G. Galvanic Anodes

Anodes shall be high potential magnesium and shall be supplied and installed by the Contractor in conformance with Detail Drawing A8-2.

Anodes shall be inspected to ensure that bentonite material surrounds the anode. The cloth containing the anode and bentonite mixture shall be intact, and any torn anode bags shall be rejected. Anodes are to be kept dry until installed. The lead wire must be securely connected to the anode and should be inspected to ensure that it is not damaged. The anode should be placed as far from the pipe and other anodes as possible. Anodes should be backfilled with compacted native soil, not sand, pea gravel, or flow fill. Care should be exercised so that lead wires and connections are not damaged during backfill operations. Lead wires shall have sufficient slack to avoid strain. Wires shall be connected via a thermite weld per the manufacturer's recommendations. Copper sleeves shall be used for #10 AWG and smaller wires. Any exposed metal shall be coated or wrapped with corrosion tape.

H. Impressed Current Systems

Impressed current systems shall be installed in conformance with these *Water LESS*. Anodes shall be inspected for conformance to Specifications including anode material and size, length of lead wire, and end cap. Care should be exercised to avoid cracking or damaging anodes during installation and handling. Lead wire shall be carefully inspected to detect defects in insulation. Care should be taken to avoid damaging the insulation on the wire. Defects in insulation must be repaired or the anode rejected. Rectifiers shall be tested after installation for proper lead wire connection and function prior to the Inspector's final approval.

I. Test Stations

Electrolysis test stations shall be installed per Section 2.6I.7, and Detail Drawings A8-4 through A8-8. Colorado Springs Utilities shall provide the test stations, and the Contractor shall install the test stations. Test stations shall be tested prior to final acceptance to ensure proper functioning. Lead wires shall be labeled to identify where they are connected.

5.18 Backfill and Compaction

The trench shall be backfilled to finished grade as shown on the Approved Construction Plans. No section of Water Main, Water Main appurtenance or Water Main Structure shall be backfilled until the Inspector has examined and approved that section of the installation.

Wet, soft or frozen material, asphalt and concrete chunks, cinders, ashes, refuse, plant or organic material, boulders, rocks or other deleterious substances shall not be used for backfill. If the excavated material is not suitable for backfill, as determined by the Inspector, suitable material shall be hauled in and utilized, and the rejected material hauled away and disposed.

No backfilling will be allowed in freezing weather except by permission of the Inspector. No additional backfill will be allowed over any frozen material already in the trench.

Water required for backfill and compaction operations may be furnished from a designated fire hydrant subject to permitting and installation requirements described in Section 5.7.

Backfill shall be consolidated and/or compacted by vibrating, tamping or a combination thereof, to the satisfaction of the appropriate controlling authority. The fill shall be placed in maximum 8 inch horizontal layers of un-compacted thickness and shall be compacted per the following criteria:

- For Cohesive Soils, a minimum compaction requirement of 95 percent of maximum Standard Proctor dry density (*ASTM D698*) at ± 2 percent of optimum moisture content.
- For Cohesionless Soils, a minimum compaction requirement of 95 percent of maximum Modified Proctor dry density (*ASTM D1557*) at ± 2 percent of optimum moisture content and 100 percent of maximum Standard Proctor dry density (*ASTM D698*) at ± 2 percent of optimum moisture content.
- For highly expansive soils (swell potential >2.00 percent under 200psf surcharge pressure), paving will not be permitted without a subgrade treatment approved by the controlling authority.

Compaction tests should be taken at a minimum of every 250 feet for utility mains in 2 foot vertical increments. One compaction test shall be conducted for every service line trench at alternating depths. The Inspector or the Governing Agency has the discretion to require additional compaction tests. (Reference City of Colorado Springs, *City Engineering Standard Specification, Section 200 – Street Section*).

Satisfactory compaction reports shall be submitted to the Inspector and the Authority Having Jurisdiction prior to the completion of the Project. The Authority Having Jurisdiction shall specify the exact number and locations of tests required. Railroad, airport and other private or special situations will require investigation and research to determine specific requirements.

Flow-fill will be required as utility trench backfill for all trenches less than 1 foot in width. This requirement applies to all pavement and gravel locations. For trench excavations greater than 1 foot in width, the slurry concrete cap in newly overlaid or newly constructed streets will be required in accordance with City of Colorado Springs Standards or as directed by the Controlling Authority. Compaction and testing of utility trench backfill will not be required if material meeting the flow-fill Specification in Section 4.4S is used.

The methods of compaction shall be sufficient to attain the required density in accordance with these *Water LESS*. Performance of the compacted trench shall be the responsibility of the Contractor and any failure, as defined by the Authority Having Jurisdiction, which occurs within 2 years following the completion of Construction shall be corrected at the expense of the Contractor.

The method of testing the compacted material shall be the responsibility of the Professional Engineer certifying the results. The Professional Engineer shall be responsible for the validity of all test results.

Fly ash or "Flashfill" materials used in public ROWs or in off-site applications i.e. under Structures must be in accordance with Section 4.4S.

5.19 Hydrostatic Testing Disinfection Procedures

Hydrostatic testing shall be completed as directed by the CSFD and may be required on a case by case basis at the discretion of Colorado Springs Utilities. All hydrostatic testing on newly installed or repaired Potable Water pipeline and associated appurtenances shall be performed prior to disinfection activities unless otherwise arranged with onsite Colorado Springs Utilities personnel. Disinfection may be performed concurrently or prior to hydrostatic testing at the discretion of Colorado Springs Utilities.

Hydrostatic testing shall be performed by an independent Contractor who is responsible for providing any pumps, temporary piping, Backflow devices and associated appurtenances needed to carry Potable Water to the section of pipeline being pressure tested, disinfected and flushed. The water source, pumps, piping and all equipment used for the purpose of hydrostatic testing shall be cleaned and disinfected using the swab method as defined in Section 5.20 before any connections are made to the Potable Water System.

5.20 Disinfection

All Water Main Extensions and Private Water Main Extensions shall be chlorinated in accordance with *AWWA C651*. The chlorination method used for main disinfection shall be approved by Colorado Springs Utilities as outlined in this section.

It shall be the Inspector's responsibility to notify Colorado Springs Utilities, Laboratory Services Section 2 working days in advance of the disinfection date. The Inspector, Contractor, and Lab Services shall be present during all disinfection and Flushing activities.

An acceptable bacteriological sample result shall be verified prior to the line extension being placed in service or the installation of any service taps. The disinfection procedure may need to be repeated at the expense of the Contractor if the following disinfection criteria are not met:

A. Water Mains 12 inch or Smaller

The Contractor shall provide High Test Hypochlorite (HTH) granules to be used for disinfection of Water Mains of 12 inch in diameter or less. A minimum of 2 oz HTH granules shall be used per 20 ft section of pipe installed to achieve a chlorine concentration acceptable to Colorado Springs Utilities. Tablets shall not be used for disinfection. The granules shall be placed inside each joint of pipe as the pipe is installed in the trench. Once the chlorine is placed in the pipe, the Contractor shall provide labor, material and an acceptable plan to transmit and contain water discharged during Flushing.

The main shall be filled with water at a rate to ensure that the water within the main will create a chlorine solution throughout the length of the pipe. The fill rate shall not exceed 1 foot/second. Precautions shall be taken to ensure that air pockets are eliminated.

Chlorinated water shall remain in the pipe for a minimum of 24 hrs to ensure adequate contact time and shall have a minimum concentration of 50 mg/L at the end of a 24 hour period.

B. Water Mains Larger than 12 inch

Colorado Springs Utilities shall disinfect all pipelines larger than 12 inch provided that the Contractor shall excavate the tapping holes, pay for all required appurtenances and provide labor, material and an acceptable plan to transmit and contain water discharged during Flushing.

All disinfections shall be evaluated on a case-by-case basis and additional appurtenances may be required for chlorine injection and air relief at the expense of the Contactor.

After the pipe is chlorinated, it is held for 24 hours. At the end of the 24 hour period, the water in the pipeline shall be flushed and tested by Colorado Springs Utilities to ensure a "free" chlorine residual of not less than 50 mg/L. If the chlorination concentration has not been met, the disinfection process may need to be repeated at the expense of the Contractor.

C. Dewatering Requirement for Highly Chlorinated Flush Water Discharges

Colorado Springs Utilities shall determine if the discharge can be made such that the chlorine will dissipate prior to reaching a predetermined Point of Compliance. All line disinfection discharges will be evaluated, planned and approved by Colorado Springs Utilities prior to any activity. Discharge must be in accordance with any applicable CDPHE permits authorizing such dewatering discharges.

The pipeline shall be thoroughly flushed to remove the heavily chlorinated water and any sedimentation until water clarity and line chlorine residual have been achieved. Discharges of chlorinated water from blow-off assemblies or other appurtenances shall be contained or discharged in a manner approved by Colorado Springs Utilities.

De-chlorination Discharge Options:

- On-site containment, which is not connected to the storm sewer system or any surface waters
- Chemical de-chlorination treatment with approved Best Management Practices (BMP) placement and an acceptable discharge plan
- Tanker off-site for proper treatment and disposal
- Discharge to sanitary sewer, with prior approval from the Las Vegas Wastewater Treatment facility

A Point of Compliance (POC) is typically located after the point of discharge (or de-chlorination) and prior to entering or converging with state waters. Construction Sites along roadways will generally have a POCs located upstream or before the discharge water enters a storm drain.

De-chlorination treatment at the point of discharge may be required to meet the chlorine reduction requirements. Water discharge at the POC shall be free of known pollutants, Total Chlorine Residual (TCR), sedimentation or Total Suspended Solids (TSS), oil and grease, construction debris, etc. Disinfection discharges to surface

waters may require additional sampling, testing and reporting per CDPHE permits, and/or any applicable Colorado Springs Utilities' supplementing procedures or Best Management Practices (BMPs). Consult and coordinate with Colorado Springs Utilities, Laboratory Services for sampling and reporting.

Discharge volumes and permit requirements may generate additional monitoring parameters as determined by CDPHE and Colorado Springs Utilities. BMP's shall be in place to minimize erosion and to prohibit pollutants from entering State waters.

Chlorine is considered a pollutant and shall not be introduced into any waters of the state. Any discharge to waters of the state is not permitted to have a TCR.

Sediment is considered a pollutant. TSS analysis measures the amount of particulate suspended solids in discharged waters. This test will be performed for discharges exceeding permit volume maximums or as determined by Colorado Springs Utilities.

All water discharges will be monitored for pH. A water discharge with a pH reading of less than 6.5 SU or more than 9.0 SU is considered a pollutant and shall not be introduced into any waters of the state.

A minimum of 2.5 ft/sec flushing velocity is required throughout the duration of the entire flush. Mainline Flushing consists of displacing 3 times the volume of water contained in the new main or until highly chlorinated water and sediment has been discharged and clarity has been achieved.

All Potable Water Mains which have been successfully disinfected and bacteriological requirements achieved shall be placed in service immediately.

Potable Water Mains isolated for more than 4 days shall be evaluated and a determination will be made by Colorado Springs Utilities as to whether re-disinfection is required.

5.21 Water Service Lines

A. Acceptance and Release for Taps

A new Water Main shall be accepted by Colorado Springs Utilities and released for taps when:

- The Water Main and all appurtenances have been installed to the satisfaction of the Inspector and all pertinent notes and measurements have been made.
- Disinfection has been completed and the main has been flushed and charged.

B. Application for Taps

Water Service permit fees must be paid before any water taps will be made. The size of the service taps shall be in accordance with the Approved Construction Plans if applicable. Development charges shall be paid prior to any User connection to a water tap.

Any relocation, upsizing or downsizing of water taps and repairs to existing Water Service Lines are subject to a water service permit fee. Repairs to existing Water

Service Lines between the Corporation Stop and Curb Stop shall be made by Colorado Springs Utilities.

In the event of a risk to public health and safety, including non-compliant water taps, Colorado Springs Utilities will repair and assess billable charges to the Contractor.

Application, payment and scheduling shall be conducted at the Customer Contract Administration Office, 2880 International Circle, Colorado Springs, CO 80910. Permits for taps shall only be issued to a licensed Excavator or Master Plumber as defined in the *City Code § 12.4.201*, as amended. Tapping permits must be applied and paid for at least 72 hours prior to tapping.

C. Responsibility for Tapping Water Mains

All service taps on Water Mains within the Colorado Springs Utilities' Water Distribution System shall be tapped per the following (Reference *Utilities Rules and Regulations -Water Section– 46*):

- Colorado Springs Utilities shall supply ¾ inch through 2 inch corporation taps and Curb Stops (not including the stop box), and shall perform the tap for all existing Colorado Springs Utilities-owned and maintained water distribution mains.
- The Contractor shall be responsible for all costs involving the installation of the tap on the main, supplying materials, equipment and appurtenances for the installation of service taps (3/4 inch through 2 inch) on new water distribution mains currently being constructed and not out of warranty.
- Colorado Springs Utilities shall install all tap connections 4 inches and greater, per the Water Rules and Regulations unless otherwise approved by Colorado Springs Utilities.

D. Excavation for Water Taps

The Contractor shall contact the Colorado Springs Utilities, Inspector's Office, LYSC, 1521 Hancock Expressway, Colorado Springs, CO 80903 2 working days prior to excavation. No service taps shall be made unless property corners are clearly marked so measurements of tap and stop box locations can be made at the time of tapping. Excavation is the responsibility of the Contractor and shall be done in accordance the following:

- The Contractor is responsible to provide safe access to and a safe excavation for Colorado Springs Utilities employees to complete the requested work. As dictated by OSHA (29CFR1926) and/or any other Authority Having Jurisdiction, the Contractor shall provide protection for employees required to work in excavations/trenches by the use of shielding, shoring, or sloping. If the depth exceeds four (4) feet, an access ladder, ramp, or stairs must be provided.
- Barricading of tapping excavations is the responsibility of the Contractor and shall be in accordance with requirements set forth by the Authority Having Jurisdiction. For work in Colorado Springs, refer to the Barricading and Detour Manual of the City of Colorado Springs. Barricading shall be in accordance with construction, installation and repair of rights-of-way openings for sub-surface utilities for work within El Paso County and in accordance with Colorado State Highway Department of Transportation standards and regulations for work within state highway rights-of-way.

- Backfilling and compaction of tapping excavations are the responsibility of the Contractor and shall meet the requirements of Section 5.18.

E. Tapping Procedures for Ductile Iron and PVC Pipe

Taps on the Colorado Springs Utilities' system shall be accomplished in a neat and professional manner. An Inspector shall be present at all times during the tapping process. The tap is subject to approval by the Inspector.

Type K copper service taps for PVC pipe shall be installed per *AWWA Manual M23 – PVC Pipe Design and Installatio*n – *Chapter 9* and the *Unibell Tapping Guide for PVC Pressure Pipe*. Type K copper service taps for DIP pipe shall be installed per *AWWA Manual M41 Ductile-Iron Pipe and Fittings* and *DIPRA's Installation Guide for Ductile Iron Pipe*. Reference Section 6.7B of these *Water LESS* for HDPE pipe tapping requirements. Tapping procedures shall comply with the following requirements:

- PVC and DIP pipe shall be direct tapped for ¾ inch & 1 inch Water Service Lines. Direct taps shall be at a 45 degree angle from the vertical.
- PVC and DIP pipe shall be saddle tapped for 1-1/2 inch and 2 inch Water Service Lines. Saddle taps shall be at a 90 degree angle from the vertical.
- PVC direct wet taps shall be made between the recommended temperature limits of 32°F (0°C) to 90°F (32°C).
- Only 6 inch through 12 inch PVC and DIP pipe can be direct tapped. Water mains greater than 12 inches in diameter shall be saddle tapped.
- Saddles taps shall be installed according to pipe manufacturer's recommendations (Do not over tighten).
- Saddle taps and direct taps shall be cathodically protected per Detail Drawing A8-10.

- Direct and Saddle Tap Placement
  - Tap no closer than 24 inches from both the back of the bell and the spigot line.
  - Stagger multiple taps and keep them at least 18 inches apart lengthwise or 36 inches on the same side of the pipe.
  - Do not tap discolored PVC pipe.

WATER TAPPING INSPECTION APPOINTMENT RETURN TRIP CRITERIA

Length of time to appointment date:	3 weeks to 4 business days prior to scheduled appointment date	1 business day prior to scheduled appointment date or scheduled appointment date	Re-Scheduled appointment date
Fee charged:	Cancel anytime No fee charged One Free Return trip fee not used up	Cancel anytime = Use up one free return trip, Next cancellation will be charged	Cancel anytime = Return trip fee applies per *Utilities Rules and Regulations*

Re-Inspection: If the water tap fails to pass inspection, the Inspector will immediately notify the Contractor of the deficiencies needing correction. All deficiencies must be corrected/remedied before a re-inspection may be requested and scheduled. Colorado Springs Utilities will schedule the re-inspection with the Contractor as appropriate.

If the Contractor is suspected to have performed an illegal, unapproved water tap into the Colorado Springs Utilities' system or any Private Water System (not behind a Master Meter connection) the tap shall be investigated and the Contractor may be fined in accordance with *City Code § 12.4.607* and *Utilities' Rules and Regulations*.

F. Tapping Asbestos Pipe

When tapping Asbestos water pipe for service connections, the Water Main shall be under pressure and the material shall be kept wet at all times. The pipe shall be tapped using a stainless steel repair clamp with a brass bushing specific to the tap size. The tap shall be made through the Corporation Stop according to the saddle tapping procedure.

To minimize the fouling of valves, pressure reducing valves, water meters and other appurtenances with Asbestos chips and the unnecessary addition of Asbestos to drinking water, provisions shall be made for downstream Flushing including the use of tapping equipment with positive purge or blow-off features. All Asbestos removal must be in accordance with Section 5.10B.

The appropriate safety equipment shall be utilized at all times when tapping Asbestos pipe.

G. New Water Service Lines

1. Inspection

All Water Service Lines (fire, Potable and Nonpotable including irrigation) shall be inspected by Colorado Springs Utilities. The inspection shall include the Water Service Line from the corporation to the Curb Stop, from the Curb Stop to the Structure, and an inspection of the meter installation.

2. Installation

When direct tapping the Water Main, an expansion loop must be left in the Water Service Line to allow for expansion and contraction of ¾ inch and 1 inch copper services, see Detail Drawing B1-1. If an existing tap has been abandoned in place per Section 2.7F it shall not be used for the Water Service Line, a new tap shall be made.

Copper Water Service Lines shall use flared joints between the main and the Curb Stop, no sweat, compression, or welded joints shall be allowed. Between the stop box and Structure, flared joints or silver wire or rods for brazing joints with the consistency of a dull grey finish in color may be used conforming to *ASTM B 32. (IPC 605)* No joints shall be placed under a vertical foundation wall or footer.

Water Service Lines 4 inches and greater must be installed in accordance with Sections 5.12 thru 5.19 and all other applicable Water Service Line installation Standards contained in this Section.

3. Crossing Other Utilities

Utility crossings shall be constructed per the Approved Construction Plans and Section 2.7E.2.

Where a sleeve is required, the ends shall be sealed to prevent the infiltration of debris and Groundwater. Refer to Section 2.7E.2 for the sleeve requirements.

Where the Water Service Line crosses another utility and less than 18 inches of clearance is maintained, the Water Service Line shall be backfilled with well graded sand or flow fill at the discretion of the Inspector.

4. Curb Stop and Stop Box

Stop boxes shall be located per the Approved Construction Plans and Section 2.7D.4. The stop box shall be centered over the Curb Stop and shall be plumb. The Contractor shall "tag" stop box lids with service addresses where multiple boxes are located in close proximity to one another using permanently affixed (bolted or screwed to lid) brass tags. (Reference Detail Drawing B2-4)

H. Fire Service Lines 2 Inches and Smaller

- All Fire Service Lines shall meet the same requirements as Water Service Lines for material and installation Standards. Fire Service Lines shall not be tapped from a Non Potable Water Main.
- Residential Water Service Lines for fire suppression installations must have plans approved by the Colorado Springs Fire Department and shall be constructed of a minimum of 1 inch copper or 1 ½ inch HDPE.
- Hydrostatic testing of Fire Service Lines shall meet the requirements of *NFPA-13* and shall be witnessed by the Colorado Springs Fire Department.

