

CONCRETE

SECTION 03210

REINFORCING STEEL

PART 1: GENERAL

1.1 DESCRIPTION

A. This work is furnishing and placing reinforcing steel or wire fabric meeting the quality, type and size specified in the contract.

1.2 REFERENCES

ASTM A-615	
ASTM A-705	
AASHTO M 31	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
AASHTO M 32	Cold Drawn Steel Wire for Concrete Reinforcement
AASHTO M 55	Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
AASHTO M 54	Fabric Deformed Steel Bar or Rod Mats for Concrete Reinforcement

PART 2: PRODUCT

2.1 Furnish all new material meeting the following requirements.

A. Bar Reinforcement

1. Furnish deformed reinforcement steel meeting ASTM A 615, (AASHTO M3 1) or ASTM A705, Grade 40 or Grade 60.

a. Small quantities purchased from warehouses may, at the Engineer's direction, be accepted if bend tested under ASTM A615 or AASHTO M31. The test specimen must cold bend around a pin without cracking on the outside of the bent portion.

B. Wire and Wire Mesh

1. Furnish wire meeting cold-drawn steel wire AASHTO M32 (ASTM A82) requirements.

2. Furnish wire mesh for concrete reinforcement meeting AASHTO M 55 (ASTMA A 185).

3. Furnish bar mats meeting AASHTO M54 (ASTM A 184).

PART 3: EXECUTION

3.1 PROTECTION

A. Protect steel reinforcement from damage at all times. Place steel free from dirt, detrimental scale, paint, oil and other foreign substance. Clean steel reinforcement having easily removed rust, loose scale, and dust using an approved method.

3.2 FABRICATION

A. Furnish four copies of shop details and placing drawings for all reinforcing steel to the Engineer for approval. Once checked, the Engineer will return two marked-up sets of prints or drawings for correction. The Engineer's review is only for general conformity with the plans. Checking the detailed dimensions is the Contractor's responsibility. The Engineer's review does not relieve the Contractor's responsibility to furnish all material meeting the Contract requirements. Detail Reinforcing, steel meeting the ACI "Standard Details and Detailing of Concrete Structures" and the "Manual of Engineering and Placing Drawings for Reinforced Concrete Structures" published by the American Concrete Institute (ACI 315).

B. Assure all bars are bent cold. Do not field bend any bar partially imbedded in concrete except as specified on the plans.

C. Ship bar reinforcement in standard bundles, tagged and marked meeting the "Details and Detailing of Concrete Structures" (ACI 315) requirements.

D. Concrete reinforcement and accessory details, not covered herein or on the drawings, must meet "Details and Detailing of Concrete Structures" and the "Manual of Engineering and Placing Drawings for Reinforced Concrete Structures" (ACI 315 and 315R) requirements.

3.3 PLACING AND FASTENING

A. Accurately place and hold firm all steel reinforcement in the plan locations as concrete is being placed.

B. Support and fasten together all reinforcement to prevent displacement due to construction loads. It is permissible to use on ground, where necessary, concrete support blocks having a minimum 4 square inches (2580 MM2) bearing area and having a compressive strength equal to the concrete being placed. Use approved bar chairs and spacers over form work. For concrete surfaces exposed to the

weather in the finished structure, assure the portions of all accessories within ½-inch (12.7 mm) of the concrete surface are noncorrosive or protected against corrosion.

C. Overlap welded wire fabric for successive mats or rolls providing an overlap measured between outermost cross wires of each fabric sheet at least 2 inches (50.8 mm). Extend the fabric across supporting beams and walls to within 4 inches (101.6 mm) of concrete edges. It may extend through contraction joints. Adequately support the fabric during concrete placement to maintain its position in the slab using the methods previously described or by laying the fabric on a concrete layer of the required depth before placing the upper slab layer.

D. Offset vertical bars in columns at least one bar diameter at lap splices. Furnish templates for all column dowels.

E. Obtain Engineer approval for all splices not shown on the plans. Mechanical connectors for reinforcing bars may be used if approved.

F. Do not use pebbles, pieces of broken stone, concrete rubble, broken brick or building blocks, metal pipe, or wooden block to position the fabric.

G. Follow the minimum concrete protective covering for reinforcement below.

1. Concrete deposited against ground: 76.2 mm (3 inches)

2. Formed surfaces exposed to weather or in contact with the ground:

   a. #6 bars or larger 50.8 mm (2 inches)
   b. Smaller than #6 bars 38.1 mm (1-1/2 inches)

3. Interior Surfaces:

   a. Beams, girders and columns 38.1 mm (1-1/2 inches)
   b. Slabs, walls and joists:

      1) #11 bars or smaller 19.05 mm (3/4-inch)
      2) #14 and #18 bars 38.1 mm (1-1/2 inches)

H. For corrosive atmospheres or fire protection, see special provisions for minimum covering requirements.

I. Obtain Engineer approval of reinforcement placement before placing concrete. Remove and replace concrete placed without Engineer approval of reinforcing.

J. Straighten fabric reinforcement shipped in rolls into flat sheets before placing it.

3.4 WELDING

A. When specified or approved, weld reinforcing steel meeting “Reinforcing Steel Welding Code” (AWSD 1 –4). Do not weld at bends in bars. Do not tack weld crossbars without Engineer approval.

PART 4: MEASUREMENT AND PAYMENT

4.1 GENERAL

A. Reinforcing steel used in the work is not measured. The cost of furnishing and placing reinforcing steel is incidental and included in the unit price or lump sum price bid for various items of the work.

END OF SECTION

SECTION 03310

STRUCTURAL CONCRETE

PART 1: GENERAL

1.1 DESCRIPTION

A. Furnish structural concrete meeting all specified requirements that is composed of Portland cement, aggregates, water. Furnish Ready-mixed concrete meeting ASTM C94 unless otherwise specified.

1.2 REFERENCES

ASTM C-94	Standard Specification for Ready-Mixed Concrete
ASTM C-150	Specification for Portland Cement
ASTM C-618	Specification for Coal Flyash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C-989	Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C-595	Specification for Blended Hydraulic Cements
ASTM C-157	Performance Specification for Hydraulic Cements
ASTM C-33	Specification for Concrete Aggregates
ASTM C-260	Specification for Air-Entraining Admixtures for Concrete
ASTM C-494	Specification for Chemical Admixtures for Concrete
ASTM C-1017	Specification for Chemical Admixtures for Use in producing Flowing Concrete
ASTM D-98	
ASTM C-138	Test Method for Density(Unit Weight), Yield, and Air Content(Gravimetric) of Concrete
ASTM C-173	Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C-231	Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C-31	Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C-39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C-172	Practice for Sampling Freshly Mixed Concrete
ACI 301	Standard Specification for Structural Concrete for Buildings
ACI 305	Hot Weather Concrete
ACI 306	Cold Weather Concrete
ACI 318	Building Code Requirements for Reinforced Concrete

1.3 QUALITY ASSURANCE

A. Codes and Standards: The codes and standards referred to in this section are declared to be part of this specification as if fully set forth herein. In addition, the following ACI Standards are incorporated in their entirety, unless specifically required otherwise:

1. ACI Standard 301, "Specifications for Structural Concrete for Buildings," American Concrete Institute, Edition.

2. ACI Standard 318, "Building Code Requirements for Reinforced Concrete", American Concrete Institute, current edition.

3. Concrete Reinforcing Steel Institute, "Manual of Standard Practice".

4. International Building Code of I.C.B.O.

B. Concrete Testing: The Contractor shall employ at his expense a testing laboratory acceptable to the Engineer to perform material evaluation tests and/or perform the mix design prior to placing any concrete. Retesting or additional testing of concrete or materials failing to meet the requirements of these specifications shall be done by the Contractor at no additional cost to the Owner.

PART 2: PRODUCT

2.1 CLASSIFICATION

A. Concrete is classified as set forth below. Place the specified class of concrete for each structure element as specified. Concrete with prefixes "C" contain 1-1/2 inch (38.1 mm) size aggregate and those with "M" contain 3/4 inch (19.05 mm) size aggregate.. Concrete with prefixes "M" may be substituted for concrete with prefixes "C."'

1. Use M-3000 concrete for structural concrete for walls, interior slabs, and footings.

2. M-3000 is concrete with 3/4 inch (19-05 mm) maximum aggregate and a 28-day compressive strength of 3000 pounds per square inch (psi) (27.6 Mpa).