I. Warranty

The Contractor shall be responsible for the Curb Stop and stop box ends until 2 years after closing of the property and the final approval by the Inspector. After the warranty time period has ended, Colorado Springs Utilities will assume responsibility for repair and maintenance of the Curb Stop and stop box.

J. Repair or Replacement Water Service Lines

Water Service Line repairs and replacements shall be made with Colorado Springs Utilities approved materials in accordance with these *Water LESS*. Repair clamps are not permitted on Water Service Line Repairs. Mechanical fittings may be used on repairs with the Inspector's approval.

1. Galvanized Lines

Where repairing galvanized Water Service Lines approved materials specific for galvanized services shall be used.

Where an existing Public Water Main is being replaced and the Water Service Lines are galvanized, Colorado Springs Utilities shall replace the Water Service Lines with type "K" copper or HDPE from the Water Main to the Curb Stop located on or near the property line and the Curb Stop and stop box. Where an existing Private Water Main is being replaced, the galvanized Water Service Lines shall be replaced as described above by the owner of the Private Water Main.

2. Repair Due to Leaks

a) Colorado Springs Utilities Responsibilities

Colorado Springs Utilities will maintain that portion of the property owner's Water Service Line in the Right-of-Way or public utility Easement between the Water Main and the Curb Stop, if the Curb Stop is located on or near the Right-of-Way or public utility Easement line, in accordance with *City Code § 12.4.410*. Colorado Springs Utilities maintenance will include repairs with backfill and restoration of property, except when leaks and/or damage are caused by persons other than Colorado Springs Utilities employees. This does not include any Curb Stops or valves on Private Water Mains or Service Lines which are the responsibility of the property owner.

Colorado Springs Utilities will replace all Curb Stops that are damaged by Colorado Springs Utilities during any maintenance or installation work. This includes any stop box and/or Curb Stop that is damaged during the exchange of a meter or a shut off by Colorado Springs Utilities.

Colorado Springs Utilities will raise or lower all stop boxes as needed or requested for existing Colorado Springs Utilities' Customers.

b) Property Owner's Responsibilities

The property owner shall maintain that portion of the Water Service Line outside of the Right-of-Way or public utility Easement between the Curb Stop and the property, building, establishment or premises to be served, if the Curb Stop is located on or near the Right-of-Way or public utility Easement line, in accordance with *City Code § 12.4.410*. It shall be the responsibility of the property owner to initiate repairs on any and all service line leaks within the property to prevent the waste of water per *City Code § 12.4.410*.

The property owner is responsible for all damages that may occur to other property, real or personal, including property of the City that were caused by failure to repair and maintain the Water Service Line.

K. Abandonment or Removal of Existing Corporation Stops

See Section 2.7F.

L. Demolition or Remodel of Property

See Section 2.7G.

M. Tracer Wire

When a plastic service is installed from the property line valve to the building, Colorado Springs Utilities requires a tracer wire to be used to locate the pipe. The

wire shall be taped to the top of the pipe every 2 feet and extended to the Structure for the purpose of locating the service. See Detail Drawing B1-6.

N. Pressure Reducing Valve

The Contractor shall provide and install the Pressure Reducing Valve per Section 2.7I and Detail Drawing B1-4 through B1-11 of these *Water LESS*.

Where an existing Water Service, meter loop or pressure reducing valve are repaired or replaced, the owner of the property shall be responsible to ensure that the pressure reducing valve be located in front of the proposed meter location.

O. Water Meters

1. Installation

The Contractor shall be responsible for installing the meter loop. Colorado Springs Utilities shall install the water meter. All water meters shall be set horizontally.

2. AMR

All water meters will be AMR (Automated Meter Read) compatible with the current Colorado Springs Utilities' operating system. For water meter installations inside the building, the Contractor shall provide and install a four conductor wire interconnecting cable between the meter and the remote reader as shown on Detail Drawings B1-4 through B-11. The cable used shall be four conductor, No. 18- 22 gauge wire, and shall be installed along the approximate center of studs and joists using No. 1 insulated staples, leaving a 2 inch stress loop within the wall and shall be extended through the exterior wall at a distance approximately 3 feet minimum and 5 feet maximum above the ground, directly under the electric meter and/or over the gas meter. The cable cannot be spliced and a minimum of 24 inches of extra cable must be left at the meter loop and at the proposed remote reader location for connection by Colorado Springs Utilities. The installed wire shall be tested for electrical continuity at the time of installation. If the cable is to be installed in concrete or masonry walls, electrical conduit must be installed in advance of the cable installation.

3. Water Meter Pits and Vaults

The Contractor shall be responsible for installing the meter Pit or Vault. Meter Pits may be used for ¾ inch and 1 inch Water Service Lines only. Water Service Lines 1 ½ inches and greater require installation of a meter Vault.

The meter Pit or Vault shall be located on or near the property line. If a problem arises at this location, prior to or during installation, the location of the meter Pit or Vault shall be changed at the discretion of the Inspector. Grade rings shall be used to raise the meter Pit or Vault cover to match the proposed elevation or slope in a driveway or landscape area application. A 12-inch wide metal ladder shall be installed securely to the wall of meter Vaults. No wooden ladders will be accepted.

There shall be no form of a reducer inside the meter Vault and/or meter Pit. All pipes coming into any meter Vault and/or meter Pit 3 inch or larger shall be

flange pipe only and shall be reverse anchored to the outside of the meter Vault or Pit. Refer to Detail Drawings B3-1 through B3-5.

The Water Service Line shall be constructed of type K copper from the Curb Stop to the outside meter Pit. Transition to HDPE may be made with an approved coupling on the outlet side of the meter inside the meter Pit (3/4 inch and 1 inch only). See Detail Drawing B1-5.

No mechanical restrained joint pipe shall be installed in the Water Service Line closer than 4 feet from either side of the meter Vault. Neither plastic pipe nor plastic fittings shall be used inside the meter Vault or closer than 5 feet from either side of the meter Vault. See Detail Drawings B3-1 through B3-5. Any Vault openings shall be grouted with non-shrink grout.

After the initial warranty period expires, meter Pits shall be maintained by the property owner in compliance with the requirements of the Colorado Springs Utilities.

P. Backflow Prevention

Containment Backflow Prevention Assemblies shall be installed per the Approved Construction Plan and Section 2.7L and Detail Drawings B1-3 through B1-22 of these *Water LESS*.

1. Installation

All installations shall conform to the design requirements specified in Section 2.7L. Additional insulation may not be applied directly to the Containment Backflow Prevention Assembly. Use of temporary mechanical joints or quick connection type fittings is not permitted. Whenever additional support is required for a Containment Backflow Prevention Assembly, the support must be independent of all plumbing and piping systems and must not interfere with the operation or maintenance of the assembly.

Requirements for the Reduced Pressure Backflow Prevention Assemblies (RP)

- An RP is only approved in the horizontal orientation unless certified for vertical use by its listing with the *Foundation for Cross-Connection Control and Hydraulic Research of the University of Southern California (USC – FCCCHR)*
- The installation height of the RP shall be measured vertically from the lowest point of the relief valve to the prevailing grade and shall conform to all design requirements listed in Section 2.7L. Particular attention must be given to the RP to ensure a proper Air Gap is maintained at the relief valve. An Air Gap shall be maintained per Detail Drawings B1-3 through B1-22.

2. Testing

Only a Cross-connection Control Technician, certified in accordance with the requirements of the State Health Department, may test a Containment Backflow Prevention Assembly. The following testing schedule shall be applied to all Backflow Prevention Assemblies:

- Initial Start-Up Testing: All Containment Backflow Prevention Assemblies must be tested at the time of installation and whenever Water Service is restored after the Water Service Line has been disconnected for 30 days or longer.
- Annual Testing: All Containment Backflow Prevention Assemblies must be tested at least once a year following the initial start-up test.

3. Operation and Maintenance

- Only a Cross-connection Control Technician, certified in accordance with the requirements of the CDPHE, may repair a Containment Backflow Prevention Assembly.
- Whenever a Containment Backflow Prevention Assembly is found to be defective, it must be repaired or replaced within 10 days of discovery pursuant to *City Code § 12.4.1211*.
- A Containment Backflow Prevention Assembly must be replaced with an assembly of equivalent or greater protection than provided by the original assembly.

4. Inspection

- Colorado Springs Utilities shall have final approval authority for all Containment Backflow Prevention Assemblies.
- Backflow Prevention Assemblies that do not meet all provision of the Colorado Springs Utilities' *Water LESS* shall be corrected within 10 days of discovery, pursuant to *City Code §12.4.1211*.

5.22 Pipe Line Markers

Utility line markers are to be used on all cross-country Water Mains and on Water Mains where development has not yet been established to locate the existing/proposed Water Main. Marker posts are to be placed at valve locations and horizontal pipe deflections or as designated by the Inspector. Spacing for marker posts shall be a maximum of 250 feet. Line markers are to be installed with Colorado Springs Utilities' decal and telephone number.

5.23 Surface Restoration and Maintenance

A. Cleanup

Upon completion of Construction, all debris, excess materials, temporary Structures and equipment shall be removed from the construction Site. The Site shall be cleaned and restored to the satisfaction of the Authority Having Jurisdiction. Disturbed areas shall be seeded or otherwise protected to control erosion as specified by the Authority Having Jurisdiction. Seeded areas will be maintained to control noxious weeds until acceptable stabilization is achieved, as determined by Colorado Springs Utilities.

B. Surfaced Areas

The Contractor shall restore all pavement, sidewalks, curbing, gutters or other surface Structures removed or disturbed as part of the work to a condition meeting the standards of the Authority Having Jurisdiction, and shall furnish all incidental labor and materials.

All streets shall be restored in accordance with the regulations and requirements of the Authority Having Jurisdiction over the street, roadway or Right-of-Way.

No permanent pavement shall be restored until, in the opinion of Colorado Springs Utilities or the Authority Having Jurisdiction, the condition of backfill is capable of properly support the pavement. See Section 5.18 of these *Water LESS* for backfill and compaction of backfill.

1. Un-surfaced Areas

The Owner/Developer shall be responsible to provide restoration and landscaping adequate to prevent erosion caused by surface runoff. Landscaping and restoration construction shall be designed in such a manner that minimal future maintenance will be required, and maintained until acceptable stabilization is achieved, as determined by Colorado Springs Utilities.

Access drives shall be constructed per the Approved Construction Plans, see Detail Drawing A3-11 and Section 2.6G.5 of these *Water LESS*.

2. Damaged Surfaces and Property

If any pavement, street, shrubbery, sod, rock, fences, poles or other property and surface Structures have been damaged, removed or disturbed by the Contractor, whether deliberately or through failure to carry out the requirements of the controlling agency or the specific directions of Colorado Springs Utilities, or through failure to employ usual and reasonable safeguards, such property and surface Structures shall be replaced or repaired, to the original condition, at the expense of the Contractor.

TABLE OF CONTENTS

CHAPTER 6
High Density Polyethylene Pipe and Trenchless Technologies

CHAPTER 6

High Density Polyethylene Pipe and Trenchless Technologies

6.1 General

The purpose of Chapter 6 is to provide the criteria to be used when designing and constructing the Water System where High Density Polyethylene Pipe (HDPE) and/or Trenchless Technologies will be utilized. All Construction Plans for HDPE and Trenchless Technologies shall be in accordance with criteria specified in these *Water LESS*. Additional information regarding HDPE and Trenchless Technologies design and construction may be found in *AWWA Manual M55, PE Pipe Design and Installation, and the Plastics Pipe Institute (PPI), www.plasticpipe.org* .

6.2 HDPE Water Main Planning

This section covers the requirements for DIPS DR9 PE4710 HDPE piping for Potable Water Distribution and Transmission Mains. HDPE pipe is typically used where directional drilling is needed for placement of Water Distribution, or Transmission Mains with no Water Service connections. HDPE may be required at the discretion of Colorado Springs Utilities where the Water Main will be constructed:

- in boring applications,
- in areas of high pressure (greater than 170 psi and less than 200 psi. Where pressure may exceed 200 psi, use of HDPE will be reviewed on a case by case basis)
- in highly corrosive soils,
- in Traditional Neighborhood Development,
- and in areas with known soil movement.

A. HDPE Planning

Planning and responsibility of a HDPE Water Main System Extension shall be in accordance with Section 2.5. It is highly recommended that when a HDPE Water Main is being proposed, the Design Engineer and Contractor be experienced with HDPE to execute the planning, design and construction of the Project, ensuring that a quality Water System Extension is obtained. Geotechnical research is required for Construction of HDPE Water Mains in open cut or directional drilling applications. See Trenchless Technology Applications beginning with Section 6.8.

B. Sizing of HDPE Water Mains

When sizing a HDPE Water Main, the Sizing of Water Mains/Hydraulic Analysis and Fire Flow Requirements in Section 2.5A will apply. Upsizing the proposed Water Main may be required due to the smaller internal diameter of DR9 HDPE pipe. HDPE Water Distribution Mains shall be a minimum of 8 inch DIPS in diameter.

C. HDPE Connection Requirements

When designing HDPE Water Mains, attention must be paid to the connections made to the existing Colorado Springs Utilities Water Distribution System. All fitting assemblies throughout the project shall be detailed on the Construction Plan.

HDPE connections to an existing PVC or DIP Water Main shall be accomplished in accordance with Section 2.6D of these *Water LESS* utilizing approved mechanical joint materials and fittings, in nominal sizes. Design and Construction for connections 16” and larger will be reviewed on a case by case basis. The Design

Engineer must specify the method of connection to the Water Distribution System on the Construction Plans. For approved connection configurations, see Detail Drawings A10-1 through A10-9. See Section 2.6D Connection Requirements and Section 5.10 Water Main Connections to Colorado Springs Utilities System, for additional connection requirements for Water Mains.

6.3 HDPE Site/Horizontal Design Criteria

When designing a HDPE system, the Design Engineer shall allow enough room or footprint for equipment and assembly of the HDPE pipe and all appurtenances.

A. HDPE System Materials

HDPE expansion and contraction must be accounted for in the design and construction of the Water System. HDPE materials will expand and contract until placed in the trench and stabilized with ambient ground temperatures and constant water pressure.

HDPE piping shall not be installed in soils where contamination incompatible with HDPE exists.

1. Expansion and Contraction

The Design Engineer shall use the following coefficients of linear thermal expansion/contraction for calculations unless specific documentation is submitted and approved for a project.

Coefficients of linear thermal expansion/contraction

Piping Material (Plastic Pipe Pressure Grades Identified by Parenthesis) (1)	Coefficient of Linear Thermal Expansion, ASTM D696 (in/in x°F)	Resultant Pipe Expansion (inches/100 feet x 10°F)
Steel	6.7×10^{-6}	.08
Cast Iron	5.9×10^{-6}	.07
Copper	9.3×10^{-6}	.11
PE, Medium Density (PE 2406)	9.0×10^{-5}	1.10
PE, High Density (PE 3408, 4710)	9.0×10^{-5}	1.10
PEX (PEX 0006)	9.0×10^{-5}	1.20
PVC, 12454 & 12364	3.0×10^{-5}	.36
PVC, Unmodified (PVC 1120 & 1220)	3.5×10^{-5}	.42

For calculation of expansion/contraction due to pressurizing the pipe, the Design Engineer shall use a Poisson Ratio of 0.45 as recommended by the *Plastics Pipe Institute Handbook of Polyethylene Pipe.*

2. Pressure Requirements

Colorado Springs Utilities has established minimum design safety factors for system piping in Section 2.6C Water Main Material and Pressure Class. All HDPE pipes shall conform to the material Specifications, and shall be installed and tested in accordance with the current version of ANSI/AWWA Standards HDPE pipe.

3. Polyethylene HDPE Pipe

For all information regarding approved HDPE pipe and materials see the Section 4.4B.6 Approved Materials.

B. Concrete Reverse Anchors for HDPE

When HDPE piping is connected to unrestrained mechanical couplings or bell and spigot joints, thermal expansion/contraction and the Poisson effect can cause pullout of the HDPE pipe from PVC or DIP joints in the transition area.

To prevent this pullout, protection shall be provided by installing a Concrete Reverse Anchor (CRA) with a wall anchor on the HDPE main. A CRA with a wall anchor shall be placed a minimum of 5 feet and maximum of 10 feet on the HDPE main at all fittings and transitions. See Detail Drawings A10-1 through A10-9 for placement details. The Design Engineer shall show the method of restraint and the location and size of CRA on the Construction Plans. CRAs shall be designed in accordance with Section 2.6G.9 Concrete Thrust Reaction Blocks, Concrete Reverse Anchors and Mechanical Joint Restraints of this *Water LESS* and Detail Drawing A4-8, also see *AWWA Manual M55* for more information regarding pullout prevention.

Where the HDPE pipe slope is 10 % or greater, a CRA with a wall anchor fitting is required within 10 feet of the Fitting before the top of the slope and 10 feet from the fitting after the bottom of the slope.

C. HDPE Fire Hydrant Lateral Criteria

Design and Construction of fire hydrants shall be in accordance with Sections 2.6G.10 and 5.13D.3 of these *Water LESS* except for the following:

Connections to HDPE mains for Fire Hydrant Laterals shall be accomplished with a cut in tee, valves and wall anchors. The hydrant lateral may be constructed of approved Water Main pipe material with the following requirements:

- When the hydrant lateral pipe is constructed of HDPE pipe, a minimum nominal diameter of 8 inch DIPS DR9 PE4710 HDPE pipe must be utilized with an 8 inch hydrant valve.
- A CRA with a wall anchor will need to be placed in the hydrant lateral at the mid point if the lateral length is 20 feet or less.
- When the hydrant lateral is greater than 20 feet in length a minimum of 2 CRAs with wall anchors will be required, each being placed a minimum of 5 feet and maximum 10 feet from the hydrant valve and hydrant shoe.
- An 8 inch by 6 inch DR9 HDPE reducer with a DR9 HDPE 6 inch MJ Adaptor shall be fused onto the HDPE hydrant lateral so that the hydrant can be bolted onto the lateral with usual hydrant placement, blocking and restraints, as illustrated in Detail Drawing A10-9.

D. Bends and Deflection

HDPE pipe may be cold field bent without affecting the working pressure rating of the pipe. The minimum cold bend radius for DR9 HDPE pipe installed in an open cut trench is 20 times the pipe OD. When a fitting or flange is present or is to be installed near or in the radius then the minimum radius is 100 times the pipe OD for a distance

of 5 times the pipe diameter on either side of the fitting location. Due to the flexibility of HDPE pipe, actual manufactured pipe bends may not be needed in some situations. If a radius is less than the minimum allowable bending radius for HDPE pipe, then a standard pipeline fabricated bend 22-1/2° or 45° bend is required. DIP material bends can also be used with HDPE pipe and HDPE MJ adapter fittings.

E. Blow Offs

All temporary dead-ends on new HDPE mains will be reviewed on a case by case basis.

F. Vaults

Transition from HDPE to steel or ductile iron pipe shall be made a minimum of 10 feet from either side of the Vault. Piping and fittings in the vault shall not be constructed of HDPE.

6.4 HDPE Vertical Design

HDPE Water Main System plan and profile Construction Plan criteria information follows in this section. This section is to be read in conjunction and applied with Chapter 2.1 of this *Water LESS*.

A. Plan and Profile Requirements and Depth of Bury

All HDPE Water Mains and Service Lines greater than 6 inch shall have both plan and profiles submitted as part of the Water Construction Plan set. In addition, all HDPE Construction Plans will be in compliance with Section 2.6H.1 Depth of Bury of these *Water LESS*.

Per *AWWA M-55* Maximum burial depth for DR9 HDPE pipes requiring no calculations is 25 feet. For depths greater than 25 feet refer to *AWWA M55 or PPI* for design calculations that must be submitted for review by Colorado Springs Utilities.

B. Crossings

This section shall be read in conjunction with Section 2.6H Crossings.