B. If concrete strength or durability requirements established by design exceed the above strength classifications, the Engineer may specify additional concrete classifications to meet those requirements, contractor shall verify this on the structural general notes found in the plan set.

2.2 COMPOSITION OF CONCRETE

A. Upon receipt of the notice of award of the contract, furnish the Engineer with names of suppliers and locations of sources of materials proposed for use.

1. Materials

a. Cementitious Material: Cementitious material consists of Portland cement meeting ASTM C 150, with or without the addition of cementitious or pozzolanic mineral admixtures meeting, ASTM C618 or ASTM C989, or blended hydraulic cement meeting ASTM C595 or hydraulic cement meetingASTM 1157. Unless otherwise specified, assure cementitious material meets ASTM C 150 Type I or Type II. Assure cementitious material used in concrete is the same brand and type and from the same plant of manufacture as the cementitious material used in the concrete represented by the submitted field test date or used in the trial mixtures.

b. Aggregates: Assure aggregates meet ASTM C33. When a single size or a combination of two or more sizes of coarse aggregates are used, assure the final gradation meets the grading requirements of ASTM C33. Obtain concrete aggregates from the same source and use the same size ranges as the aggregates used in the concrete represented by submitted historical data, or used in trial mixtures.

c. Water and Ice: Use concrete mixing water and water to make ice meeting requirements of ASTM C94.

d. Admixtures: Use admixtures meeting the following requirements:

1)	Air entraining, admixtures -	ASTM C260
2)	Chemical admixtures-	ASTM C494

3) Chemical admixtures for use in producing, flowing concrete- ASTM C1017
4) Calcium Chloride - ASTM D98
5) Use admixtures in the concrete that are the same as those used in the concrete represented by submitted field test data or in trial mixtures.

2. Change of materials

a. When brand, type, size, or source of cementitious materials, aggregates, water, ice or admixtures are requested to be changed, submit new field data or data from new trial mixtures or furnish evidence that indicates that the change will not adversely affect the relevant properties of the concrete for acceptance before using the concrete.

B. Performance and Design Requirements

1. Assure the cementitious material content is adequate to meet the specified requirements for strength, water-cement ratio and finishing requirements. For concrete used in floors, assure the cement content is at least that indicated in Table 2.1. For concrete exposed to freezing and thawing or concrete exposed to deicers, assure a maximum water-cement ration of 0.45.

TABLE 2.1
MINIMUM CEMENT CONTENT REQUIREMENTS

Nominal Maximum size of aggregate, in(mm)	Minimum cement content lb/yd3 (kg/m3)
1-1/2 (38-1)	470* (163.0)
1 (25.4)	520 (180.3)
3/4 (19-05)	540 (187-3)
3/8 (9-5)	641 (222.3)

* Minimum cement content is 520 lb/yd^3 (180.3 kc,/m^3) and maximum H2O/cement ratio of 0.45 if concrete will be exposed to freezing and thawing and/or in the presence of deicing chemicals.

2. Furnish concrete at the point of delivery having a slump of 4 inches (max) (100 mm) determined by ASTM C 143. Meet slump tolerances in ACI 117. When a plasticizing admixture is used meeting ASTM C 10 17 or when a Type F or G high range water reducing admixture meeting ASTM C494 is approved to increase the concrete slump, assure the concrete has a slump

of 2 to 4 inches (50-100mm) before the admixture is added and a maximum slump of 8 inches (200 mm) at the point of delivery after the admixture is added.

3. Assure the nominal maximum size of coarse aggregate does not exceed three fourths of the minimum clear spacing between reinforcing bars, one-fifth of the narrowest dimension between sided of forms or one-third of the thickness of slabs or toppings.

4. Concrete must be air entrained. Measure air content under ASTM C 138, C 173 or C231. Unless otherwise specified, ASTM C231 shall be used.

TABLE 2.2
TOTAL AIR CONTENT* OF CONCRETE
FOR VARIOUS SIZES OF COARSE AGGREGATE

Nominal maximum Size of aggregate mm, (in.)	Total air content, percent		
	Severe exposure	Moderate exposure	Mild exposure
Less than 9.53(3/8)	9	7	8
9.53 (3/8)	7.5	6	4.5
12.5(1/2)	7	5.5	4
19 (3/4)	6	5	3.5
25.4(l)	6	4.5	3
12.7(1-1/2)	5.5	4.5	3
50.8(2)	5	3.5	1.5
76.2(3)	4.5	3.5	1.5
152.4(6)	4	3	1

* Measure in accordance with ASTM C 138, C 173, or C 231.
Air content tolerance is +/- 1 1/2 percent

a. When admixtures are specified in the Contract documents for particular parts of the work, use types specified. Use of calcium chloride or other admixtures containing chloride ions is subject to the limitations in Table 2.3 Chloride Ion Concentration. When approved, use calcium chloride in solution form only, when introduced into the mixture.

1) Assure the maximum water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days attributed to the ingredients including water, aggregates, cementitious materials and admixtures do not exceed the limits of Table 2.3. Use tests to determine water soluble chloride ion content meeting AASHTO T260. The

type of member described in Table 2.3 applies to the work as indicated in the Contract Documents.

TABLE 2.3
MAXIMUM ALLOWABLE CHLORIDE ION CONTENT

Type of Member	Maximum water soluble chloride (CI) Content in concrete, percent by weight of cement
Prestressed concrete	0.06
Reinforced concrete exposed to chloride in service	0.15
Reinforced concrete that will be dry or protected from moisture in service	1.00
Other reinforced concrete construction	.30

b. When the average of the highest and lowest temperature during the period from midnight to midnight is expected to drop below 40°F (40°C) for more than three successive days, deliver concrete in accordance with ASTM C-94.

c. Furnish the compressive strength and the water-cement or water cementitious, material ratio of concrete for each portion of the work as specified in the Contract documents.

1) If cementitious or pozzolanic mineral admixtures meeting, ASTM C618 or ASTM C989 are used, the cement portion of the water-cement ratio must be the total weight of cementitious material.

2) The maximum weight of fly ash, pozzolan or ground granulated blast-furnace slag included in the calculation of water-cementitious material ratio cannot exceed the following percentages of the total weight of portland cement plus fly ash, pozzolan and ground granulated blast-furnace slag:

3) The combined weight of fly ash and pozzolan meeting ASTM C618 cannot exceed limits in ACI 318.. The fly ash and pozzolan present in an ASTM Type IP or IPM blended cement meeting ASTM C595 must be included in the calculated percentage.

4) The weight of ground granulated blast-furnace slag meeting ASTM C989 cannot exceed 50 percent of the total weight

of cementitious material. The slag used in manufacture of a Type IS or ISM blended hydraulic cement meeting ASTM C595 must be included in the calculated percentage.

5) If fly ash or pozzolan is used in concrete with ground granulated blast-furnace slag, the portland cement constituent meeting ASTM C 150 cannot be less than 50 percent of the total weight of cementitious material. Fly ash or pozzolan must not constitute more than 25 percent of the total weight of cementitious material.

6) Strength requirements are based on the 28-day compressive strength determined on 6" x 12" (150mm x 300mm) cylindrical specimens made and tested under ASTM C31 and C39 respectively.

2.3 PROPORTIONING AND DESIGN OF MIXES

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to the Engineer for preparing and reporting proposed mix designs.

B. Submit written reports of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed and approved.

PART 3: EXECUTION

3.1 CONCRETE MIXES

A. Job-Site Mixing: Mix materials for concrete in appropriate drum type batch match mixer. For mixers of one cu. Yd., or small capacity, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than one cu. Yd., increase minimum 1-1/2 minutes of mixing time by 2.5 minutes for each additional cu. yd., or fraction thereof.

B. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, batch quantities, and amount of water introduced.

C. Ready-Mix Concrete: Comply with requirements of ASTM C94, and as herein specified.

D. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ANSI/ASTM C94 may be required.

E. When air temperature is between 85°F (30°C) and 90°F (32°C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90°F (32°C), reduce mixing and delivery time to 60 minutes.

3.2 CONSISTENCY

A. Assure concrete is of such consistency that it will flow around reinforcing steel, but individual particles of the coarse aggregate, when isolated, show a coating of mortar containing its proportionate quantity of sand. The consistency of the concrete will be gauged by the ability of the equipment to properly place the concrete in its final position and not by the difficulty in mixing or transporting. Use the minimum quantity of mixing water necessary to provide workability within the ranges of slump specified.