1. Utilities

When crossing another utility or service line, minimum vertical separation is required to be maintained, refer to Sections 2.6G regarding Separation Criteria and 2.6H Crossings. In the event that a water lowering may be required to meet the vertical separation criteria the lowering can be accomplished with a bore or with HDPE fittings fused in place.

Where the Water Main crosses a Wastewater Main, Nonpotable Water Main, or Storm Sewer and the vertical separation criteria cannot be met the Water Main shall be constructed of HDPE with no fittings located within 9 feet of the centerline of the crossing.

Where an HDPE Water Main crosses under another utility greater than 30 inches in size, the Water Main may need to be engineered for a boring application or another construction alternative.

Generally a casing is not used with a HDPE lowering. However, if the HDPE pipe is to be installed in a casing pipe, care must be taken to ensure that the HDPE pipe entering and exiting a rigid (non-PE) casing is not subjected to shear or bending loads.

If the HDPE Water Main crosses over or under another utility infrastructure, bridging and anchoring of the upper utility infrastructure may be required. Refer to Section 2.6H and Detail Drawing A7-5.

2. Drainageways

When crossing under any drainage channel the HDPE Water Main shall be designed as a Trenchless application with a minimum 7 foot separation from the existing or proposed channel flow line, whichever is greater, to the top of the HDPE pipe.

3. Bridges

Use of HDPE on a bridge or an aerial crossing is not allowed.

4. Major Roadways and Railways

Installation of HDPE Water Mains across Rights-of-Way or Easements, such as major roadways, railroads, irrigation channels etc. may require casing pipes or a Trenchless application as determined by Colorado Springs Utilities and the agency granting permission to cross. The type of casing material and its properties or the boring design shall be reviewed by the agency granting permission to cross with the approval of Colorado Springs Utilities. In the absence of casing Specifications refer to Detail Drawing A7-3 and A7-4 for design and construction of the casing.

5. Traffic Calming Devices, Medians and Above-Ground Structures

Colorado Springs Utilities shall review and approve any plans where the existing or proposed HDPE Water Main crosses traffic calming devices such as roundabouts, Refer to Section 2.6H.6.

Generally, when HDPE is used under a traffic calming device, a sleeve is not required. Refer to Section 6.8.

6. Galvanic Anodes with HDPE Installations

All metallic fittings and appurtenances (valves, hydrants, bends, crosses, tees, etc.) shall be installed with one high potential magnesium anode bonded to the metal. Where fittings are electrically continuous, a minimum of one anode may be installed to protect all the fittings. Anode sizes shall be a minimum of 9 lbs for individual fittings and 17 lbs for hydrants, temporary blow off valve assemblies, bridging supports, and bonded fittings, based on the average soil resistivity in Colorado Springs and a design life of 25 years for the anode.

6.5 HDPE Water Service Line Design

The design of HDPE Water Service Lines shall be done in conjunction with Section 2.7. In general HDPE Water Service Lines shall be upsized one nominal pipe size from type K copper sizing.

A. HDPE Water Taps and Service Line, Sizing and Material

HDPE Service Line taps and sizes include 1inch, 1-1/2 inch, and 2 inch. The minimum CTS DR9 PE4710 HDPE Service Line size is 1 inch. The maximum size of an HDPE service line and tap is 2 inch. Water Service Line connections on HDPE Water Mains shall be accomplished by applying a HDPE Sidewall fusion tapping saddle to the main See Section 4.5B.3 for additional information.

Table 6-5 - HDPE 4710 CTS Pipe Size compared to Copper Type "K" Tube Size

Pressure Class	Pipe Size (inch)	Minimum Wall (inch)	O.D. (inch)	Approximate I.D. (inch)	Typical Type "K" copper I.D. (inch)
250	1"	0.125	1.125	0.860	0.995
	1 1/2"	0.181	1.625	1.241	1.481
	2"	0.236	2.125	1.625	1.959

Flow capacity of HDPE CTS pipe varies with the inside diameter of pipe, pressure source, length of pipe connection to the Structure, elevation differences and number of fixtures within the building. It may be necessary to up-size the Water Service Line to a larger size to meet the necessary flow capacity, See 6.5 Table 6-5. The Water Service Line shall be the same size from the Corporation Stop to the Curb Stop or Secondary Valve. If necessary, the size of the Water Service Line may be increased or reduced from the curb stop or Secondary Valve to the meter and/or Containment Assembly if applicable per Section 2.7C.

Where HDPE is used between the Curb Stop and the inside meter, transition to copper shall be made at a transition coupling inside the building. Copper shall then be used until 5 feet after the meter outlet valve and/or Containment Assembly outlet valve as applicable, See Detail Drawing B1-6 and B1-7. For outside meter pits (3/4 inch and 1inch meters) the Water Service Line shall be copper from the Curb Stop to the tandem copper meter setter, transition to HDPE shall be made inside the pit after the tandem copper meter setter. For outside meter vaults (meters 1 ½ inch and greater) the Water Service Line shall be copper from the Curb Stop/Secondary Valve to the meter continuing to a point 5 feet outside the meter vault. Transition to HDPE may be made after the Containment Assembly in an above ground lockable enclosure or in a separate vault. In no case shall the transition coupling be buried.

1. Sizing of HDPE Residential Water Service Lines

Typical residential HDPE water service can be accomplished with a 1 inch CTS DR9 HDPE PE4710 Water Service Line. See Section 2.7C for sizing of Water Service Lines and Fire Lines.

2. Sizing of HDPE Commercial Water Service Lines

HDPE Water Service Lines shall be sized per Section 2.7C for sizing of Commercial Water Service Lines. If the Mechanical Engineer has determined that the Water Service Line sizing is larger than 2 inches, then an alternate approved material for the Water Service Line must be used.

B. HDPE Water Service Line Horizontal Design Criteria

1. Residential HDPE Water Service Line Horizontal Design Criteria

When designing residential HDPE Water Service Lines refer to the information listed in Section 2.7D Residential Water Service Line Horizontal Design Criteria for Easement and Water Service Line alignment into the lot. The HDPE Water Service Line must extend from the Curb Stop into the foundation and up through the lowest level floor. The HDPE Water Service Line may not be terminated in a crawl space, and must be extended a minimum of 6 inches above the floor to allow for bracing and transition to the meter loop assembly. All HDPE Water Service Lines shall have a tracer wire from the corporation tap in the main to the Curb Stop and from the Curb Stop to follow Water Service Line to the outside of the foundation and is to be terminated in a test station box. See Detail Drawing B1-6 and Section 6.7D Tracer Wire.

2. HDPE Commercial Water Service Line Horizontal Design

Horizontal separation between the HDPE Water Service Line and other utility infrastructure shall meet the requirements as stated in Section 2.6G Separation Criteria and in accordance with Section 2.7D.2 Commercial Water Service Line Horizontal Design.

C. HDPE Separation Design Alternatives

Horizontal and vertical separation between the Water Service Line and other utility mains shall meet the requirements as stated in Section 2.7D.3 Separation Criteria.

D. HDPE Curb Stop and Stop Box

All HDPE Water Service Lines shall comply with Section 2.7D.4 Curb Stop and Stop Box.

E. HDPE Water Service Line Vertical Design Criteria and Depth of Bury

All HDPE Water Service Lines and Curb Stops shall be in compliance with Section 2.7E.1 Water Service Line Vertical Design Criteria of this *Water LESS*.

F. Water Metering on HDPE Water Service Lines

Metering of HDPE Water Service Lines shall be in compliance with Section 2.7J Water Meters of this *Water LESS*.
If a Meter is to be placed in a Meter Pit or Vault then it shall be installed in accordance with Drawing B1-5 or B 3-1, B3-2, B3-3, B3-4 and B3-5.

6.6 HDPE Construction

This section shall be read in conjunction with Chapter 5.1 in regards to the Construction of HDPE Water Mains. View Chapter 4.1 Approved Materials for approved pipe and fittings allowed to be used for HDPE mains and Water Service Line Construction.

A. Fusion Certification

The Contractor shall ensure that persons making heat fusion joints have received training in the manufacturer's recommended procedure and a copy of this training certification for said persons is available for inspection by the Inspector. The Contractor shall maintain records of trained personnel, and shall certify that training was received within twelve (12) months before commencing Construction. Only a

certified operator shall be permitted to weld, fuse and install HDPE pipe. Training shall comply with the *Recommended Minimum Training Guidelines for PE Pipe Butt Fusion Joining Operators for Municipal and Industrial Projects- PPI -TN-42*.

B. Fusion Records

Electronic print-out records of appropriate joint fusion procedure details shall be kept on pipe fusions for all HDPE pipes 6 inch and larger. Copies of the data logger information and drawing showing locations shall be submitted to Colorado Springs Utilities (Water/Wastewater Standards Department) for review and recordation purposes before final approval of the job. The minimum typical information to be given is illustrated in the image below. (Output may vary with recording device).

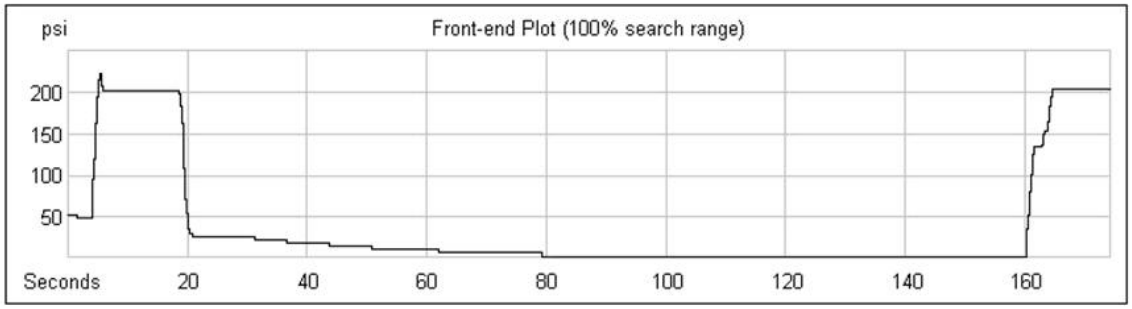
Each weld/fusion on the pipe and fittings during Construction is to be labeled and marked with a contrasting permanent color marker detailing: Company name, fusion technician's initials or stamp in the bead, date of the fusion and construction project number, and joint number to correspond with the fusion data log record.

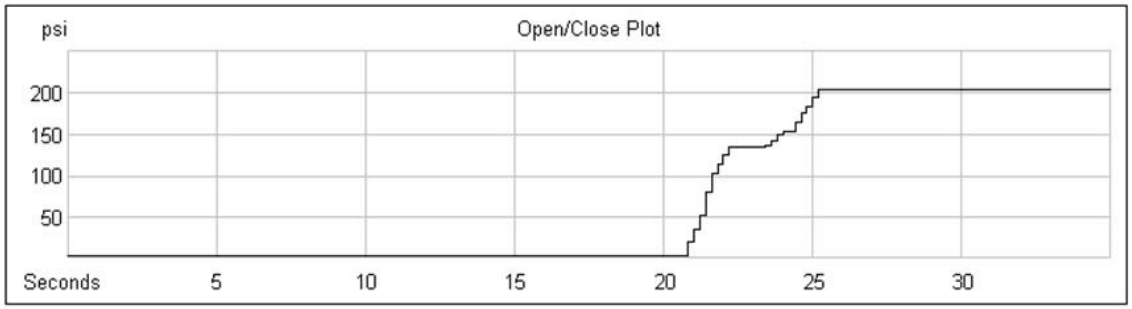
1. Date && Time: 2004/09/02 08:20:09
2. Joint Number : 9
3. Job Number : gdru
4. Employee ID : Jesse
5. Machine ID : mr3
6. Mach. Model : #28 HF
7. Piston Area : 4.710 in²
8. Pipe Material : US Poly PE 2406
9. Pipe Size : 6" IPS DR 11.5

Interfacial Pressures (psi):
12. Heat : --
13. Soak : 0
14. Fuse : 75
15. Cool : 75

Recommended Gauge Pressures (psi):
18. Heat : -----
19. Soak : 30
20. Fuse : 204
21. Cool : 204

Recorded Data:
23. Drag Pressure: 30 psi
24. DataLogger Probe: 440 °F
25. External Probe: ---
26. MDL3-0151 v0.1.4 DL3-PPC v0.1.6
27. Notes:





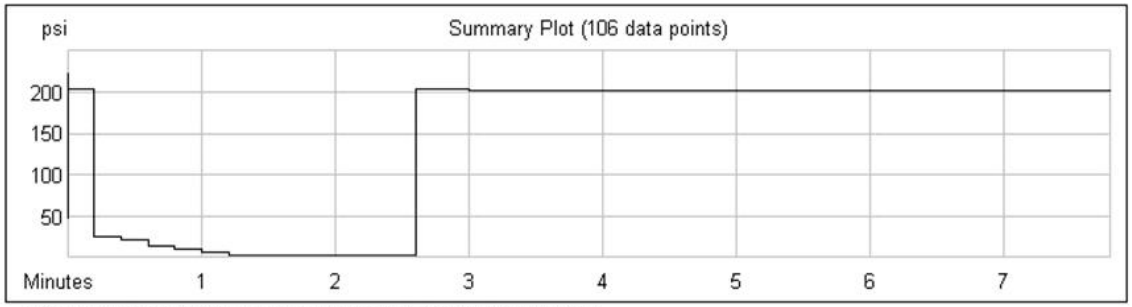


Figure 6-1 - Example of a Heat Fusion Joint Record (typical output for a McElroy Data logger)

C. Inspections
All Construction shall be inspected by an Inspector with the authority to halt Construction if, these *Water LESS* are not met. Whenever any portion of these *Water LESS* is violated, Colorado Springs Utilities may order further Construction to cease until all deficiencies are corrected.

D. Tracer Wire
A tracer wire shall be used to locate the pipe, being taped to the top of the pipe on all open trench placed main and Water Service Lines. (Reference Section 4.4P of these *Water LESS*)

In a boring application 2 tracer wires shall be pulled in along with the pipe. In the event that both tracer wires are broken during the pipe pull then the Contractor shall separately install a parallel HDPE tubing to place a new tracer wire approximately 3 to 4 feet above the HDPE pipe. If additional tracer wires need to be placed, potholes every 50 feet will be needed to verify the location of the tubing and wire are located above the HDPE Water Main. Additional information will need to be referenced on the record Construction Plan so that future locates can be made aware of the difference in depth and location to the actual Water Main placed.

E. Trench Placement of Pipe
HDPE pipe shall not be dragged over the ground as it may be susceptible to damage from sharp objects. Ropes, fabric, or rubber protected slings and straps shall be used when handling pipes. Chains, cables, or hooks inserted into the pipe ends shall not be used. Two slings spread apart shall be used for lifting each length of pipe. Pipe or fittings shall not be dropped, or placed onto rocky or unprepared ground. Slings for handling the pipeline shall not be positioned at butt-fused joints. Sections of the pipes with cuts and gouges exceeding 10 % of the pipe wall thickness or kinked sections shall be removed and the ends rejoined. The open ends of all sections of joined and/or installed pipe (not in service) shall be plugged at night to prevent animals or foreign material from entering the pipeline or pipe section.

Waterproof nightcaps of approved design shall be used to prevent the entrance of any type of natural precipitation into the pipe. The practice of stuffing cloth or paper in the open ends of the pipe is unacceptable.

When the HDPE pipe has been placed in the trench and backfilled, the Contractor shall leave the two end sections exposed to allow for any expansion or contraction of the pipe. After a period of 48 hours or once the pipe has reached ambient temperature of the existing (trench) ground, the end sections can then be connected to the fitting or existing pipe. HDPE should not be installed where temperatures drop below 40 degrees Fahrenheit.

F. Heat Fusion Joining
Joints between plain end pipes and fittings shall be made by butt fusion. The butt fusion shall be made in accordance with the pipe and fitting manufacturers' recommendations (*reference PPI TR-33*). HDPE branch connections to the Water Main shall be made with a tee or cross of fabricated/molded fittings.

G. Bead removal from HDPE Pipe

All internal beads and some external beads around HDPE fittings shall be removed unless otherwise specified, after the allowable cooling time for bead removal using a suitable bead removing tool specified for HDPE pipe. The bead removal tool shall not induce any slits, gouges or defects in the pipe wall, as recommended by the manufacturer. The minimum length of pipe allowed to be fused is 30 feet. When mating up to a fitting configuration a shorter HDPE pipe pup may be used. Excessive fusions in the HDPE Water Main may increase the disinfection contact time for the pipeline to pass, see Section 6.6J.

H. Electro fusion Fittings and Couplings

Electro fusion fittings and couplings are not permitted for use in the Colorado Springs Utilities systems.

I. Stainless Steel HDPE Stiffener Insert for HDPE Pipe

A stainless steel stiffener shall be installed and used whenever the plain end of a HDPE pipe is to be placed into a mechanical fitting. The connection shall be restrained to prevent pullout during thermal expansion and contraction of the pipe see Section 6.3B.

J. Disinfection of HDPE Pipe

All Water Main extensions shall be chlorinated in accordance with *AWWA C651*. The chlorination method used for main disinfection shall be approved by Colorado Springs Utilities as outlined in Section 5.20.

All HDPE Water Mains shall use the chlorine solution injection method. The Contractor must provide an injection tap or suitable hydrant with the proper isolation valves for disinfection as well as a suitable flush point. Colorado Springs Utilities shall disinfect HDPE Water Mains at no charge to the Contractor, with the exception that the Contractor shall excavate the tapping holes, pay for all required appurtenances and provide labor, material and an acceptable plan to transmit and contain water discharged during flushing, and have a representative present during the disinfection procedure.

All disinfections shall be evaluated on a case-by-case basis and additional appurtenances may be required for chlorine injection and air relief at the expense of the contactor. It shall be the Contractor's responsibility to notify Colorado Springs Utilities, Laboratory Services Section 2 working days in advance of the disinfection date.

NOTE: All HDPE Water Mains must have a minimum contact time of 36 hours – they may be flushed the morning of the second day after disinfection.

6.7 HDPE Water Service Line Construction – All New and Replacement HDPE Water Service Lines

Typical Construction for HDPE service lines is done by excavation or trenching. Colorado Springs Utilities will require pre-approval for any micro tunneling, pipe bursting or directional boring installations for HDPE water service connections see Section 6.11 on Trenchless Technology Applications.

A. HDPE Certification

The Contractor shall ensure that persons making heat fusion joints have received training in the Manufacturer's recommended procedure for the size of installation in

accordance with *ASTM F2620 and Plastic Pipe Institute (PPI) TR-33*. A copy of this training card/certification for said person shall be available, for inspection by the Colorado Springs Inspector, if required. The Contractor shall maintain records of trained personnel, and shall certify that training was received within twelve months before commencing Construction. Only a certified operator shall be permitted to fuse and install HDPE Water Service Line pipe.

B. HDPE Service Line Tapping

All HDPE Service Taps off of a HDPE Water Main shall be accomplished utilizing a side wall fusion tapping saddle connection, it shall be the same size of tap as proposed Water Service Line material, for 1 inch, 1-1/2 inch and 2 inch taps, and shall be at a ninety (90°) degree angle from the vertical (i.e. 3 or 9 o'clock position), see Detail Drawing B1-1. No reducing couplings or additional fittings are allowed at the Corporation Stop. The brass Corporation Stop shall be wrapped to prevent corrosion.

C. HDPE Water Service Line Installation

The HDPE Water Service Line shall be installed horizontally in a "snake-like" laying configuration to allow for both expansion/contraction movement of the pipe in the trench. The HDPE Water Service Line shall consist of 1 piece of continuous pipe from the Corporation Stop to the Curb Stop/Secondary Valve, no fittings or connections are allowed. The Curb Stop/Secondary Valve may not be placed under concrete or paved driveway areas. If the Water Service Line needs to be extended to accommodate moving the Curb Stop/Secondary Valve out of a concrete or paved area, only butt fusion additions to the Water Service Line may be used.

HDPE Water Service Lines shall not be in direct contact with concrete. A sleeve is required at the location where HDPE pipe penetrates the foundation or concrete wall of a building, see Detail Drawing B1-12.