3.3 MIXING

A. Thoroughly mix concrete to assure a uniform distribution of the materials throughout the mass. Mix concrete only in quantities required for immediate use and place it within the time limits specified. Waste all concrete which initial set has begun. Retempering of concrete is prohibited. Aggregates, or bags of cement containing lumps or crusts of hardened material shall not be used. Mix concrete in an approved truck mixer meeting the requirements of ASTM C94 herein.

B. The capacity of the plant and the transportation equipment must ensure delivery at a rate that will permit proper handling, placement and finishing at the point of delivery. Maintain the concrete delivery rate to provide for the continuous operation of placing, handling and finishing concrete as is practical. Maintain the interval between delivery of loads so that layers or lifts of concrete in place do not harden before succeeding layers or lifts are placed. In general, no lift or layer of concrete can remain exposed for more than 20 minutes before being covered by fresh concrete.

C. The volume of mixed concrete in the mixing drum shall not exceed the manufacturer's rating, on the capacity plate.

D. During freezing weather, other approved methods of measuring water will be permitted.

E. A recording water metering device is always required at the primary point of the batching operation.

F. Do not add water to concrete in transit. Water may be introduced into the mixer at the job site under direction of the Engineer, if the specified water-cement ratio is not exceeded. Water must be added in accordance with ASTM C94, Assure the drum revolves continuously after the introduction of the cement and water until the concrete is discharged.

G. Begin mixing immediately after introduction of the cement and water and continue for at least 70 revolutions of the drum at mixing speed. This minimum revolution count will be waived when the concrete is produced at a central mixing plant. Not more than 100 drum revolutions can exceed 6 revolutions per minute. All other revolutions must be at agitating speed of not less than 2 or more than 6 revolutions per minute.

H. Discharge the concrete at the job and place in its final position within 1- 1/2 hours after the introduction of the mixing water and cement. When the air temperature is 90°F (30°C) or above, place the concrete in its final position within 1 hour after the introduction of the mixing, water and cement. Concrete mixes with an approved set retarding admixture may be held an additional ½ hour beyond limits specified above.

I. No mixed or agitated concrete that has remained in the drum of the truck mixer more than 10 minutes without agitation can be used. If the Engineer determines the concrete has not suffered any detrimental effects. It may be used, after remixing for a minimum of 20 revolutions of the drum at mixing speed, if it can still be placed in the forms within the specified time limits.

J. Provide a revolution counter on each truck that registers the number of revolutions of the drum.

K. Mount the counter so it can be easily read by both the operator and the Engineer.

3.4 PLACING CONCRETE

A. Thoroughly compact concrete into its final position. Assure it is thoroughly consolidated around fittings and embedded items. Assure all reinforcement and embedded items are accurately placed as shown on the plans and are clean and free from coatings of dried mortar, detrimental rust, scale, oil or foreign matter..

3.5 CURING CONCRETE

A. Thoroughly cure concrete surfaces subject to premature drying by covering as soon as possible with canvas, plastic sheets with sealed joints, burlap and sand or other satisfactory materials and keep concrete moist. If the concrete surfaces are not covered, keep them moist by flushing or sprinkling. Continue curing for at

least 7 days after placing the concrete. Concrete surfaces placed against forms may be cured by leaving the forms in place for at least 7 days, when approved.

B. Protect concrete against freezing or other conditions detrimental to strength development meeting the applicable requirements of this specification.

C. To aid finishing, side forms on ornamental work, curbs and sidewalks, railing and parapets may be removed after 12 hours, not to exceed 48 hours, depending on weather conditions. Continue moist curing during the concrete finishing operation.

D. Untreated forms and existing concrete must be kept continuously wet for at least 1 hour before any concrete is placed. Keep wet until covered with concrete except that adequately treated forms must be thoroughly washed with a water spray immediately before placing the concrete.

E. The curing of concrete, by either water curing or membrane curing, must be as follows unless otherwise approved by the Engineer.

1. Water Curing

a. Keep all concrete top surfaces continuously moist after finishing, with a fine water spray, until the concrete has set. Cover the moist concrete with water or an approved curing covering.

b. Cure concrete deck slabs and concrete floors for at least 7 days. Cure by placing burlap, cotton mats or other absorptive material as close behind the finishing operation as possible without marring the finished surface. Keep the absorptive material continuously moist for the full time it is used. The absorptive material may be kept in place for the entire curing period or it may be removed as soon as practical and the entire surface covered with approximately 1-1/2 inches (38.1 mm) of sand, kept continuously moist for the entire curing period.

c. Remove forms and repair surface irregularities without interfering with any of the curing requirements. As soon as the vertical forms have been removed and the surface irregularities repaired, cover the concrete with absorptive material, kept continuously wet for the balance of the curing a period.

2. Impervious Membrane Curing

a. Assure membrane curing compounds are delivered to the job in the manufacturer’s original container, clearly labeled to show the name of the manufacturer and the contents. The clear curing

compound must be sufficiently transparent and free from permanent color that would change the color of the natural concrete. Use clear compound containing a fugitive dye having color sufficient to render the film visible on the concrete for at least 4 hours after application. The concrete surface must maintain its natural color after curing.

b. Use a compound ready for use as shipped by the manufacturer. Dilute following the manufacturer's recommendations. Use curing compound only with written approval. Sampling will not be required if manufacturer's certification is available. Apply the curing compound under pressure with a spray nozzle to cover the entire exposed surface thoroughly and completely with a uniform film not exceeding manufacturer's specifications. Maintain the required pressure in the spray machine to force the material to leave the nozzle in a fine mist. Keep all concrete surfaces moist with a fine water spray or with wetted burlap until the sealing compound is applied. Keep the curing compound application close to the finishers of the top surface of concrete at all times. Seal the concrete immediately after the finishing operations have been completed, to the satisfaction of the Engineer.

c. If it is necessary to allow workers or equipment on the surface before the 7 day curing period is completed, cover the top surface of sealed concrete with a protective cushion for runways. Use a cushion consisting of a moist, 1 –inch (25mm) minimum thick layer of fine sand, or layers of moist burlap that will prevent damage to the finished concrete. Cover the approved cushion with four by eight foot sheets of 3/4 inch(19mm) plywood laid over the cushion. Do not place the cushion material for at least 8 hours after the final application of the curing compound. Obtain the Engineer's written approval for any other proposed cushion material before use. Layers of plastic, visqueen or canvas are not an acceptable cushion material.

d. Keep concrete, which has not completed its curing period, continuously moist during the stripping and surface repair operations. Remove all surface irregularities, repair all depressions, voids or holes, including those formed by trapped air, to the satisfaction of the Engineer. Immediately apply the curing compound before the surface has had an opportunity to dry out. Keep concrete, from which forms have been stripped, continuously moist until surface repair and finishing are completed and the impervious membrane curing has been applied.

3.6 WEATHER AND NIGHT LIMITATIONS

A. General

1. Stop concreting operations when darkness prevents obtaining the specified placing, and finishing work. Night operations may be conducted with written approval and when approved artificial lighting is provided.

2. Cold weather concreting is governed by ACI 306 unless otherwise specified herein. Hot weather concreting methods is governed by ACI 305 unless otherwise specified herein. Except by specific written authorization, stop concreting operations when a descending air temperature in the shade and away from artificial heat falls below 40°F (4°C), or do not resume until an ascending air temperature in the shade and away from artificial heat reaches frozen foundation course or subgrade.

3. Assume all risk of placing concrete in cold weather. Placing concrete during cold weather does not relieve the Contractor of the responsibility for obtaining the specified results. Remove and replace all concrete injured by frost at Contractor expense.

4. Before any concrete is placed, remove all ice, snow and frost completely from the formwork receiving the concrete.

5. Heating and Placing Concrete

   a. When concreting is authorized during cold weather, assure concrete temperature meets ASTM C94.

6. Protection of Concrete

   a. During the curing period, if the air temperature is anticipated to fall below 32°F (0°C, provide an approved blanket type insulating material along the work for covering all concrete that has been in place for 7 days or less. If, at any time, the ambient temperature drops to 32°F(O°C) or less, protect the concrete using a method approved by the Engineer. The minimum method of protection under such conditions is as follows: between two layers of plastic sheeting, the insulating materials, with the exception of commercial blankets, must be spread loosely to a minimum depth of 6 inches (150mm), but in all cases, to the depth required to prevent freezing of, or frost damage to, the concrete. Maintain the blanketing material at least until the end of the regular specified curing, period which is not less than 7 days. The Engineer may direct leaving the blanketing material in place for an additional

period if the recorded temperatures indicate that additional curing may be necessary. If during the construction period the mean daily temperature is expected to fall below 40°F(4°C) for 3 consecutive days, furnish approved heating enclosures and devices capable of maintaining the surface temperature of the concrete in place between 55°F (13°C) and 80°F (26°C). The curing, period under these conditions is 7 days when Type I-II cement is used and 5 days when a pre-approved "high early strength" mix is used. At the close of the curing period, the heat may be reduced so that the temperature inside the housing does not decrease faster than 15° per hour until the temperature inside the housing is the same as outside.