D. Water Service Line Tracer Wire

Colorado Springs Utilities requires No. 12 copper clad steel (boring and direct bury applications) insulated tracer wire to be used to locate the pipe. Tracer wire shall be taped to the top of the HDPE pipe on all Water Service Lines at every 2 feet. Wire connections shall be waxed taped for corrosion protection, Reference Section 5.21M of these *Water LESS*.

E. Stainless steel CTS Stiffener

Inserts are required at all HDPE connections to fittings, see Section 4.5B Approved Materials.

F. Repair of HDPE Water Service Lines

The Contractor shall ensure that persons making heat fusion joints have received training and are certified as per Section 6.7A HDPE Certification.

Repair to HDPE buried Potable Water pressure pipes shall be in accordance with general guidelines in *ASTM F2620, PPI Handbook of Polyethylene Pipe Chapter* 15. Colorado Springs Utilities recommends that repairs be made by butt fusion. Mechanical couplings are allowed with the approval of Colorado Springs Utilities.

Reference Approved Manufacturer's heat fusion joining procedures and *PPI TR-33 - Table* 2.

G. Water Service Line Transition and Repair Fittings

No splice connections are allowed between the Corporation Stop (tap) and the Curb Stop and from the Curb Stop to the meter set on new Construction of Water Service Lines (See Detail Drawing B1-6, B1-7). Also see Section 4.5B.3 Approved Materials for approved HDPE transition and repair couplings. Repair couplings are only to be used to re-establish a damaged HDPE Water Service Line.

6.8 Trenchless Technology Applications

The purpose of this section is to provide the criteria to be used when designing the layout and construction details of the Water System utilizing Trenchless Technology applications (Trenchless).

Horizontal Directional Drilling (HDD), Boring by Tunnel Bore Method (TBM) or Guided Bore Method (GBM), Auger Bore Method (ABM) and Pipe Bursting as well as Pipe Lining are considered Trenchless construction methods. The Owner/Developer will be responsible for hiring an experienced Design Engineer, Contractor, and Geotechnical Engineer as required to design and construct a Water Main utilizing these methods of construction. The Design Engineer should coordinate with the Contractor and the Geotechnical Engineer to develop the Construction Plan. Colorado Springs Utilities recommends professionals experienced in working with Trenchless methods to streamline the planning, design and construction of the Project and to ensure that a quality Water System Extension is obtained.

Additional reference information regarding Specifications Codes and Standards of Trenchless design and construction may be found in:

- *AWWA Manual M55*
- *ASTM F1962*
- *PE Pipe Design and Installation, Plastics Pipe Institute (PPI), www.plasticpipe.org*
- *Trenchless Technology Pipeline and Utility Design, Construction, and Renewal, WEF Press*
- *Horizontal Directional Drilling Good Practices Guidelines, HDD Consortium*

A. Trenchless Planning and Design

This section addresses a wide range of information and precautions necessary to ensure that a proper Trenchless design is adequately addressed.

1. Geotechnical Requirements

The Design Engineer shall obtain a geotechnical analysis report to determine constructability and feasibility of the project. Core sample locations shall be determined by the Design Engineer, Geotechnical Engineer, and the Contractor. A minimum of 3 core samples shall be collected for every 1,000 feet of the project, or as determined by the Design Engineer. A minimum of one core sample shall be collected at the deepest projected point of a bore or tunnel. All core samples shall be located a minimum of 25 feet off of the bore or tunnel alignment with the exception of pipe bursting where the core samples may be located on the center line of the Water Main alignment. For projects 200 feet in length or less, the necessity and number of core samples will be determined by the

Design Engineer, Geotechnical Engineer, and the Contractor. Colorado Springs Utilities may require additional core samples as needed for information.

2. Horizontal Directional Drilling (HDD) Site Design Criteria

This section covers installation of underground utility infrastructure using the directional boring (horizontal directional drilling, HDD) method of installation, also commonly referred to as guided horizontal boring. The Design Engineer shall consider equipment, materials, protection of existing Utilities infrastructure, environmental protection and restoration.

All HDD Construction Plans shall have a plan and profile drawing detailing all existing Utilities Infrastructure within the scope of the project to identify potential conflicts (applies to all Trenchless applications). The profile must show depth, curvature of the pipe and separation from all existing utility infrastructure, structures and obstacles.

The Construction Plan shall also include, at a minimum:

- entry and exit pits
- size, capacity and arrangement of Trenchless equipment
- layout of carrier pipe
- layout of any proposed construction staging areas.

The Design Engineer shall design the project for the largest drill needed to complete the bore to ensure that the minimum separation requirements are maintained.

3. Pipe Bursting Design Criteria

Pipe bursting is a Trenchless method of replacing buried Water Mains without the need for a traditional construction trench. Launching and receiving pits allow new Water Main to be pulled in place through the existing Water Main with a bursting head. The Design Engineer shall design the project from valve to valve and shall include allowance for the expansion of materials and soil due to the insertion of the new Water Main.

The Construction Plans shall include at a minimum:

- a plan and profile drawing showing the dimensions of the launching and receiving pits,
- proposed line replacement,
- area needed for the layout of the pipe prior to pipe bursting
- identification of all existing utilities within the scope of the project
- depth of the pipe, and separation from all existing utilities, Structures and obstacles.

4. Micro Tunneling Boring Method (MTBM)

Micro tunneling is a digging technique used to construct small tunnels. These small diameter tunnels make it impossible to have an operator in the machine itself. Instead, the micro tunnel boring machine (MTBM) must be operated remotely.

The Design Engineer should coordinate with the Contractor to plan and design the project. The same design plan and profile requirements for HDD Construction Plans will apply to micro tunneling, see Section 6.8A.2 . Due to the uniqueness of this application all Construction Plans submitted by the Design Engineer to Colorado Springs Utilities for approval will be reviewed on a case by case basis to determine that all design requirements are included.

5. Tunneling Boring Method (TBM)

Tunneling Boring Method (TBM) is a method used for construction of large tunnels. The footprint area for these types of projects will be unique to each project for entry and exit pits as well as tunnel alignment. The Design Engineer should coordinate with the Contractor to plan and execute the project. Construction Plans submitted to Colorado Springs Utilities for approval will be reviewed on a case by case basis.

6. Guided Boring Method (GBM)

Guided boring (GBM) can be used for the Trenchless installation of new pipelines or casings.

The Design Engineer will need to have a precise Construction Plan alignment to be utilized with the GBM project. The Design Engineer should understand the equipment parameters to be able to stay within the design constraints. The same design criteria will be required for the Construction Plan as is needed for a HDD project, see Section 6.8A.2.

7. Auger Boring Method (ABM)

Auger Boring, also known as jack and boring, is a Trenchless method for installation of casing pipes. The bore is formed from a launch pit by means of a rotating cutting head. The soil is removed back to the launch pit by helical auger flight sections and the steel casing is advanced forward into place. The rotating head is pushed ahead by an auger boring machine, traveling on tracks, and is typically a dry method for installing steel casings. This method offers limited steering capabilities and is used when precise accuracy is not crucial. The advantages of this system are that it causes little or no surface disruption and the spoil is removed by augers. The Design Engineer will need to have a detailed Construction Plan alignment to be utilized with the ABM project with no room for changes in the alignment. This method can only be used when there is no other utility infrastructure, Structures or obstacles in the planned drill path.

6.9 Pipe Rehabilitation

Water Main rehabilitation will be reviewed on a case by case basis depending on the conditions of the pipe and the requirements of the Water Distribution System.

A. Cured in Place Pipe

Cured in Place Pipe (CIPP) is currently not allowed for use in the Water Distribution System.

B. Sliplining

Sliplining is completed by installing a smaller, "carrier pipe" into a larger "host pipe", using the host pipe as the path to install a new structurally sound pipeline. The new

pipe is not always snug to the host pipe which requires the sliplining materials to be structural by itself. Grouting the annular space between the two pipes can be done also, and sealing the ends before connection to the system is required. Some materials utilized in this process are dependent on the integrity of the host pipe which will reflect on the performance of the liner. Cleaning and CCTV assessment of the host pipe is required prior to placement of a slipliner. Sliplining can be used restore structural integrity to an existing pipe. Sliplining can occur in any size pipe given appropriate access and a new pipe small or large enough to install. Sliplining will need to be designed from valve to valve and where there are no bends or Water Service Lines attached to the pipe. Sliplining projects will be reviewed on a case by case basis.

6.10 Material

Specifications on all materials proposed for placement must comply with this *Water LESS*; see Chapter 4.1Approved Materials.

6.11 Construction Plan Submittals

The Design Engineer shall submit to Colorado Springs Utilities copies of the Construction Plan and geotechnical report for construction approval. The geotechnical report shall include the subsurface conditions that may impact Construction and recommendations for mitigating any geotechnical hazards. If the subsurface conditions are known to the Contractor by previous work or geotechnical studies done in the immediate area, the information shall be recorded in the geotechnical report along with any additional geotechnical studies performed by the Contractor. The Construction Plan Submittal shall comply with Chapter 3.1Submittal Requirements including the following:

- Geotechnical Information
- The projected path of the bore or tunnel
- Proposed Trenchless Method
- Plan and Profile Drawings
- Proposed Materials

6.12 Trenchless Construction

Colorado Springs Utilities' approval of any aspect of any Trenchless operation covered by this *Water LESS*, shall in no way relieve the Contractor of their ultimate responsibility for the satisfactory completion of the Construction Plan.

Line and grade accuracy tolerances when constructing any Trenchless method project shall be plus or minus 3 inches. Accuracy may be impacted by the environment, ground conditions, conflicting utilities and depth, which may affect the connection between the transmitter and receiver for locating and tracking the drill path. The Design Engineer shall be aware of the accuracy of the method and equipment selected to address any potential separation concerns. Where extreme accuracy is demanded, alternate tooling can be used to increase accuracy, i.e. cable transmitters. During construction all separation criteria from other utilities shall be maintained (See Section 2.6G.2).

The Contractor shall notify Colorado Springs Utilities 48 hours in advance prior to the start of Construction. All Trenchless construction shall be in compliance with Chapter 5.1 and include the following:

The Contractor shall develop the following Plans. All of these plans shall be made available to Colorado Springs Utilities upon request:

A. Construction Work Plan
The Construction Work Plan should include the noise reduction program, solids control plant, pilot hole drilling procedure, the reaming operation, and the pullback procedure as well as document the planning required to successfully complete the project.

B. Equipment Plan
The Contractor shall list Specifications, and calibration documentation on all equipment to be used and ensure that the equipment will be adequate to complete the project. The Contractor will need to plan for the footprint and layout of all of the equipment and materials to be used and placed during Construction. Guidance system documentation and calibration records shall be dated within the last 24 months.

C. Drilling Fluid Plan
The Contractor shall prepare a plan which addresses the drill fluid to be used based on the Geotechnical Report. The plan shall include MSDS sheets of mud composites and additives, a plan for handling the fluid during Construction, and the disposal plan that complies with all federal, state and local environmental regulations.

D. Frac Out Action Plan
The Contractor shall prepare an action plan in case of a drill fluid frac out including how it will be contained and cleaned up in compliance with all federal, state and local environmental regulations. This plan should also address restoration of the land or property affected and any alteration in native grade or settling, created by the Trenchless process.

E. Stormwater/Best Management Practices Plan (SWMP/BMP)
The Contractor is responsible for complying with all applicable state, federal and local environmental regulations and shall obtain all permits necessary to complete Construction. Construction Projects may require a Stormwater Management Plan (SWMP) to be submitted to CDPHE, the City of Colorado Springs, or the Regulatory Authority.

F. Personnel Qualifications
Documentation of training and relevant experience of personnel shall be kept on Site and a qualified operator designated by the Contractor.

The Contractor shall be trained by the respective manufacturer of the equipment in the use of that equipment. The Contractor shall provide certification that the Contractor has been trained and is proficient in the use of the equipment. Only the Contractor's employees who are trained and certified shall be allowed to operate the equipment during the project.

The Contractor shall submit a list of completed projects demonstrating experience in performing the type of Trenchless construction proposed for the project. The list shall include the Owner of the project, Engineer, addresses, phone numbers and dates

that said projects were completed. The list shall be submitted to the Design Engineer and Owner/Developer. These reference documents must also be available for review if requested by Colorado Springs Utilities.

6.13 Drill Path Survey

The entire drill path shall be accurately surveyed and staked by a Surveyor licensed by the State of Colorado. Staking shall be done in accordance with Section 5.3.

6.14 Inspections

The Contractor shall notify the Colorado Springs Utilities Inspector when Construction begins each day. If the Inspector is not on-site, the Contractor shall keep the Inspector advised of all concerns and issues that arise.

6.15 Locates and Visual Verification

All Utilities shall be located prior to the start of Construction per Section 5.9A. Colorado Springs Utilities reserves the right to require the Contractor to expose Utility crossings to verify and monitor required separations.

6.16 Tracer Wire

2 tracer wires must be placed with all non-metallic pipe materials and shall be rated for boring applications, refer to Section 6.6D.

6.17 Pipe Placement

The Water Main shall not be dragged on the ground during pull back operations. Pipe rollers or equivalent pipe support equipment must be used. Any damaged pipe will be rejected per Section 6.21.

A. Concrete Thrust Blocks and Anchors

Shall be applied as in Section 2.6G.9.

B. Deflection

Allowable pipe deflections shall not exceed the pipe manufacturer's recommendations and the recommended capability of the equipment utilized for the project. Refer to Section 6.3D .

C. Bends

If additional DIP fittings are required they shall be placed according to Section 5.13D.

6.18 Pipe Bursting Construction Requirements

- It is the responsibility of the Contractor to obtain all available records, and CCTV the line to locate all fittings on the existing pipeline before pipe bursting occurs.
- The Contractor is responsible for protecting and maintaining separation of all nearby Utilities and Structures which will need to be located and exposed if they are within the expansion corridor of the pipe burst. The Inspector shall be on Site when the bore crosses existing Colorado Springs Utilities facilities.
- The Trenchless project must avoid heaving of the ground and shall leave no voids.

6.19 Trenchless Copper Water Service Line Installation

Water Service Lines may be placed by HDD application. The Contractor shall limit the amount of force used during installation to insure there is no damage to the Water Service Line pipe. When copper tubing is being placed and more than 1 coil length is needed, a flare by flare coupling shall be used to add additional pipe length. The coupling must be exposed after the tubing is in place to verify that there is no damage to the tubing or coupling and that there are no leaks during pressure testing. For HDPE Water Service Line information see Section 6.6.

6.20 Record Keeping

The Contractor shall maintain a daily project log of Construction operations which shall be provided to Colorado Springs Utilities upon request. Compaction reports shall be kept and filed as required. Record Drawings shall be certified as to accuracy by the Design Engineer.

The Qualified Operator shall record and keep a bore log and pull back log and shall submit this information to the Inspector. Bore depths shall be recorded on the Record Drawings at defined station points on the Construction Plan or in increments of drill rod length. The Qualified Operator shall keep and maintain the calibration record of the locating equipment.

6.21 Site Restoration

Following the Trenchless construction and demobilization, the Contractor shall restore the work-site per Section 5.22. All excavations shall be backfilled and compacted to the required density per Section 5.18. All construction debris and materials shall be disposed of by the Contractor.

TABLE OF CONTENTS

CHAPTER 7
Pump Stations

CHAPTER 7

Pump Stations

7.1 General

The purpose of Chapter 7 of these *Water Line Extension & Service Standards* (*Water LESS*) is to set forth minimum criteria for design and construction of unstaffed pump station facilities for Raw, Potable, and Nonpotable Water.

7.2 Cost Responsibilities

A. Design

Unless specifically modified by written agreement, Colorado Springs Utilities will be responsible for engineering design of Raw Water and Potable Water pump stations at no expense to the Owner/Developer. See Colorado Springs *Utilities Rules and Regulations Section 42* for additional details. Colorado Springs Utilities may, at its discretion, serve as the Design Engineer or contract a Design Engineer for the completion of their responsibilities. If Colorado Springs Utilities contracts with a Design Engineer for the completion of their responsibilities, a project manager from Colorado Springs Utilities will serve to oversee all aspects of the design.

Nonpotable pump station design will be paid for by the Owner/Developer unless specifically modified by written agreement between Colorado Springs Utilities and the Owner/Developer. Colorado Springs Utilities will be integrally involved during the design process and will approve all final design elements prior to construction.

B. Construction Management

Colorado Springs Utilities will be responsible for Construction Management services during construction of the pump station. Colorado Springs Utilities may, at its discretion, serve as the Construction Manager or contract a Construction Manager for the completion of their responsibilities.

C. Construction

The Owner/Developer will be responsible for all Potable Water and Nonpotable Water pump station construction costs including but not limited to facilities, land, and all appurtenances unless specifically modified by written agreement between Colorado Springs Utilities and the Owner/Developer. Details regarding the cost responsibilities of infrastructure can be found in Colorado Springs *Utilities Rules and Regulations* found at www.csu.org.

Colorado Springs Utilities will be responsible for all construction costs associated with pump stations for Raw Water being delivered to any of its water treatment plants as well as costs to replace, repair, or improve existing Raw Water pump stations owned by Colorado Springs Utilities.

1. Cost Recovery

The cost to construct or increase the capacity of a pump station will be shared by the property Owners/Developers served by the pump station.

Where Colorado Springs Utilities has determined that additional area or lands will benefit from the pump station than necessary to serve the initial development, Colorado Springs Utilities may require a greater pumping capacity. In the event that the initial Owner/Developer pays the entire cost of the pump station, and the other Owners/Developers that will be served by the pump station do not choose to financially participate at the time of pump station construction, the initial Owner/Developer can apply for a Recovery Agreement. In accordance with the Colorado Springs *Utilities Rules and Regulations*, the Recovery Agreement, good for a 20 year term, will allow non-participating property owners, before they are allowed to benefit from the installed pump station, to pay for their portion of the actual cost of such facilities at the time of connection and Colorado Springs Utilities will refund such share of the cost to the initial Owner/Developer. See *Sections 42 and 43* of Colorado Springs *Utilities Rules and Regulations* for additional details.

2. Advance Cost Recovery or Participation

Where Colorado Springs Utilities has identified a future need for pump station construction, improvement, or expansion to provide or continue service to an area, including areas that are provided interim service that require pump station facilities in the future, Colorado Springs Utilities may prepare an advance Recovery Agreement to collect a proportional share of the cost to construct a pump station to serve that area. Any Owners/Developers requesting interim service will be required to pay the advance Recovery Agreement charge at the time of service contract prior to the provision of service. See *Sections 42 and 43* of Colorado Springs *Utilities Rules and Regulations* for additional details.

D. Operations and Maintenance

Colorado Springs Utilities will assume responsibility for ownership, operation, and maintenance of the pump station following final completion, commissioning, startup, and acceptance. Warranty periods will apply following acceptance by Colorado Springs Utilities.

7.3 Planning

Most pump station Projects, depending on their characteristics and location, require permits from federal, state, county, and local Authorities Having Jurisdiction prior to and during construction. In addition, compliance with the plan review and permitting processes of Colorado Springs Utilities, City of Colorado Springs, Pikes Peak Regional Building Department, and/or the applicable Authority Having Jurisdiction is required.

A. Reference Colorado Springs Utilities Publications

1. Guide to Development and Building

Colorado Springs Utilities has created a *Guide to Development and Building* (*Guide*) available at www.csu.org. The purpose of the *Guide* is to assist Owners/Developers and Design Engineers in understanding the entire land development process including planning, design and construction of the Water Distribution System.

2. Master Plans

The pump station shall be compatible with the current Master Plans for Potable Water, Nonpotable Water, and Raw Water held by Colorado Springs Utilities, in which future growth and development is planned.

3. Hydraulic Analysis Report (HAR)

The pump station shall be compatible with the *Hydraulic Analysis Report* for the area to be served. See Section 2.5A for additional information.

B. Public Planning Process

For Projects within the El Paso County, the City of Colorado Springs City Planning Department or El Paso County Planning Commission will determine if public hearings, neighborhood meetings, or notifications, including property postings, are required. For Projects outside El Paso County, the public planning process shall conform to applicable requirements of the Authority Having Jurisdiction.

C. Easements and Property Titles

For transfer of property title to Colorado Springs Utilities, refer to *The City of Colorado Springs Procedure Manual for the Acquisition and Disposition of Real Property Interests*, available at www.springsgov.com. Easements that Colorado Springs Utilities acquires must be acquired in accordance with Quality By Design (QBD) document *WSD-00011, "Utility Easement Acquisition Instructions"* accessible through Colorado Springs Utilities Project Managers.

D. Environmental Assessments, Surveys and Clearances

Environmental Assessments and/or Environmental Reviews will be required as a preliminary investigation to determine if a particular parcel of real property is subject to recognized environmental conditions. Surveys and findings shall be documented in a report to Colorado Springs Utilities.

1. Cultural

In the effort to identify historic properties of all types (buildings, Structures, objects, districts, and Sites) including the area of potential effect, it may be prudent to request assistance from Colorado Springs Utilities to investigate as to whether the proposed property has recordable cultural, paleontological and/or archeological value protected under the State Historical Preservation Office (SHPO).

2. Endangered and Threatened Species

To ensure compliance with the *Endangered Species Act*, all properties selected for pump station location must be surveyed prior to construction disturbance to determine if there are potential effects to listed plants and/or animals. Any potential impacts must be avoided, minimized, or mitigated.

3. Migratory Birds

To ensure compliance with the *Migratory Bird Treaty Act*, all properties selected for pump station location must be surveyed prior to construction disturbance to ensure protection of migratory birds and nests. If any active nests for protected birds are located, construction may be delayed or modified to protect migratory birds.

E. Permitting

It is highly recommended that permit planning start as early as possible. The Design Engineer shall identify all required permits early in the design process, assist Colorado Springs Utilities in the preparation and timely submittal of permit application packages, and assist Colorado Springs Utilities in complying with any follow-up requests for additional information or clarification of permit submittals. The Design Engineer shall prepare plans and studies required for permits as necessary. Key permitting agencies for design and construction are included, but not limited to, the list in Table 7A at the end of this chapter.

1. General Permit Procedures

The Design Engineer will assist Colorado Springs Utilities in obtaining the required permits for the pump station design. Colorado Springs Utilities shall retain the original permit files, while the Design Engineer shall retain copies. The Design Engineer shall ensure that permits and approvals required during construction are described in the final Contract Documents for bidding purposes.

The Contractor shall obtain permits required for the pump station construction and shall furnish copies of executed permits and compliance inspection reports to Colorado Springs Utilities within 14 Days of receipt. The Contractor shall inform Colorado Springs Utilities of any conflicts between the permit requirements and the Contract Documents. The Contractor shall maintain a readily available portfolio of all required permits, drawings, approved plans, agreements, and compliance inspection reports onsite during the construction period. The Contractor shall coordinate with Colorado Springs Utilities as necessary to clarify permit requirements. Unless the permitted activity is specifically limited, permits obtained shall cover the entire work.

2. Permits Initiated by Colorado Springs Utilities and Contractor Obtained

Some permit applications may be initiated by Colorado Springs Utilities during the design phase and transferred to the Contractor who will be responsible for obtaining the final permits. Colorado Springs Utilities does not guarantee the accuracy of the permit applications, requirements, and/or fees. The Contractor shall complete the permit applications and submit to the permitting agency.

3. Permits Obtained by Colorado Springs Utilities and Transferred to Contractor

All applicable permits, plans, and clearances obtained by Colorado Springs Utilities during design shall be transferred to the Contractor as necessary. The Contractor shall comply with the conditions and terms of the permits and with applicable local, county, state, and federal Laws and Regulations established by the Authority Having Jurisdiction. The Contractor shall assist in the transfer of permits as necessary.

7.4 Design Reports and Design Drawings

All design tasks shall be completed per these *Water LESS* and best engineering practices. The design shall include, but shall not be limited to, the tasks and deliverables as outlined below. A specific statement of work, which could deviate from these criteria as necessary for the individual Project, will be developed with the selected engineer.

The design shall be reviewed and supervised by a qualified Design Engineer. All applicable project documents prepared by the Design Engineer shall bear the seal of the Professional Engineer in responsible charge.

A. Kickoff, Site, and Review Meeting Minutes

The Design Engineer shall:

- Organize and facilitate a project kick-off meeting with appropriate Owner/Developer and Colorado Springs Utilities representatives to review the Project and establish roles and responsibilities for each component of the Project
- Prepare a list of data needed prior to the kick-off meeting
- Conduct Site walkthrough(s) with appropriate Owner/Developer and Colorado Springs Utilities representatives to assess current conditions of the proposed pump station Site(s)
- Provide meeting sign in sheets, agendas and summaries/minutes of each meeting

B. Preliminary Design Report

The purpose of the *Preliminary Design Report* is to develop alternatives, recommend a preferred alternative, establish the preliminary design, and finalize the design criteria. Following the submittal of the *Preliminary Design Report*, a meeting will be held between the Design Engineer, Owner/Developer, and Colorado Springs Utilities to discuss the content.

The *Preliminary Design Report* submitted by the Design Engineer shall:

- Review, evaluate, and incorporate existing reports with respect to the proposed Project
- Identify potential permits, clearances, surveys, and agreements for the Project and required lead times
- Locate potential pump station Sites and recommend a preferred Site
- Document adjoining parcels, rights-of-way, Easements, above and below ground utilities, walls, drainages (natural and engineered), fences, wells, and existing Structures
- Present preliminary geotechnical findings and evaluations
- Present preliminary hydrological analysis for 100 year and 500 year floodplain corridors specific to the project as applicable
- Include a corrosion study based on field and laboratory tests and recommend cathodic protection for the pump station and its appurtenances
- Show a preliminary Site layout including the pump station, process piping, yard piping, electric conduit, telecommunication conduit, chemical feed, sewer pipe, storm pipe, vaults, appurtenances, backup generator, and any water storage tanks as applicable
- Identify alternative layouts of the pump station's interior with a recommended layout
- Indicate operating conditions, maximum and minimum flow capacity of the pump station, the number and type of pumping units, and their performance characteristics such as design pump head range, number of stages, efficiency, and pump motor speed, source of water to the pump station and a hydraulic grade line for the system
- Prepare pump station sustainability evaluation to consider energy conservation, sustainable building materials, Site selection, etc.

- Present alternative analyses and rough-order-of-magnitude costs with recommended alternatives using Life Cycle Cost Analysis (LCC), Net Present Value (NPV) or Internal Rate of Return (IRR) depending on the applicability for the project
- Submit information on major equipment recommended for the pump station to include equipment access, relocations, and/or rotation for future operation and maintenance requirements
- Recommend containment methods and capacities for oil/petroleum/chemical containers, associated piping, and loading/unloading areas to prevent an overfill, spill, and/or leak from entering a waterway, associated conveyance (i.e. storm drain), or sanitary sewer
- Recommend piping, structural, electrical, instrumentation, and control elements for new pump stations or modifications to existing pump stations
- If a chemical feed system is required, indicate the requirements for dosage, storage, and containment of chemicals
- Code review to establish building occupancy, mechanical, HVAC, electrical, structural, architectural and fire protection design criteria
- Include a preliminary drawing and Specification list

C. Geotechnical Hazards Study

A geotechnical investigation for the selected pump station location and a corresponding *Geotechnical Hazards Study* should contain the following items except as modified by Colorado Springs Utilities:

- Geotechnical suitability for the proposed pump station facilities, including water storage tanks as applicable
- Potential effects extending into the Site from adjacent areas or from the Site into adjacent areas
- Allowable soil bearing capacities with respect to anticipated loadings at different pertinent depths and locations
- Recommendation of Site slope grading, cut and fill slopes, and any required stabilization efforts
- Foundation design criteria and recommendations
- Recommendations for excavations
- Shoring requirements and other construction considerations
- Irrigation and drainage controls such as dewatering, surface, and subsurface drains
- Backfill Specifications and compaction recommendations for utilities, Structures, pavements, and slopes
- Corrosivity potential of the soil
- Recommendations for clearing/removal of deleterious materials such as canyon cleanout, over excavation, existing building foundations, pavements, debris, fills, designated trees, shrubs, roots, etc.
- Recommendation for abandonment of existing buried utilities as applicable
- Recommendations for reuse of onsite recyclable building material (i.e. asphalt, concrete, fabricated walls, insulation, etc.)
- Other pertinent geotechnical information for the development of the site

D. Basis of Design Report

The *Basis of Design Report* shall be a dynamic report throughout the design of the pump station. It must be updated and included with each submittal of the Contract Documents. The report shall not be limited to the design of the pumps, but shall encompass all pump station systems (HVAC, plumbing, structural, instrumentation and controls, communication, chemical feed system, etc.). The Design Engineer shall include all final studies, alternative analyses, cut sheets of equipment, and calculations used as the basis of the pump station design for Colorado Springs Utilities' future reference.

The *Basis of Design Report* shall include, but shall not be limited to:

- A hydrologic study to determine onsite and offsite runoff and associated impacts, assumptions and calculations for storm duration, return frequency, drainage area, and peak flows, as well as recommendations for addressing any impacts to ensure compliance with the standards established by the Authority Having Jurisdiction
- Design flow estimates consisting of present and future minimum, average, and maximum flows
- Calculation of net positive suction head available (NPSHa) and comparison to candidate pump net positive suction head required (NPSHr)
- System head curves, operating curves with operating points, efficiency curves, and NPSHr curves for candidate pumps
- Calculations to determine total dynamic head (TDH) for each pump, minimum and maximum capacity of pump station, pump head range, hydraulic grade line of the system, Hazen Williams C factor, determination of minimum pump (bowl) efficiency, pump brake horsepower, minimum pump motor efficiency, and motor speed
- Surge analysis of pumping system performed near the beginning of the design phase and validated at the end of the design phase, calculations used to size surge control equipment, open/closure rates of the pump control valves, and calculations used to determine location of air release and/or vacuum relief valves
- Calculations used to determine the material, size and pressure class of piping, including assumptions for the design pressure, hoop stress, longitudinal forces, combined stresses, external pipe loads, and buckling and collapse analysis for the piping if performed
- Geotechnical laboratory and field test results and calculations used to design the cathodic protection system
- Potholing results from locating existing utility infrastructure
- Research and surveys performed in locating property and Easement lines
- Documentation and calculations for chemical feed pump selection, chemical dosing, storage volumes, and containment sizing
- Calculations and rationale for containment capacities relating to oil/petroleum containers
- Design calculations and Specifications for any installed oil/sand/water interceptors or separators
- Calculations verifying the motor starts per hour can meet demands and motor criteria
- Comparison and recommendation, which shall be based on operational needs and lifecycle costs, of constant speed pumps, soft starts, and variable frequency drives

- An architectural program documenting and supporting selections
- Calculations and loads used in the design of structural components, such as foundations, bridge cranes, roofs, and pump pedestals
- Calculations to size water storage tanks located on site, as applicable
- Pump control description with input from Colorado Spring Utilities Water Instrumentation and Control group

E. Design Submittals and Contract Documents

The following criteria are minimum requirements for design submittals. A review meeting between Colorado Springs Utilities, the Owner/Developer, as applicable, and the Design Engineer will be held following the completion of each design submittal.

1. Design Schedule and Budget

At the onset of the design, the Design Engineer shall submit an electronic copy of the overall design schedule showing the entire Project broken into sub-tasks with corresponding dates and milestones. The schedule shall be updated and submitted monthly. Due to Colorado Springs Utilities staffing availability, a more detailed 2 week look-ahead schedule shall be submitted on an as needed basis to ensure access to a requested facility or attendance of a particular staff member at critical events.

The Design Engineer shall also submit a budget and monthly cash flow estimate for the overall Project. The budget shall be cost-loaded corresponding to the schedule. The cash flow estimate shall be updated and submitted monthly for the duration of the Project.

2. Design and Contract Document Submittals

At a minimum, the Design Engineer shall prepare and submit the *Preliminary Design Report*, the current *Basis of Design Report*, Contract Documents, and a cost estimate at 30%, 60%, 90%, and final levels of completion. The submittal shall cover the subjects listed below in Section 7.5. Colorado Springs Utilities and the Owner/Developer, as applicable, will review each submittal and provide feedback to the Design Engineer.

The Design Engineer shall prepare and include the draft agenda and preliminary value engineering opportunities in the 30% submittal.

The final submittal shall be reviewed and approved by Colorado Springs Utilities and the Owner/Developer, as applicable, before final Contract Documents are produced for bidding purposes.

Once the contractor has been selected for the Project, the Design Engineer shall prepare final conformed Contract Documents issued for construction. See Section 7.6D.

3. Design Review and Value Engineering Workshop

The Design Engineer shall conduct a workshop with Colorado Springs Utilities and the Owner/Developer, as applicable, to review the *Preliminary Design Report*, the current *Basis of Design Report*, and the value engineering

opportunities submitted by the Design Engineer. This value engineering workshop shall be conducted following the 30% design submittal.

For value engineering opportunities presented during the workshop, the Design Engineer shall include a 40 year present worth life-cycle analysis of both capital and operation and maintenance costs to facilitate discussions of the opportunities. The Design Engineer shall also present advantages and disadvantages of each opportunity.

All value engineering opportunities, which would impact, alter, or differ from required and/or recommended applicable industry safety guides and/or Colorado Springs Utilities' *Water System Operations - Safe Design Guidelines*, shall be reviewed by the Project team and the Colorado Springs Utilities Safety and Health department prior to acceptance.

The Design Engineer shall prepare a technical memorandum summarizing the value engineering opportunities reviewed, evaluation results, and any value engineering opportunities accepted.

4. Commissioning and Startup Plan

Due to varying complexities of pump stations, the Design Engineer shall develop procedures in the Contract Documents for the testing, commissioning, and startup of the pump station that is appropriate for the complexity of the pump station. A technical memorandum shall be prepared at 60% design and finalized at 100% design to address commissioning and startup procedures.

7.5 Design Criteria

This section contains the minimum design criteria and requirements for the pump station. Specific Colorado Springs Utilities documents may be obtained through the project manager of the Project.

A. Health and Safety

The pump station shall meet all Colorado Springs Utilities and OSHA health and safety requirements. Adhere to the Colorado Springs Utilities' *Water System Operations - Safe Design Guidelines* by Colorado Springs Utilities for additional pump station safety requirements.

1. Operation and Maintenance

Consideration to operator safety includes the following:

- First-aid and safety equipment
- Positive floor drainage so that there is no standing water from leaking equipment or wash-down maintenance
- Nonslip floor finishes on all walking/working surfaces to include, but not limited to: floors, stairs, ladder rungs, ramps, bridging, catwalks, and work platforms
- Code mandated clearance around electrical equipment, such as transformers, switches, switchgears, and drives
- Process piping layout so that operator may walk completely around pumps and have adequate clear space for operation and maintenance
- Readily accessible equipment for operation and maintenance

- Platforms, ladders, or other alternative access systems as needed for safe access to equipment that must be located in hard to reach areas
- Chain wheels for valve hand wheels that are out of reach
- Lifting assistance for heavy items (see Section 7.5E.3)
- Overhead pick points shall be located a sufficient distance above serviceable components to accommodate the use of appropriate lifting and rigging equipment
- Identify confined space areas as applicable

2. Noise Control

The Design Engineer shall use mitigation devices, systems, or programs to achieve compliance with state, OSHA, and local regulations established by Colorado Springs Utilities, and the Authority Having Jurisdiction regarding noise limitations during construction and pump station operation. Noise control shall mitigate the effect of noise on the surrounding properties as well as any individuals in or around the pump station during construction or operation.

3. Hazardous Substances

A facility with regulated and/or other extremely hazardous substances subject to the *General Duty Clause* of the *Clean Air Act* is, among other things, responsible for:

- Using appropriate hazard assessment techniques to identify hazards which may result from releases
- Designing and maintaining a safe facility taking such steps as are necessary to prevent releases
- Minimizing the consequences of accidental releases

B. Applicable Codes

For work in El Paso County, buildings associated with pump stations shall conform to all codes currently adopted by the Pikes Peak Regional Building Department. For work outside El Paso County, the design shall conform to local codes established by the Authority Having Jurisdiction. Where a local building code has not been adopted, the design shall conform to all codes currently adopted by the Pikes Peak Regional Building Department.

Because Colorado Springs Utilities will be the owner of the pump station, the design of the pump station must comply with Colorado Springs Fire Department (CSFD) requirements. When the pump station is located outside of CSFD jurisdiction, it must meet the requirements of the Authority Having Jurisdiction and CSFD.

C. Environmental Compliance

All pump station Projects shall be reviewed by Colorado Springs Utilities for compliance with the environmental requirements and design criteria of these *Water LESS*.

1. Chemical Review and Use

The Design Engineer shall adhere to the Colorado Springs Utilities Hazard Communication Program and New Chemical Review Program, as described in the *Safety and Health Program Manual*. Colorado Springs Utilities will review and

approve any chemicals proposed for use within the Water System. Any chemicals or materials that come in contact with Potable Water, and Raw Water as applicable, shall be certified under the *National Sanitation Foundation (NSF)/ American National Standards Institute (ANSI) Standards 60 and 61*.

2. Existing Asbestos or Lead Materials

The Design Engineer shall inspect and/or test any existing item to be demolished for Asbestos and lead-based paint. If Asbestos or lead-based paints are present, the Design Engineer shall identify the location(s) and incorporate requirements into the Contract Documents to properly dispose of the waste. The Design Engineer shall ensure that a Certified Building Inspector inspects and samples any existing areas for Asbestos that may be renovated or demolished as per CDPHE's *5 CCR 1001-10; Regulation No. 8 – Part B.* In addition, CDPHE's *5 CCR 1001-23; Regulation No. 19 – Part A* contains procedures and requirements for the accreditation of lead-based paint activities training programs, procedures and requirements for the certification of individuals and firms engaged in lead-based paint activities, and work practice standards for performing such activities. See Chapter 5.1 for additional information.

3. Contaminated Soils

If contaminated soils are identified in the *Geotechnical Hazards Study*, the Design Engineer shall identify location and incorporate mitigation requirements into the Contract Documents including the proper disposal of contaminated soils at a permitted disposal facility approved by the Environmental Services Department of Colorado Springs Utilities (EVS). The ground surface shall be inspected for evidence of hazardous material or petroleum product spills such as soil staining and unusual odors or colors. Refer to *QBD Document EVS-11804 Contaminated Soils Handling Procedure* for more information.

D. Site Civil Engineering

1. Design Survey

A Project coordinate system shall be established, fully described, consistently used, and referenced on all Contract Documents. The design shall include a process for conversion from the local, ground distance coordinate system to the Colorado Springs Utilities' Facilities Information Management System (FIMS) coordinate system which is the Colorado State Plane Coordinate system, Central Zone, North American Datum of 1983 (NAD 83/86), using the National Geodetic Vertical Datum of 1929 (NGVD 1929). This shall include a combined scale factor (grid and sea level) and northing/easting shift. All elements of the pump station shall be related to the grid and/or local control system.

2. Demolition

The Design Engineer shall indicate which items are to be demolished, salvaged, or abandoned in place.

3. Geotechnical Conditions and Earthwork

The *Geotechnical Hazards Study* findings shall be incorporated into the design and included in the Contract Documents as applicable. See Section 7.4C for *Geotechnical Hazards Study* requirements.

4. Traffic Control

The Design Engineer shall:

- Develop a construction traffic plan, as required, for construction ingress and egress
- Develop a final traffic plan, as required, for final ingress and egress
- Indicate signage type and locations
- Comply with all Authorities Having Jurisdiction over the traffic design

The traffic plan shall, at a minimum, accommodate a WB-50 design vehicle entering the Site.

5. Access Road and Parking

The pump station Site shall have a paved access road from the nearest street to the truck bay of the pump station. If the Site is large enough, the access road shall be looped with 2 traffic lanes. The road shall, at a minimum, accommodate a WB-50 design vehicle such as a semi-trailer with 50-foot wheelbase and HS-20 loading. This allows for the delivery/pick-up of pumps, motors, other essential equipment, and access for fire fighting vehicles. If the pump station has pumping equipment components that require a larger vehicle, adjust the road design accordingly.