b. A Contractor may, at their own expense, field cure concrete cylinders with their in-place concrete and discontinue protection when those field cylinders reach 70 percent of design strength as indicated by the 28 day requirement of these specifications.

c. Perform all concrete protection using methods consistent with ACI-306-1-87 and approved by the Engineer.

3.7 TESTING

A. All concrete must be tested by an ACI Grade I or equivalent certified testing technician. Unless otherwise specified, the contractor shall be responsible for all acceptance testing during the on-site placement of the concrete.

1. Materials

a. The Testing Firm or their representative must have access to the ready mix production facility for sampling constituent materials during production to assure the materials meet these specifications and represent those stated on the approved mix design.

2. Standard Slump Tests

a. The Testing Firm hired by the contractor shall , during each day's placement, check the consistency of the concrete by slump test. A slump test will also be made each time that strength specimens are made . Slump tests are performed meeting ASTM C143"Method of Test for the Slump of Portland Cement Concrete".

3. Compression Tests

a. A minimum of three specimens, 6 inch (150 mm) in diameter or 4 inch(100 mm) , shall be made and tested for every concrete placement. Mold and test one set of test cylinders for every 100 yards (76.5 cubic meters) of concrete or fraction thereof placed each day. On a given project, if the total volume of concrete is such that frequency of testing required above would generate less than 5 strength tests for a given class of concrete, make tests from at least 5 randomly selected batches or from each batch if fewer than 5 batches are used. Cure these cylinders under laboratory conditions except that additional test cylinders cured entirely under field conditions may be required by the Engineer to check the adequacy of curing and protection of the concrete.

b. Take samples for strength tests in accordance with ASTM C172, entitled

c. Mold test cylinders and laboratory-cure in accordance with ASTM C31. Test cylinders in accordance with ASTM C39, entitled " "Method of Test for Compressive Strength of Cylindrical Concrete Specimens", ASTM C39, using an independent testing laboratory, as approved by the Engineer.

d. Of each of the 3 cylinders take for a pour, test 1 for information strength at 7 days and test 2 for acceptance strength at 28 days. To meet this specification, average strength of two cylinders from the same sample, tested at 28 days or the specified earlier age, is required for each strength test. Strength level of an individual class of concrete is considered satisfactory if both of the following requirements are met:

1) The average of all sets of 3 consecutive tests equal or exceed the specified strength.
2) No individual strength test (average of two cylinders) falls below specified strength by more than 500 psi (3400 kPa).

e. Cure field cured cylinders under field conditions meeting Section 7.4 of "Method of Making and Curing Concrete Test Specimens in the Field" (ASTM C31).

f. Mold field cured test cylinders at the same time and from the same samples as laboratory cured test cylinders. Improve procedures for protecting and curing concrete when strength of field cured cylinders at the test age designated for measuring specified

strength is less than 85 percent of that of companion laboratory cured cylinders. When laboratory cured cylinder strengths are appreciably higher than the specified strength, field cured cylinder strengths need not exceed the specified strength by more than 500 psi (3400 kPa) even though the 85 percent criterion is met.

g. The strengths of any specimens cured on the job are to indicate the adequacy of protection and curing of the concrete and may be used to determine when the forms may be stripped, shoring removed or the structure placed in service. When the strengths of the job cured specimens are below those specified above, the Contractor must improve the procedures for protecting and curing the concrete.

h. When concrete fails to meet the requirements above or when tests of field cured cylinders indicate deficiencies in protection and curing, the Owner's representative may order tests on the hardened concrete under Chapter 17.3 of ACI-301-84 or order load tests in Chapter 20 of the ACI Building Code (ACI 318-83) for that portion of the structure where the questionable concrete has been placed. In the event the load or core tests indicate that the structure is unsatisfactory, make all modifications as directed by the Engineer to make the structure sound. If the load or core tests indicate the concrete is satisfactory, all cost of testing shall be paid by Owner.