Road and parking design shall comply with City of Colorado Springs standards or the Authority Having Jurisdiction, as applicable. In residential areas, the pump station access road may resemble a driveway. However, it shall still be designed for HS-20 loading.

6. Stormwater Quality

The pump station Project shall be designed in compliance with, and shall meet the requirements of, the following:

- Local government; i.e. City of Colorado Springs or similar Municipal Separate Storm Sewer System (MS4)
- Colorado Department of Public Health and Environment, Water Quality Control Division (CDPHE, WQCD)
- Federal and state anti-degradation policies
- The *Federal Clean Water Act*

7. Site Drainage and Landscaping

The Design Engineer shall refer to the City of Colorado Springs *Drainage Criteria Manual* and the Colorado Spring Utilities *Site Design Guidelines* for Site design and landscaping guidance. The Design Engineer shall:

- Situate the pump station finished floor a minimum of 1 foot above the 100-year flood elevation or as required by the authorized flood plains administrator
- Design positive slope grading for drainage swales, for access roads, and away from Structures
- Direct all storm water to a stormwater detention pond (when required) with the use of grading, swales, ditches, inlets, storm drains, culverts, or other approved means

- A storm water detention pond may not be designed to receive non-storm water influents or storm water that has been in contact with solid waste without approval by Colorado Springs Utilities
- Adhere to City, County, or other standards established by the Authority Having Jurisdiction, as applicable
- Include existing and future utility infrastructure in plans to ensure there are no conflicts with the proposed Site improvements

8. Vaults

Vaults shall be cast-in-place or precast concrete. They shall have removable panels for equipment access and a hatch for personnel access. A ladder, forced ventilation, or lighting may also be required. Groundwater and/or stormwater discharges to the surface should be incorporated into the design phase to avoid high-profile discharges after the vault has been installed.

Vaults in a paved area, or within 5 feet of a paved area without curb and gutter, shall have a minimum rating of HS-20 loading.

9. Pump Station Bypass

In the event that the pump station is out of service, a bypass shall be available for connection to a Colorado Springs Utilities truck-mounted pump. The bypass shall consist of a pipeline from the low pressure side ending in a hydrant or connection pipe and a pipeline from the high pressure side ending in a hydrant or connection pipe. The 2 hydrants or connection pipes shall be within 20 feet of vehicle access and within 40 feet of each other, see Detail Drawing A6-12.

The hydrants or connection pipes shall have signage indicating “low pressure” and “high pressure” for the fire department’s use during fires.

A fire hydrant may be used with pressures less than or equal to 250 psi. A connection pipe shall be used for pressures over 250 psi. If a connection pipe is used, include a blowoff to drain the pipe when not in use. The connection pipe shall be 4 ½-inch and compatible with the fire hose typically used to connect to the hydrant. See Detail Drawing A6-13.

Colorado Springs Utilities may choose, at its discretion, to waive the bypass requirement where the size of the bypass would be cost prohibitive.

10. Security

The Colorado Springs Utilities Security Administrator maintains the *Physical Security Hardware Specifications*, which shall be incorporated as applicable for each pump station. At a minimum, the following security features are required:

a) Perimeter Fencing

If the pump station is protected with a fence, the fence shall be 7 feet tall chain link with an additional 1 foot of 3-strand barbed wire.

b) Vehicle Gate Entrance

If the pump station is protected with a fence, a vehicle gate entrance is required for access. Each vehicle each gate entrance shall have a high-low card reader for

entry, intercom to speak to Security, Pan-Tilt-Zoom (PTZ) camera, door position switch located on the gate, exit loop instrument to open the gate during exit, safety loop to prevent the gate from closing until the path is clear, and a Knox Box for the fire department's entry.

c) Exterior Windows

Exterior windows of the buildings shall have shatter resistant film and glass break alarms.

d) Doors and Hatches

An iSTAR panel shall be included in the design for door control. The interior doors to the control room and communications room shall have card readers and door position switches. Truck bay and roll up doors shall have door position switches. Each exterior door shall have a door position switch mounted in the door frame, an intrusion alarm, and a request-to-exit style door handle that meets emergency egress requirements. A card reader may be required, especially if there is no gate entrance.

Outdoor reservoirs shall have anti-pry locks and steel bars on each hatch and ladder access. Each hatch shall be fitted with a door position switch and an intrusion alarm.

e) Location of Cameras

At least 4 Pan-Tilt-Zoom (PTZ) cameras shall be mounted on the exterior of each building to provide 360-degree coverage of the pump station Site. Include at least 1 PTZ camera for each pump room, electrical room, and chemical room. A fixed security camera shall provide coverage of each exterior door. At least 4 PTZ cameras shall be mounted on above-ground storage reservoirs. Mount the cameras high enough to be out of pedestrian reach.

f) Lighting

The Site shall have sufficient light for the cameras to be functional at night. Lighting shall comply with the *Physical Security Hardware Specifications* and requirements of the Authority Having Jurisdiction.

g) Oil Containing Items

If the facility is required to comply with the Oil Pollution Prevention regulations described within *40 CFR Part 112*, to prevent discharges that could result from unauthorized access to oil containing items with a capacity equal to or greater than 55 gallons, the facility must:

- Secure and control access to the oil handling, processing, and storage areas
- Secure master flow and drain valves
- Prevent unauthorized access to starter controls on oil pumps
- Secure out-of-service and loading / unloading connections of oil pipelines
- Have appropriate security lighting to both prevent acts of vandalism and assist in the discovery of oil discharges

E. Structural

Structural design shall address walls, roof, foundation, and other structural components of the building enclosure as well as pump supports and foundations. Reference applicable standards from the American Concrete Institute (ACI), the American Institute of Steel Construction (AISC), The Masonry Society (TMS), and others as needed for a complete and acceptable design.

1. Loads

Design loads, including, but not limited to, dead, live, hydraulic, soil, wind, impact, and seismic loads, shall be determined by applicable local codes and accepted engineering practice. Design loads for the Structure shall be evaluated and determined by the Design Engineer and Colorado Springs Utilities for each significant portion of the facility, but shall not be less than those specified by the local code or *ASCE 7, Minimum Design Loads for Buildings* for the specific Site, building height, and applicable exposure category.

Where available, Site-specific data, such as wind gust or snow load data, may govern over minimum code values. The Design Engineer must evaluate and design against loads for floors and platforms that may differ from *ASCE 7* and local codes.

2. Structure and Equipment Foundations

Concrete shall have a minimum compressive strength of 4,000 psi and rebar shall have yield strength of 60 ksi.

The foundation shall be designed in accordance with the findings and design recommendations of the *Geotechnical Hazards Study* including, but not limited to, foundation type, allowable bearing pressure, subgrade modulus and liquefaction potential.

The Design Engineer shall reference *ACI 350.4R, Design Considerations for Environmental Engineering Concrete Structures* for design guidance. Allowable deflections within the Structure shall be evaluated and determined by the Design Engineer and Colorado Springs Utilities for each significant portion of the facility.

The Design Engineer shall reference *ACI 351.3R, Foundations for Dynamic Equipment* for design guidance. Provide isolation joints as required to limit transmission of vibrations to other parts of the Structure.

Bolts that anchor equipment to concrete foundations need to be designed for shear and tension loads due to all loading combinations. Equipment anchors shall be designed in accordance with *ACI 318 Appendix D- Anchorage to Concrete* and shall be cast in place. The concrete base must provide adequate edge distance and depth for the anchors to be installed.

Individual pumps with a horsepower rating of 500 or more require a detailed Finite Element Analysis to estimate the natural frequency of the foundation system for the pumping equipment, as well as to evaluate dynamic vibration

response. The Finite Element Analysis shall bear the seal of the Professional Engineer in responsible charge.

The ratio of natural frequency of the foundation system for the pumping equipment to the operating frequency of the equipment shall be below 0.5 "low-tuned" or above 1.5 "high-tuned". The ratio should remain outside of the range of 0.5 to 1.5 to minimize resonant vibrations and provide protection against structural and mechanical deterioration of the foundation and equipment. "High-tuned" foundations are preferable to "low-tuned" foundations. For additional information see Section 7.5H.2 below.

3. Cranes and Hoists

The Design Engineer shall reference and incorporate the requirements of the Crane Manufacturers Association of America and the Hoist Manufacturers Institute when designing cranes and hoists for the pump station.

Incorporate a permanent bridge crane and hoist able to lift the heaviest assembled pump, motor, equipment, or valve plus a 10% safety factor. Vertical, transverse, and longitudinal impact loads during operation of the crane and hoist shall be evaluated when determining structural loads. When the primary crane has a 5 ton capacity or more, a secondary jockey unit shall be installed with a capacity of 20% of the primary crane. The crane shall be integrated into the structural and architectural design as required.

If a permanent crane is not included in the design, roof hatches or access spaces for removal of pumps and valves with a portable crane is required. If a permanent bridge crane cannot be used, other lifting devices, such as monorail hoists, jib cranes, trolleys, or lifting eye bolts must be considered for movement of heavy equipment. Lifting devices for heavy items shall also be integrated into the design of vaults.

All cranes and lifting devices shall be load tested at their rated loads before final acceptance. If cranes or lifting devices are used for construction to assist with construction activities, they must be recertified prior to final acceptance.

Wireless remote controllers for the bridge cranes, trolleys, and hoists are required.

Adequate clear height inside the building shall be designed to allow for the largest piece of equipment to be moved through the pump station and loaded onto a truck bed. Adequate mobility and horizontal space shall also be designed to ensure the lifting device can reach and move the proper pieces of equipment.

F. Architectural

1. Visual Aesthetics

Design shall incorporate Site-specific measures to minimize a Project's visual impacts. To the extent feasible, the design and location of above-ground Structures shall minimize potential visual effects and the permanent blockage of views from surrounding public and private perspectives.

A Project's visual impacts vary depending on the nature of the Project and the natural or aesthetic importance of the existing landscape. In general, aesthetic impacts shall be minimized through the following measures:

- Ensuring that architectural details incorporate materials that blend with the existing environment and Structures
- Incorporating surface painting or concrete staining and/or coloring to tint and match the colors of surrounding environments or Structures
- Incorporating cut-and-fill techniques that include rough and feathering cuts
- Using earthen berms, when appropriate, to reduce visual impact on viewsheds and adjacent communities
- Incorporating landscape elements such as large boulders and vegetative planting
- Limiting the use of artificial outdoor lighting to safety and security requirements and directing light toward objects requiring illumination

2. Architectural Program

The design of the pump station shall include an architectural program, developed in cooperation with Colorado Springs Utilities and the Owner/Developer, as applicable, to facilitate discussion and document all decisions regarding various spaces within the pump station. The program may include some or all of the following spaces, depending on specific Site needs:

- Pump Room
- Electrical Room
- Control Room
- Communications Room
- HVAC Room
- Restroom
- Maintenance Area
- Battery Area/Room
- Chemical Area/Room
- Space for equipment dismantling, repair, etc.

3. Truck Bay and Rollup Door

A truck bay shall be incorporated in the design and sized to accommodate a service truck capable of carrying the largest single piece of pump station equipment. A roll-up door shall be included with sufficient clearance to remove and replace the largest single piece of pump station equipment. The design and layout of the truck bay and roll-up door shall allow lifting the equipment from operating position onto a service truck by use of the crane and hoist.

4. Roof Design

Roof drains shall be designed per the architectural requirements of the Project. The roof shall shed rain and snow away from the main entrances or doorways of the pump station.

5. Building Materials

Finishes shall be selected for long-term durability, appearance, economy, and sustainability. Finishes requiring minimal ongoing maintenance shall be given

preference to those requiring periodic cleaning, waxing, or other maintenance activity.

Within pump rooms, wall finishes within 3 feet of the finished floor shall be resistant to damage from impact during pump maintenance activities or periodically wetted environments. Examples of acceptable material include reinforced concrete or concrete masonry units.

Interior partitions and wall finishes shall offer a moderate degree of impact resistance and be capable of low-cost field repairs over the life cycle of the building.

The selected roofing system shall be architecturally appropriate for the Site, and deliver an expected service life before replacement of no less than 30 years.

The building's exterior wall design and materials shall be architecturally and aesthetically appropriate for the Site, and deliver an expected service life before replacement of no less than 30 years.

6. Lighting

Electric lighting shall meet or exceed minimum efficiencies specified by the *Pikes Peak Regional Building Code* and the currently-adopted *International Energy Conservation Code*. For pump stations outside of El Paso County, the lighting shall meet or exceed the more stringent of the codes adopted by the Authority Having Jurisdiction or those specified above. Preference shall be given to high-efficiency lighting systems with minimal maintenance and environmental disposal requirements. Illumination shall be a minimum of:

- Control Area: 40 ft-candles
- Pump Room: 30 ft-candles
- Vaults: 20 ft-candles

Interior lighting shall be placed to minimize horizontal transmittance through glazing or other openings to the building exterior and to neighboring properties.

Where security considerations allow, daytime illumination shall be incorporated in the pump room, control room, and restrooms through the use of clerestory windows or other similar architectural elements. Penetrations through the roof shall be minimized.

Exterior lighting shall be provided by full cut-off ("dark sky") luminaires, placed to minimize glare into security cameras and to minimize light cast onto neighboring properties. Exterior illumination levels shall be limited to the illuminance levels required for the intended purpose as defined in the current edition of *The Lighting Handbook* published by the Illuminating Engineering Society (IES).

G. Mechanical

1. HVAC

The Design Engineer shall:

- Observe design criteria pertinent to the Site altitude and ASHRAE weather data for Project location (summer 1% Dry Bulb temperature)
- Design for a maximum of 95º F in the summer and a minimum of 55º F in the winter in the pump room
- Design for a maximum of 85º F in the summer and a minimum of 50º F in the winter; maintaining less than 85% relative humidity, in the electrical room
- Design for a maximum of 74º F in the summer and a minimum of 70º F in the winter in the communication and/or control room
- Design ventilation to meet 6 air changes per hour based on the volume of pump room
- Design ventilation system to be operated via thermostatic control with Hand-Off-Auto switch
- Design all ventilation systems with a minimum of 30% efficient filters/filter media, including any louvers used for ventilation make-up air
- Equip all louvers/make-up air systems with motor actuated dampers controlled by the thermostatic call for ventilation
- Limit maximum ventilation fan noise load at 1 meter to 85 dBA
- Recommend whether to use mechanical cooling, based on the sensible load present in the space

2. Plumbing

The Design Engineer shall:

- Design a Potable Water Service Line to the Site (where available) with a water service meter for pump station Potable Water usage, see Section 2.7 for details
- Design minimum ¾-inch piping up to the second to last fixture
- Design emergency eye wash and shower equipment (with Potable Water) to meet OSHA requirements
- Recommend a means for potable drinking water and eye wash stations where Potable Water is unavailable or cost prohibitive
- Design hose bibs inside and outside the facility so that all work areas can be washed down with a 50-foot hose
- Design each hose bib with a back flow preventer
- Design floor drains for wash-down per *International Plumbing Code* with all drains routed through an oil/water separator then to a sanitary sewer or an appropriate discharge as required by the Authority Having Jurisdiction
- Design a restroom within the pump station or, where a sanitary sewer connection is unavailable or cost prohibitive, an alternative restroom such as an incinerating toilet or septic system
- All piping subject to freezing shall be thermally insulated and/or heat traced

3. Cross Connections

Cross connections between Potable Water and Nonpotable Water, chemicals, or fluids used in mechanical and/or service processes of the pump station are prohibited. Refer to Section 2.7L for more information regarding cross connection control.

H. Pumps

Pumping Systems shall meet or exceed applicable guidelines and standards by the Hydraulic Institute (HI).

All pump materials and coatings shall be compatible with the service liquid to provide corrosion, wear, and cavitation resistance. All gaskets and elastomeric materials exposed to chloraminated or ozonated water shall be Teflon or equivalent material resistant to chloramines and ozone. Bronze and brass materials shall meet the requirements of the *Reduction of Lead in Drinking Water Act*.

1. Pump Operating and System Head Curves

The Design Engineer shall:

- Plot system head curve for initial and future conditions using friction factors for new and old pipe
- Determine the operating range of the pump along the system head curve
- Specify pump operating point (operating flow at the required head) with 5% margin to allow for loss of operating capacity from pump wear and increased pipe friction
- Select a pump that operates in an acceptable operating range of total dynamic head conditions
- Establish the estimated flow and head for which the pumps are expected to operate most of the time
- Not oversize the pump to the extent that the pump operates at a lower efficiency point during standard operation
- Specify acceptance performance test grade 1U per *ANSI/HI 14.6* to prevent over-sizing pumps
- Optimize pump efficiency by selecting the pumps so that their best efficiency is at/or near the operating point for which they are expected to operate most of the time
- If operating point is not located at the best efficiency point, locate it to the right of the best efficiency point
- Select motors to be non-overloading throughout the pump curve
- Avoid pumps with a “flat” curve or a “dip” located along the operating range of the pump curve where a small change in total dynamic head results in a large change in pump flow

2. Pump Vibration

Colorado Springs Utilities has a vibration monitoring program in place to monitor pump stations in the Water System. The Design Engineer shall dictate the acceptable vibration parameters for each pump type in the Contract Documents. Vibration maximum limits shall be equal to or less than the limits set by the standards of *ANSI/HI 9.6.4*, American Petroleum Institute in *API 610*, and International Organization for Standardization in *ISO 10816*. Parameters shall include displacement (measured in mils, peak to peak), velocity (measured in inches-per-second, peak), and acceleration (measured in g, peak). The data collected by Colorado Springs Utilities or its vibration consultant shall be in a format that can be uploaded into its SKF @ptitude Analyst database.

To minimize vibration and resonance, the Design Engineer shall design sufficient mass in the mounting pedestal.

Individual pumps with a horsepower rating of 500 or more, or pumps in remote locations, may require a continuous vibration monitoring system. SKF Multilog DMx shall be acceptable, no equals. The design shall indicate the number and location of vibration transducers on each pump and motor.

3. Cavitation

To prevent cavitation, the Design Engineer shall:

- Design suction and discharge configurations per HI standards
- Minimize air entrainment to the pump suction
- Design minimum upstream and downstream pipe lengths to meet the requirements set forth by the pump manufacturer and accepted practices
- Operate pumps within its preferred operating range (POR) for continuous operation and within allowable operating range (AOR) for intermittent operation
- Select a pump that operates within a stable operating range on its operating curves
- Use HI standards or requirements from the pump manufacturer for allowable margins between NPSH required and NPSH available and select a pump where NPSH available is greater than the NPSH required at maximum speed conditions

4. Pumping Unit Procurement

Pumping units, which include pumps, motors, starter, drive, and appurtenances, shall be furnished by a single Supplier responsible for manufacturing, factory testing, delivery, and assisting with field installation, field testing, and certification of the pumping units.

In certain applications Colorado Springs Utilities may require specific procurement requirements. In such instances these requirements will be detailed in the Contract Documents.

5. Horizontal Split Case Pumps

Horizontal split case pumps 500 horsepower and less shall have the features listed below. Horizontal split case pumps larger than 500 horsepower will have additional requirements.

- Acceptable manufacturers include Peerless, Aurora, Goulds, Fairbanks Nijhuis, or approved equal. Manufacturer shall be licensed to manufacture and distribute in the USA.
- Casing: Enclosed double suction, double volute, cast iron (or ductile iron when necessary to accommodate higher pressures). All water passages of cast iron and ductile iron material shall be fusion bonded epoxy coated with minimum thickness of 10-12 mils Dry Film Thickness (DFT).
- Impeller: Hand finished, statically and dynamically balanced to *ISO 1940,* balance quality grade G2.5 or better and keyed to shaft. Impeller shall be stainless steel, nickel aluminum bronze, or approved equal.

- Wearing Rings: For stainless steel impeller material use renewable wear rings made of Nitronic 60 on the casing and 316 stainless steel on the impeller. For bronze impeller, use hardened zero lead content bronze for both casing and impeller wear rings with a hardness number difference of at least 50 Brinnell Hardness (BHN) to prevent galling, or approved equal. Non-metallic wearing rings will be considered if they meet the requirements of NSF 61.
- Shaft: 17-4PH stainless steel, machined and ground, designed for total indicated runout not to exceed 0.002 inches measured at the mechanical seal journal.
- Shaft Sleeve: Type 316 stainless steel sealed to shaft to prevent leakage.
- Bearings: Heavy-duty grease lubricated ball type double row thrust bearings. Minimum L-10 life 100,000 hours per American Bearing Manufactures Association. Grease bearings are preferred.
- Mechanical Seals: Chesterton 442 Split Seals only, no substitutions. For Raw Water applications, include the EnviroSeal SpiralTrac by Chesterton.
- Shaft Coupling: Heavy-duty flexible type with OSHA safety guard. Falk gear couplings are preferred. Supply fixed coupling guard with mechanical attachment to base.
- Base: Heavy cast-iron or steel base, with integral rim or pan and drain. Grout material shall be non-shrink epoxy grout. Grout shall be applied between the underside of the pump base and the concrete foundation with coverage greater than 95%.
- Pump shall be hydrostatic tested to 150% of the maximum shut-off head for a minimum of 10 minutes.

6. Vertical Turbine Pumps

Vertical turbine pumps 500 horsepower and less shall have the features listed below. Vertical turbine pumps larger than 500 horsepower will have additional requirements.

- Acceptable manufacturers include Weir Floway, Sulzer, Fairbanks Nijhuis, Ebara, or approved equal. Manufacturer shall be licensed to manufacture and distribute in the USA.
- Barrel or Can: Steel with 10 to 12 mils DFT epoxy lining internally and externally. Concrete-encased where applicable. Designed to support the unit without vibration at any operating speed. Vortex suppression must be evaluated for each pump. Barrel or can shall be supplied by the pump manufacturer and shall be compliant with the most recent version of *ANSI/HI 9.8*.
- Column Pipe: Minimum Schedule 30 steel pipe with epoxy lining and coating.
- Discharge Head and Discharge Elbow: Fabricated steel with epoxy lining and coating.
- Bowls: Cast iron (or ductile iron when necessary to accommodate pressures) with minimum thickness of 10-12 mils DFT fusion bonded epoxy coated) water passages.
- Impellers: Enclosed, statically and dynamically balanced to *ISO 1940* balance quality grade G2.5 or better. Impeller shall be cast bronze, stainless steel or approved equal.

- Shaft: 17-4PH or 416 stainless steel with maximum section lengths of 10 feet designed for total indicated runout not to exceed 0.002 inches over the ten foot length. Flanged connections are preferred between shaft sections.
- Shaft Couplings: Type 304 stainless steel. Coupling shall be threaded or keyed to shaft.
- Wearing Rings: For stainless steel impeller material use renewable wear rings made of Nitronic 60 on the bowls and 316 stainless steel on the impeller. For bronze impeller, use hardened zero lead content bronze for both casing and impeller wear rings with a hardness number difference of at least 50 Brinnell Hardness (BHN) to prevent galling, or approved equal. Non-metallic wearing rings will be considered if they meet the requirements of NSF 61.
- Mechanical Seals: Chesterton 442 Split Seals only, no substitutions. For Raw Water applications, include the EnviroSeal SpiralTrac by Chesterton to prevent solids from entering the seal cavity.
- Bearings: Heavy-duty grease lubricated ball type or angle contact roller bearings. Minimum L-10 life 100,000 hours per American Bearing Manufactures Association. Grease bearings are preferred.
- If hollow shaft is used, the pump motor coupling shall allow for adjustment of the pump impeller at the upper end of the motor. If solid shaft is used, the pump motor coupling shall allow for adjustment of the pump impeller at the adjusting nut located on top of the motor.
- The vertical turbine pump discharge head, sole plate, column, and cans shall be supplied by a single pump manufacturer as a package.

7. Standby and Fire Pumps

All pumping stations shall meet the firm capacity required with the largest pump out of service, excluding the fire pump.

Fire pumps shall be required in pump stations where water storage in the pressure zone and/or the regular pumping units are not sufficient for firefighting needs, which will be determined by Colorado Springs Utilities. Fire pumps shall meet NFPA requirements.

I. Piping and Appurtenances

All material in contact with Potable Water shall comply with *NSF/ANSI Standard 61,* and the Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Division's *Design Criteria for Potable Water Systems*.

1. Process Piping Pipelines

This section covers process piping. For yard piping design, Chapters 2.1, 5.1, and 6.1 requirements apply with the exceptions noted here:

The suction and discharge piping shall be sized for current and future flows. The manifolds shall be configured to accommodate future flows without having to take the pump station out of service when expansion is required. The pipe sizing and layout should minimize friction head loss and avoid air entrainment and siphoning. Piping lengths shall be short enough to remove pipe from the pump station using the crane or lifting equipment included in the design.

Exposed piping and appurtenances shall be coated in the appropriate color to indicate Raw Water, Potable Water, Reclaimed Water, building drain, sewerage, chemical piping, and others as applicable per CDPHE Water Quality Control Division's *Design Criteria for Potable Water Systems*. Flow direction shall be indicated on the piping.

The discharge piping shall be pressure rated for the greatest of:

- Maximum pump shut-off pressure
- Test pressure
- Surge pressure

The maximum pump shut-off pressure is defined as the pump shutoff head at maximum rated speed under zero flow conditions with the maximum possible pump suction pressure. The test pressure is defined as 1.25 times the maximum working pressure. Surge pressure is defined as the maximum resultant pressure generated by a power failure condition with all pumps operating at maximum rated speed (including the spare pump) under maximum flow conditions.

Piping under Structures shall be welded steel encased in concrete or controlled low-strength material (maximum compressive strength of 250 psi) for a minimum of 5 feet beyond the outside edge of the building footprint to avoid differential settlement around entry/exit piping. Use flexible joints as necessary to accommodate anticipated settlement. The steel piping shall be designed in accordance with *AWWA M11*. Coating of the pipes shall be consistent with the cathodic protection system in use. At no time shall rebar be in contact with any part of the piping.

Under special circumstances, a relief/bypass line may be required to recirculate discharge water to the suction manifold. This line can also be used to recirculate fire pump test flows. The bypass line shall include an Isolation Valve, a pressure relief valve by Cla-Val followed by a vacuum relief valve, flow meter, and Isolation Valve.

2. Flow Meters

The Design Engineer shall locate at least 1 magnetic flow meter for each transmission line leaving the pump station Site. Location of the flow meter shall be chosen to optimize accuracy according to the manufacturer's installation instructions. Select and size the flow meter to accurately measure the minimum and maximum flows through the pump station at initial and future conditions.

The flow meter shall be accessible for operations and maintenance. In case the flow meter must be removed for maintenance or replacement, design a bypass around the flow meter or a pipe spool piece to limit the amount of time that the station is out of service, see Detail Drawing A6-11.

3. Pressure Gauges and Pressure Transmitters

At a minimum, pressure gauges and instruments for transmitting pressures to SCADA shall be located at the:

- Suction and discharge sides of each pump
- Pump seal water line, when applicable
- Discharge header
- Upstream and downstream sides of a Raw Water strainer
- On a storage tank or reservoir for liquid level
- Chemical injection devices, as applicable

The Design Engineer shall specify a compound pressure gauge (combination vacuum and pressure) on the suction piping and a regular pressure gauge on the discharge pipe of each pump installed. Gauges shall be 4.5-inch diameter glycerin-filled. Gauges shall be mounted using flexible hose and tubing on a separate stand to dampen equipment mechanical vibration. Gauges shall have a built-in safety plug for blowout protection in an overpressure condition. Each gauge should include the following:

- Stainless steel nipple
- Corporation Stop
- Isolation ball valve
- Air release cock
- Stainless steel pulsation snubber

4. Air Release and Vacuum Relief Valves

Combination air release and vacuum relief valves (ARVs) shall be installed at high points in the process piping, yard piping, and other critical locations, see Detail Drawing A6-10.

Each pipeline train shall have at least 1 ARV sized for that pipeline's flow. Each ARV shall be equipped with a stainless steel nipple, Isolation Valve and union to allow easy removal for maintenance.

Additional air release and/or vacuum relief valves shall be installed where determined to be necessary by surge analysis. See Section 4.4I for acceptable manufacturers.

5. Drain Valves

Blow-offs shall be installed at low points of the yard piping and shall discharge to washes, storm drains, or roadways. See Detail Drawings A2-4 through A2-8.

The design shall include a capped ball valve on the suction and discharge side of each pump to drain pumps and check for residual pressure during maintenance prior to opening fittings. Stainless steel or brass materials are acceptable.

6. Pump Control Valves

Unless a VFD is used with the pump, each pipeline train shall have a pump discharge control valve that is coupled with the pump motor start and is equipped with a manual bypass that is pressure rated to accommodate the highest pressure expected in the system. Acceptable manufacturers of pump discharge control valves include Cla-Val or approved equal. The valve shall have a stainless steel

seat. All opening and closing times shall be adjustable to accommodate the recommended times from the final surge analysis.

If a VFD is used with the pump, each pipeline train shall have a counter-weighted check valve.

7. Isolation Valves

Isolation Valves shall be designed for use under the highest pressure expected in the piping system. Each pipeline train shall have an inlet and discharge Isolation Valve with wheel operator. The valves shall isolate the train for removal of the pump and control valve without requiring shut down of the entire pump station.

The entire pump station shall have Isolation Valves located on the suction and discharge piping to isolate the pump station facility and buried manifolds for maintenance. The valves may be located inside the pump station on the suction and discharge manifolds or outside the pump station.

If a tank is located on the Site, its inlet and outlet piping shall have Isolation Valves to isolate the tank from the pump station and the distribution system.

Isolation Valves shall also be located where any system or piece of equipment requires bypassing.

8. Valve Actuators

Rotork actuators with limit switches shall be specified. If a valve is remotely actuated, it must also have a manual actuator. Because of maintenance difficulties, pneumatic valve actuators using air compressors shall not be used.

9. Surge Control

Surge control is required to mitigate hydraulic transients as recommended by the final surge analysis. Relief to other parts of the system shall be the preferred method of surge control.

10. Pipe Supports and Restraints

Construction Drawings shall indicate location, type, and size of pipe supports and restraints. Supports shall be designed and located such that no force or stress from the connected piping is exerted on the pumps. All piping joints and thrust restraints shall withstand the maximum anticipated surge pressure. Pipe supports must be designed to minimize abrasion and corrosion and allow for expansion/contraction. Seismic supports shall be incorporated as necessary.

11. Strainers and Filters

Strainers and filters shall be included in the design as necessary to protect all equipment and facilities within the pump station.

J. Electrical, Instrumentation, and Controls

Colorado Springs Utilities Water Instrumentation and Control has developed *Standard Requirements for Instrumentation, Control, and Electrical (SRICE) for Pumping Stations*, which documents additional standards. This document is available upon request. Further electrical standards are documented in the *Electric Line Extension and Service Standards* available at Colorado Springs Utilities' website

(www.csu.org). In addition, the following design requirements described below shall apply to pump station design.

1. Electrical Area or Room

The electrical area, room, or equipment shall be elevated at least 4 inches above the pump room floor to provide positive drainage in the event of a pipe failure. If there is a separate electrical room, it shall have a window in the wall between the pump room and the electrical room for safety and to view pump operation.

2. Electric Service Metering

An electric service meter shall be installed for pump station electric usage. Refer to Colorado Springs Utilities *Electric Line Extension and Service Standards* for pump station Sites within its service territory. If the pump station is located outside the Colorado Springs Utilities service territory, arrange for electric service with the appropriate electric service provider.

3. Pump Motors

The pump motor shall meet the following requirements:

- Acceptable pump motor manufacturers include Hyundai-Ideal, Nidec-USEM, ABB, Siemens, TECO, WEG, GE, or approved equal
- Energy efficiency shall meet or exceed the requirements for National Electrical Manufacturers Association (NEMA) premium efficient motors and the manufacturer shall submit a certified statement of motor efficiencies
- Nameplate horsepower shall exceed the maximum horsepower required by the pump under all operating conditions
- The motor specified should operate in a range within 90% to 100% of its rated power for best efficiency
- Maximum rotational speed shall be 1800 rpm
- Rated for 10 starts per hour
- Service factor of 1.15 at installed Site conditions for pumps with a horsepower rating of 500 or less, larger pumps will have a project-specific service factor
- Temperature rise that does not exceed Class B rise at full load under the installed Site conditions
- Underwriter's Laboratory (UL) or Factory Mutual (FM) rating
- Cast iron frame or welded heavy plate steel box frame construction
- Copper windings shall be acceptable, aluminum windings shall not be acceptable
- Completely sealed insulation system consisting of Class F materials
- Heavy-duty 100,000 hour rated bearings
- If bearings are oil lubricated, incorporate a visual oil level indicator
- Condensate drain openings and breathers to allow removal of accumulated moisture from enclosures
- Lockout to keep motor from starting when pump is running in reverse or antireverse rotation ratchet
- Resistance Temperature Detectors (RTDs) shall be installed on all motors with a horsepower rating of 200 or more

4. Variable Frequency Drives and Soft Starters

The pump motor may be either constant speed or equipped with a soft start or variable frequency drive (VFD). The Design Engineer shall make a recommendation during the value engineering workshop based on operational needs, capital costs, and operational and maintenance costs. Colorado Springs Utilities prefers to use Allen Bradley-Rockwell Automation VFDs.

If the motor is VFD driven, the design shall include AEGIS® bearing protection rings, VFD rated cables, and a motor that is rated for inverter duty. Soft starts and VFDs shall have a manual bypass connection to allow manual motor start operation (full voltage and constant speed motor operation). They shall also be compatible with the motor selected.

VFDs shall vent to the exterior of the pump station and shall be screened to prevent rodent entry. Supplier shall ship VFDs with multi-axis accelerometer. Pumping unit Supplier shall submit shipping performance plan for approval prior to shipment and provide final accelerometer test reports to Colorado Springs Utilities for delivery acceptance.

5. Backup Power

For critical pump stations, as determined by Colorado Springs Utilities or another Authority Having Jurisdiction, secondary power or backup power generation is required.

The Design Engineer shall size the generator and engine based on emergency pump station loading and starting requirements, given the characteristics of the generator and engine. The generator shall be de-rated 3% for each 1,000 feet of elevation above 3,000 feet mean sea level. At a minimum, generators shall be sized for the largest pump or combination of pumps capable of meeting average day flows and required ancillary equipment.

The backup generator and accessories shall be selected to comply with applicable noise ordinances established by the Authority Having Jurisdiction. Where adjacent to existing or future residential properties, use a “hospital grade” muffler and size generator appropriately for increased exhaust backpressure.

The backup generator shall comply with applicable state and federal requirements.

Backup power generators shall be diesel powered. Generators shall be equipped with fuel to operate for 24 hours without refueling. Generator fuel tanks must be designed and permitted in accordance with the Colorado Department of Labor and Employment, Division of Oil and Public Safety’s *Underground Storage Tanks and Aboveground Storage Tanks (7 CCR 1101-14)* and the local fire code.

If a backup generator is not included in the design, incorporate a transfer switch for connection of a portable generator.

The systems requiring uninterruptible power supply shall include, but not be limited to:

- Security systems
- SCADA
- Emergency Lighting
- Other critical systems as determined by Colorado Springs Utilities or the Authority Having Jurisdiction

6. Raceways

Conduit inside the pump station for electric, instrumentation and control wiring shall be no smaller than ¾-inch galvanized rigid steel conduit (GRC). It shall be installed and supported per *National Electric Code (NEC)* requirements. Schedule 40 PVC shall be used for underground duct banks or conduits through concrete.

7. Telecommunications

The telecommunication network and services developed for the pump station shall support supervisory control and data acquisition (SCADA), corporate computing devices, telephones, and physical security systems.

Physical network infrastructure may include copper cabling, fiber optic cabling, and wireless/radio links. Physical network infrastructure shall be owned and operated by Colorado Springs Utilities after acceptance of the Project.

Given that each pump station Project is unique, Colorado Springs Utilities Information Technology Services staff shall be consulted early in the design process to help identify specific telecommunication requirements.

K. Chemical Systems

All chemical additives that come in contact with the Potable Water shall comply with *NSF/ANSI Standard 60* and Colorado Department of Public Health and Environment (CDPHE) regulations.

1. Post Chlorination Chemical Processes

In parts of the Potable Water Distribution System where low chlorine residual is possible, an injection point may be installed for calcium hypochlorite, sodium hypochlorite, or chlorine dioxide. Chlorine gas is prohibited at pump stations in the Potable Water Distribution System.

Within Raw Water pump stations, a potassium permanganate injection system could be installed to eliminate mussel growth and contamination. Other chemicals recommended for injection to the pumped water shall be considered on a case by case basis. Colorado Springs Utilities will review and approve any chemicals proposed for use within the Water System.

Each injection point shall have an active and a standby chemical feed pump. The chemical feed pumps, dosage amount, and number of injection points shall be designed based on the minimum and maximum flows through the pump station.

2. Chemical Storage

Chemical storage shall comply with federal, state and local regulations established by the Authority Having Jurisdiction.

Calcium hypochlorite, sodium hypochlorite, or chlorine dioxide shall be stored in approved chemical storage containers appropriate for each disinfectant. Specific chemical hazards unique to each disinfectant shall be mitigated on an individual basis.

Storage of potassium permanganate shall be in compliance with the *International Building and Fire Codes* in regards to shared wall fire ratings, sprinkler systems, secondary containment, ventilation system, etc. Potassium permanganate is classified as a Class 2 oxidizer and a corrosive.

Size the stored capacity for approximately 1 month of the average chemical dose unless chemical shelf life dictates otherwise. Provisions shall be made for measuring the quantities of chemicals used.

3. Chemical Containment

Chemical storage, handling, and delivery areas shall have containment for accidental spills or overflows. Chemicals shall not enter the storm drain or sewer. Secondary containment of chemicals shall be in compliance with all applicable codes and regulations of the Authority Having Jurisdiction.

4. Water Quality and Chemical Analyzers

Colorado Springs Utilities will determine how each additive will be monitored and recorded.

L. Oil and Petroleum

Oil and petroleum storage shall comply with federal, state and local regulations established by the Authority Having Jurisdiction. The following are additional items for general consideration:

- Compatibility of container, piping, and related components (elbows, couplings, unions, valves, fittings, epoxies) with the liquid stored and the conditions of storage
- Overfill prevention devices / alarms
- Separation and barriers with non-compatible or reactive materials / liquids
- Protection from vehicle impact, static build-up, and lightning
- Security of controls and valves, etc.
- Warning signage cautioning vehicles of aboveground piping
- Labeling of container and piping
- Ventilation of storage and use areas
- Proximity of eyewash stations and safety showers

1. Oil and Petroleum Containment

Oil and petroleum containers, piping, and loading / unloading areas shall have containment to prevent an overfill, spill, and/or leak from entering a waterway, associated conveyance (i.e. storm drain), or sanitary drain. Containment capacities should consider fire suppression and precipitation.

M. Water Storage

Water storage shall comply with CDPHE regulations and these additional requirements. Tanks in operation with pump stations shall have:

- Bypass piping and Isolation Valves to permit operation of the pump station while the tank is out of service
- A 10-foot wide minimum clear area around the tank for vehicular access and turnaround
- Sampling ports or hatches to test Water Quality per Colorado Springs Utilities and/or CDPHE requirements
- All water storage tanks shall have level indicating devices, type to be determined by Colorado Springs Utilities
- Chemical injection points, when required, shall be equipped with locking covers Hydropneumatic tanks shall be equipped with a Site glass on the tank

N. Corrosion Protection

The Design Engineer shall assess the corrosivity of the Site and design a cathodic protection system appropriate for the protection of the above and below ground facilities.

7.6 Construction Bidding

A. Procurement Methods

Depending on the Project, the Construction may be procured using 1 of the following 3 methods.