4. Air Content Tests

a. The Testing Firm hired by the contractor shall during each strength test, check the air content by either the "Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method" (ASTM C23 1), "Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method" (ASTM C173) or "Method of Test for Unit Weight, Yield and Air Content (Gravimetric) of Concrete" (ASTM C138)

5. Temperature

a. Test hourly when air temperature is 40°F (4°C) and below, and when 80°F (27°C) and above; and each time a set of compression test specimens is made.

PART 4: MEASUREMENT AND PAYMENT

4.1 GENERAL

A. The method of measurement and basis of payment is as outlined in the contract documents for the various items of concrete work found within the project. If cubic yard measurement is required for payment the contractor is responsible for verifying and submitting these measurements for payment.

4.2 REQUIRED SUBMITTALS

A. The following are submittals required to become an approved source of supply for Portland Cement concrete placed:

1. Complete concrete mix design meeting all specification requirements. Meet the Mix proportions specified in ACI 301, Chapter 3. Submittals will include the following:

MIX PROPORTIONS	
-cement in lbs (kgs)	Type and source of supply
-coarse aggregate	Size and source of supply
-fine aggregate	Source of supply
-water, gallons(liters)	City or well
-admixtures,oz/yd3(g/M3)	Brand and description*

*description as retarder, accelerator, air entraining, etc.

B. MATERIALS INFORMATION

1. Specific gravity (bulk s.s.d. Basis) of coarse and fine aggregate and 1 percent absorption-coarse aggregate unit weight (dry-rodded)-ASTM C33 quality tests including the following:

a. Fine aggregate

1) gradation AASHTO, T27 and T11 deleterious substances soundness (AASHTO T104) organic impurities (AASHTO T21) mortar-making properties (AASHTO T71)

b. Coarse aggregate

1) deleterious substances gradation (AASHTO T27 and T11) soundness (AASHTO T104) percentage of wear (AASHTO T96)

c. Current chemical analysis of mixing water (if well)

d. Current cement mill analysis

2. CONCRETE MIX DATA

a. slump

b. % air

c. unit weight

d. 7 and 28 day compressive strength

3. VARIATIONS

a. The following variations will be cause for submittal of a new mix design.

1) Change of aggregate source
2) Change of cement content
3) Addition or exclusion of certain admixtures including, but not limited to, pozzolans, accelerators, retarders and water reducers
4) Change in aggregate size
5) Change in type of cement
6) Failure to attain strength requirements as outlined in ACI 214 or ASTM C94

b. A variation in any of the following will require 'Informing the City Engineer and possibly data indicating acceptability for use in existing mix designs.

1) Change of cement supplier
2) Change of admixture brands or dosages (not types)
3) Minor adjustments of aggregate proportions accompanying materials changes or to accommodate placement conditions (same w/c ratio)

C. Certification of Ready Mixed Concrete Production Facilities

1. Concrete producers are to allow access to their facilities by Engineer or their representatives for inspecting their facilities and/or sampling materials. All facilities should meet the requirements of the "National Ready-Mix Concrete Association" check list for concrete production facilities.

2. Items directly affecting a facility's ability to properly proportion, transport and deliver concrete may be reason for disqualifying that facility as a source of supply until such deficiencies are corrected. Examples would include cement and aggregate scales that will not accurately weight materials or mixer units that will not thoroughly mix concrete materials.

D. The following chart indicates the submittal frequency for each item required for approval as a source of supply.

TABLE 4.1 SUBMITTAL FREQUENCY

SUBMITTAL	FREQUENCY		
	Monthly	Twice Yearly	Other
1- Complete mix design			(See Item 1, No 4)
2. Aggregate gradations	X		With mix design
3. L.A. Abrasion			With mix design
4. Soundness			With mix design
5. Deleterious substances			With mix design
6. Water quality (if well)		X	
6a. Cube strengths and time of set			With mix design
7. Cement mill certificates	X		
8. Organic Impurities			With mix design
9. Inspection of facilities			As indicated

Note: The above chart applies to the first year of this program. Frequency of submittals may change as dictated by variations of test data.

END OF SECTION