1. Invitation for Bid

Colorado Springs Utilities shall issue the Invitation for Bid (IFB) package. The Design Engineer shall review bids received from bidders and make recommendations of award to Colorado Springs Utilities, including whether or not the low bidder was a responsive and responsible low bidder. Colorado Springs Utilities shall award to the lowest responsive and responsible bidder.

2. Statement of Qualifications and Invitation for Bid

The Design Engineer shall present pre-qualification criteria to Colorado Springs Utilities, who will prepare a Statement of Qualifications (SOQ) issued by Colorado Springs Utilities. The Design Engineer shall assist with review of SOQ packages submitted to Colorado Springs Utilities and make recommendations of pre-qualified bidders.

Colorado Springs Utilities shall issue the IFB package to the pre-qualified bidders only. The Design Engineer shall review bids received and make recommendations of award to Colorado Springs Utilities. Colorado Springs Utilities shall award to the lowest bidder.

3. Request for Proposals

This method is typically not used in selection of a Contractor, but may be considered if the Project warrants its use under a design build contract.

The Design Engineer shall specify items required for the IFB package and qualification criteria for the Request for Proposals (RFP) package issued by Colorado Springs Utilities. If required, the Design Engineer will assist with review of proposals received from respondents and make recommendations of

award to Colorado Springs Utilities. Colorado Springs Utilities shall award to the best value respondent.

B. Mandatory Pre-Bid Site Meeting

The Design Engineer shall attend the pre-bid Site meeting and answer technical questions. The bidders shall be required to attend the meeting in order to bid on the pump station Project.

C. Addenda Assistance

The Design Engineer shall assist Colorado Springs Utilities in preparing addenda to answer questions, provide clarification, and interpret Contract Documents before bids are received by Colorado Springs Utilities.

D. Conformed Contract Documents

The Design Engineer shall incorporate all changes to the Contract Documents from addenda into a final set of conformed Contract Documents. This shall occur after the notice of award is issued and before the notice to proceed is issued to the selected Contractor.

7.7 Construction

A. Contractor Duties

This section covers the tasks assigned to the Contractor in addition to completing the requirements of the Contract Documents. Prior to construction, the Contractor shall obtain all licenses and insurance required for construction of the pump station Project.

1. Application for Payments

The Contractor shall submit a schedule of values that divides the work into sufficient detail to serve as the basis for progress payments during construction. The sum of all items included in the schedule of values shall equal the total contract price.

The Contractor shall submit an application for payment no more frequently than once a month. Application for payments shall be submitted on Colorado Springs Utilities' standardized form with notary witness.

2. Record Documents and Red-Lines

The Contractor shall maintain a record copy of the Contract Documents on Site that is updated to reflect changes made during construction (Red-Lines). Upon completion of the Construction, the Contractor shall submit the Red-Lines to be included by the Construction Manager into the record documents.

3. Contractor Permits

Before any construction work commences, the Contractor shall deliver to Colorado Springs Utilities copies of all required permits for the pump station Project. Permits that are not available to be obtained prior to construction must be submitted once they are obtained. Refer to Section 7.3E for additional information.

4. Schedules

Upon award of the contract, the Contractor shall submit a preliminary schedule indicating the times for starting and completing various stages of the Construction, including any milestones specified in the Contract Documents. Once construction is underway, the Contractor shall submit a 3 week look-ahead schedule each week. The overall schedule shall be updated at least once a month.

5. Utility Costs

The Contractor is responsible for all temporary utility costs prior to substantial completion and the owner's ability to receive beneficial use of the facility. Contractor shall obtain all temporary meters for electric and water in their names as part of the construction permits. Upon successfully obtaining substantial completion after commissioning and startup, meters can then be transferred to Colorado Springs Utilities as owners.

B. Construction Manager Duties

This section covers the tasks assigned to the Construction Manager. The Construction Manager may be from a different company than the Design Engineer. In such cases, the Design Engineer may be retained during construction to provide clarification of design intent to Colorado Springs Utilities and the Construction Manager as needed.

1. Submittal Reviews

The Construction Manager shall review the Shop Drawing submittals, operation and maintenance manuals, Samples, test reports, and Contractor's proposed substitute materials on behalf of Colorado Springs Utilities. If the Construction Manager is different than the Design Engineer, the Design Engineer will also review the submittals.

2. Inspection Services and Verification of Quantities

The Construction Manager shall perform Site visits to assist Colorado Springs Utilities in monitoring construction for general compliance with the Contract Documents and design intent. During Site visits, the Construction Manager shall document the Contractor's activities and quantities for payment. At a minimum, Site visits shall occur during critical construction stages, such as concrete pours, Structure construction, connection to existing piping, equipment installations, and all Pikes Peak Regional Building Department inspections.

The Construction Manager shall submit 1 electronic copy of each Site visit report documenting the Contractor's activities and quantities for payment. The report shall include time and date of observation, photos, measurements, and any pertinent information from the Site visit. The Construction Manager shall submit the reports on a weekly basis.

The Construction Manager shall review applications for payment and verify all quantities for payment.

3. Record Documents Based on Contractor Red-Lines

The Construction Manager shall prepare record documents from contractor red-lines. Record documents shall reflect addendums, clarifications, RFIs, field

directives, change orders, and all other modifications that reflect the installed facilities.

4. Punch Lists

The Construction Manager shall perform a Site visit with Colorado Springs Utilities and the Contractor at substantial completion and assist in developing a punch list of outstanding items to complete the Construction. The Construction Manager shall also perform final Project walkthroughs to confirm all punch list items are complete.

C. Construction Requirements

1. Construction Safety and Health

Colorado Springs Utilities expects every Contractor, Construction Manager, and anyone entering the Site to comply fully with all applicable federal, regional, and local safety and health regulations. See Section 5.4 for detailed requirements.

2. Environmental Compliance

Construction shall be in accordance with all applicable federal, state and local environmental regulations. The following procedures are available in Colorado Springs Utilities Quality By Design (QBD) documents and can be acquired by request from the Environment, Health and Safety Department:

- *Aboveground Storage Tank Control Procedure (EVS-11800)*
- *Air Pollution Control Procedure (EVS-11801)*
- *Asbestos Control Procedure (EVS-11802)*
- *Container Control Procedure (EVS-11803)*
- *Contaminated Soils Handling Procedure (EVS-11804)*
- *Environmental Compliance Inspection Procedure (EVS-11250)*
- *Hazardous Waste Control Procedure (EVS-11805)*
- *Migratory Bird Management Procedure (EVS-12986)*
- *Pesticide Control Procedure (EVS-11807)*
- *Petroleum Products and Used Oil Management Procedure (EVS-10712)*
- *Solid Waste Control Procedure (EVS-11809)*
- *Underground Storage Tank Control Procedure (EVS-11810)*
- *Universal Waste Control Procedure (EVS-10711)*
- *Water Pollution Control Procedure (EVS-11812)*

3. Stormwater Quality

Projects involving a disturbed construction area of 1 acre or greater shall comply with all requirements of the Colorado Discharge Permit System (CDPS) *General Construction Stormwater Permit* of the CDPHE, WQCD. To comply with the general permit, a *Storm Water Management Plan (SWMP)* shall be prepared and implemented before construction begins. The *SWMP* shall be prepared by the Contractor and approved by the CDPHE.

In addition to CDPHE requirements, other requirements from the Authority Having Jurisdiction may apply. Ground disturbances in the City of Colorado Springs are required to comply with the requirements set forth in the City of Colorado Springs *Drainage Criteria Manual*.

Dewatering operations shall comply with the Colorado Discharge Permit System (CDPS) construction dewatering requirements.

A copy of all permits or approvals from CDPHE, or any other Authority Having Jurisdiction, shall be presented to the Colorado Springs Utilities Inspector prior to commencement of any dewatering activities. The Contractor shall also submit copies of stormwater compliance inspection reports to Colorado Springs Utilities during construction.

The Contractor shall provide laboratory and field sampling services during construction in accordance with the permits during construction dewatering and/or hydrostatic testing procedures. The Contractor shall retest unsatisfactory Samples as necessary.

4. Chemical Review and Use

Before Contractors purchase materials for construction of the pump station Project, they shall adhere to the Colorado Springs Utilities Hazard Communication Program and New Chemical Review Program, as described in the *Safety and Health Program Manual*. Colorado Springs Utilities will review and approve any chemicals proposed for use within the Water System. Colorado Springs Utilities shall not be responsible for materials and substances brought to the Site by the Contractor. Refer to Section 7.5C.1.

5. Asbestos Materials

See Section 5.10B for construction requirements for demolition and disposal of Asbestos material.

The Contractor shall ensure that materials containing Asbestos are not used in the Construction of the work. Upon completion of the Project, Colorado Springs Utilities shall obtain a letter signed by the Contractor or Owner/Developer responsible for construction stating, "No Asbestos Containing Building Materials (ACBM) were specified as building material, and to the best of my knowledge, no ACBM was used as a building material." Refer to *Regulation Number 8, Control of Hazardous Air Pollutants*, by the CDPHE Air Quality Control Commission.

6. Excavation

If evidence of contaminated soil is observed but is not identified in the Contract Documents, immediately notify Colorado Springs Utilities for direction on how to proceed. Refer to Section 7.5C.3.

If contaminated soils are identified in the Contract Documents, the Contractor shall remove and properly dispose of the contaminated soils at a permitted solid waste disposal facility.

If any previously unknown historic paleontological, archeological remains are discovered while working at a Site, Colorado Springs Utilities Environment, Health and Safety Department shall be notified immediately to determine required actions.

7. Construction Survey

During construction, at least 2 permanent survey control monuments shall be established at the Site, being inter-visible, preferably on opposite sides of the site, where the possibility of being disturbed is minimized. A Professional Land Surveyor licensed to practice in the State of Colorado shall be in responsible charge for all layout and construction staking using accepted standard of care. With established methods and practices, coordinates and elevations shall be assigned to these monuments using the FIMS coordinate system. The control monuments shall be related to each other with a demonstrated accuracy which meets the Federal Geographic Data Committee (FGDC) Specification for Second Order, Class I Engineering and Construction Control Survey (horizontal and vertical).

Each monument shall consist of a 3 ¼ -inch aluminum survey marker bearing the control point information on a rod driven to refusal, collared with 6-inch schedule 40 PVC and concrete, and enclosed by a recessed-hinge access cover. Markers and accessories shall be manufactured by Berntsen or approved equal.

8. Existing Facilities

The Contractor shall:

- Protect existing facilities from damage during construction activities
- Provide safe access for Colorado Springs Utilities personnel to existing facilities during construction so that they may perform their regular operations and maintenance work
- Ensure compliance with the requirements of the Advisory Council on Historic Preservation, Colorado Springs Utilities, City of Colorado Springs, and the Colorado State Historic Preservation Officer, and any Agreements between the Bureau of Reclamation, as applicable

9. Pump Anchorage

To minimize vibration and resonance,

- Pump base shall be grouted with no void space below the base plate
- The Contractor shall install a level pump base and anchor bolts
- The pump Supplier shall dynamically balance pumps

The concrete pedestal shall be poured to the correct height to provide flush, unbroken support to the pump and base plate and to avoid pipe strain. A Colorado Springs Utilities representative shall be present for piping installation and pump connections to confirm final alignments. Under special circumstances when the process piping shall be installed first and then the pump raised to mate to the piping, raising the pump and base plate with C-channels or pump supports shall not acceptable.

10. Spare Parts for Pumps

Spare parts shall be stored and left on site for future use. The Contractor shall supply the following spare parts for each size of pump installed:

- Mechanical seal
- Set of gaskets and O-rings

- Complete set of any special tools required for dismantling the pump (i.e. metric sizes or oversized tools)

11. Warranties

a) Construction Warranty

The Contractor shall warrant that construction of the pump station shall meet applicable Colorado Springs Utilities' requirements and shall agree to correct deficiencies in any services performed, in whole or in part within a 2 year warranty period unless specifically modified by the Contract Documents.

b) Equipment Warranty

The pump station and its appurtenances shall be under warranty for 2 years from the date of final acceptance or for 1 year from the date that Colorado Springs Utilities begins to utilize the pump station, whichever is the later date. Extended warranties on select equipment shall be negotiated as required.

7.8 Pump Station Commissioning and Startup

Construction shall not be considered substantially complete until the commissioning and startup of the pump station is complete. Commissioning and startup shall include the following processes:

1. Factory Testing
2. Commissioning
3. Startup
4. Training

The Contractor shall submit a commissioning and startup plan, which finalizes the procedures outlined in the Contract Documents. The plan shall be a compilation of detailed factory and field testing plans, equipment, pump station, and system performance testing procedures, testing documentation forms, check lists, schedules, and all other information necessary to describe and document all of the commissioning and startup activities. Final test reports shall be submitted upon successful completion of each test.

A. Factory Testing

Colorado Springs Utilities personnel shall witness all factory testing of individual pumps with a horsepower rating of 500 of more or pumps determined to be critically important by Colorado Springs Utilities. If the testing and startup schedule changes, Colorado Springs Utilities shall have at least 3 weeks' notice.

The Contractor or manufacturer must prepare a factory test plan for each item or system that is required to be factory tested. The plan shall include detailed step-by-step procedures describing how the test will be conducted and shall be delivered to Colorado Springs Utilities prior to testing. Test documentation and acceptance records shall be submitted upon successful completion of the testing.

1. Pumps

Factory pump tests shall be conducted in accordance with the latest issue of the Hydraulic Institute (HI) standards. Acceptance criteria shall be 1U as defined by the Hydraulic Institute Standards. The following specific tests and inspections shall be performed at a minimum:

- Hydrostatic test
- Hydraulic test with minimum of 7 readings between shutoff head and 110% of best efficiency point, recorded on data sheets as defined by HI, signed, dated and certified
- Certified test logs and pump curves showing head/flow, bhp, efficiency, actual NPSH required curves
- Certification that the pump horsepower demand shall not exceed the rated motor horsepower beyond the 1.0 service rating at any point on the curve
- Certified factory power cost, when required
- Vibration measurements at all conditions tested during the factory tests

Calculated NPSH required may be accepted at the option of Colorado Springs Utilities. Actual NPSH required curves shall be within 10% of the published data as required by *API 610*. Pumps with actual NPSH required curves that do not meet this standard shall not be accepted. Pump curves shall be certified by a registered Professional Engineer or company officer.

Vibration levels shall comply with factory test requirements of HI standards.

If any pump tested fails to meet any Specification requirement it shall be modified until it meets all requirements. If any pump tested fails to meet the efficiency requirements of the Contract Documents and all reasonable attempts to correct the inefficiency are unsuccessful, the pump(s) shall be replaced with a unit(s) that meets the specified requirements.

2. Motors

Each motor shall be tested per National Electrical Manufacturers Association (NEMA) and ANSI standards to determine that it is free from mechanical and electrical defects. Pump manufacturer shall submit a certification to the Utility that the VFD and the motor are capable of starting and accelerating the pumping assembly throughout the operating range of the pump. The results of each test shall be submitted to Colorado Springs Utilities. Tests shall be performed in accordance with *Institute of Electrical and Electronics Engineers (IEEE) 112*, and include:

- Winding resistance
- Polarity of field coils
- High-potential test on field and armature
- Measurement of Air Gap
- Current balance at no load
- No-load field current check at normal voltage and frequency

Additional testing in accordance with IEEE includes:

- Tests to establish motor efficiencies, including the determination of I-R losses, core losses, friction and windage losses, and stray load losses
- Tests to establish winding temperature rise by the embedded detector method, including a zero power factor heat run or open and short circuit heat runs

- Tests to establish starting characteristics such as starting and accelerating torque and current by the reduced voltage method
- Noise test
- Vibration test
- Record ambient and bearing temperature measurements

3. Process Control and Instrumentation Systems (PCIS)

Before shipment, the complete PCIS system shall be assembled, connected, and all software loaded for a fully functional factory acceptance test of the integrated system.

B. Commissioning

Commissioning will be referred to as installation and functional testing in the field. The Contractor must complete all commissioning and shall demonstrate satisfactory operation and performance, without causing excessive noise, cavitation, vibration, leakage, overheating, or other operational deficiencies.

Commissioning plans shall be developed for, but not limited to, the following systems:

- Pumps
- Motors
- Electrical/Instrumentation
- Chemical systems (if used)
- Cathodic protection equipment

The plan shall include detailed step-by-step procedures describing how the test will be conducted. For tests requiring water, the plan shall also include water management procedures, i.e. how the pumps and piping will be isolated and filled for each of the tests, and how the water will be disposed of after the test.

1. Pumps

Vibration testing on each pump shall be performed by the Contractor to verify the actual natural frequency of the installed pumping units. Start up, check, and operate each pumping unit and pumping units in combination over the entire operational range.

Pump performance shall be documented by obtaining concurrent readings, showing motor voltage, amperage, pump suction head, and pump discharge head for at least 4 pumping conditions, including the most extreme conditions that could be encountered. Each power lead to the motor shall be checked for proper current balance. All instrumentation necessary to conduct the testing, other than vibration testing, shall be provided by the pump Supplier or factory certified service technician.

2. Motors

For commissioning motors:

- Perform insulation resistance tests in accordance with manufacturer's instructions

- Perform a phase rotation test to ensure proper shaft direction with load uncoupled
- Check all connections with wiring diagram prior to energizing
- Inspect for unusual mechanical or electrical noise or signs of overheating during initial test run
- Measure running current and evaluate relative to load conditions and nameplate full load amperes

If any motor fails during performance testing, the Contractor or manufacturer may make minor repairs and retest. If the unit requires major disassembly to repair, or is inoperable, the motor shall be rejected and the Contractor shall replace it with a new motor. If a motor fails to perform to the level demonstrated at the factory, but is otherwise operable, the rejected motor shall remain in place until the replacement motor has been delivered to the pump station Site.

3. Electrical/Instrumentation

The electrical and/or instrumentation Subcontractor shall certify:

- Motor control logic that resides in motor control centers, control panels, and circuit boards furnished by the electrical and/or instrumentation Subcontractor has been calibrated and tested and is properly operating
- Control logic for equipment startup, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly operating

In addition to demonstrating correct operation of instrumentation and control systems, Contractor shall demonstrate how the systems react and recover from abnormal conditions, such as equipment failure, operator error, communications error, power failure, process equipment failure, and high system loading conditions.

Commissioning shall not be considered complete until all repairs and adjustments have been made and each piece of equipment is fully operational.

At completion of commissioning, the manufacturer's representatives shall furnish written reports, signed and certifying that each piece of equipment:

- Has been properly installed, adjusted, aligned, and lubricated
- Is free of any stresses imposed by connecting piping or anchor bolts
- Is suitable for satisfactory full-time operation under full load conditions
- Operates within the allowable limits of vibration
- Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning
- Control logic for startup, shutdown, sequencing, interlocks, and emergency shutdown have been tested and are properly functioning

C. Startup

Startup is the testing of the entire system operating together and shall commence upon successful completion of commissioning tests and once Contractor has supplied

all required safety equipment, such as safety chains, handrails, gratings, safety signs, fire extinguishers, etc.

To achieve substantial completion, the pump station must undergo a 7 Day system wide performance test unless specifically modified by written agreement. For the full duration of testing, the Contractor shall serve as an authorized representative of the manufacturer for all major equipment, to verify operation, calibration, and adjustments of the equipment.

If any major item fails or malfunctions during the 7 Day test, the item shall be repaired and the 7 Day test shall be re-started at time zero.

The testing shall include all possible operation scenarios, from routine to emergency conditions. Specific tests shall be performed to demonstrate, in both manual and automatic modes of operation, that all components and systems are functioning properly.

Following a successful performance test and following acceptance of the pump station, Colorado Springs Utilities will assume responsibility and ownership of the pump station. See Section 7.2D for additional information.

D. Training

Authorized representatives of the manufacturers shall provide operation and maintenance training and operation and maintenance manuals for each major piece of equipment. The training shall include demonstration on how to safely operate the equipment, maintain, and repair the equipment and systems. Training shall include troubleshooting common problems, removal, inspection, and cleaning of equipment.