

## **APPENDIX B**

### **SANITARY SEWER CONSTRUCTION SPECIFICATIONS**

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## SECTION 01525A

### TEMPORARY CONSTRUCTION AIDS AND ENVIRONMENTAL CONTROLS (Private Development Project)

#### **PART 1 -- GENERAL**

##### **1.01 SCOPE OF WORK**

- A. The Developer/Contractor shall furnish temporary utilities, including electricity, lighting, telephone service, water and sanitary facilities; temporary controls, including barriers, protection of work and water control; and construction facilities, including parking, progress cleaning and temporary building as required for the project.

##### **1.02 TEMPORARY UTILITIES**

- A. Temporary Electricity: Developer/Contractor shall provide, maintain and pay for all power required by the Developer/Contractor, including electrical service to the field office, if required.
- B. Temporary Lighting: Developer/Contractor shall provide all temporary lighting required for prosecution of his work and for employee and public safety. As a minimum, lighting levels during working hours shall meet the requirements of UOSHA, subsection 1926.56 illumination.
- C. Temporary Water Service
1. The Developer/Contractor shall provide for all workers on the project, an adequate and reasonably convenient, uncontaminated drinking water supply. All facilities shall comply with the regulations of the local and State and County Departments of Health.
  2. Developer/Contractor shall be responsible to arrange for water, both potable and non-potable water.
  3. When water is taken from a City water system or any other potable water supply source for construction purposes, suitable precautions shall be taken to prevent cross connection and contamination of the water supply. This shall include properly obtaining a City construction water meter with attached backflow prevention devices through the City's Finance Department, Utility Billing Division.
- D. Temporary Sanitary Facilities
1. Developer/Contractor shall provide and maintain sanitary facilities for his employees and his Developer/Contractors' employees that will comply with the regulations of the local and State Department of Health.

##### **1.03 TEMPORARY CONTROLS**

- A. Barriers: Provide barriers as necessary to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations.

- B. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into the atmosphere. Give all unpaved streets, roads, detours, or haul roads used in the construction area an approved dust-preventive treatment or periodically water to prevent dust. Applicable environmental regulations for dust prevention shall be strictly enforced. Contact the Utah Department of Environmental Quality, Division of Air Quality for an appropriate permit and regulations.
- C. Protection of Work: Developer/Contractor shall protect installed work and provide special protection where specified in individual specification sections. Developer/Contractor shall provide temporary and removable protection for installed products, and shall control activity in immediate work area to minimize damage.
- D. Open Burning: No open burning or waste materials is allowed.
- E. Explosives and Blasting: The use of explosives on the work is not allowed.
- F. Noise Abatement: In inhabited areas, particularly residential, operations shall be performed in a manner to minimize unnecessary noise generation and shall comply with City ordinances and standards.
- G. Storm and Ground Water:
  - 1. The Developer/Contractor shall provide and maintain at all times during construction, ample means and devices with which to promptly remove and properly dispose of all water entering the excavation or other parts of the work, whether the water be surface or underground water.
  - 2. In excavation, fill and grading operations, care shall be taken to disturb the pre-existing drainage pattern as little as possible. Particular care shall be taken not to direct drainage water into private property or into streets or drainage ways inadequate for the increased flow.
  - 3. The Developer/Contractor shall maintain effective means to minimize the quantity of sediments leaving the work area either by storm water or the Developer/Contractor's own dewatering operations. These means and methods shall be approved by the City Engineer as part of the 'Released for Construction Drawings' review process.

#### **1.4 CONSTRUCTION UTILITIES**

- A. Parking: Developer/Contractor shall provide temporary parking areas to accommodate use of construction personnel. Parking shall be located in an area approved by the City.
- B. Progress Cleaning:
  - 1. Developer/Contractor shall maintain areas free of waste materials, debris and rubbish. He shall also maintain the site in a clean and orderly condition. Upon completion of work, repair all damage caused by equipment and leave the project free from rubbish or excess materials of any kind.
  - 2. Thoroughly clean all spilled dirt, gravel or other foreign materials caused by the construction operations from all streets, roads, and storm water facilities at the conclusion of each day's operation.
  - 3. It shall be the responsibility of the Developer/Contractor to promptly clean up and remove any oil and or fuel spills caused by the Developer/Contractor or his subcontractors during the course

of the project. The Developer/Contractor shall properly dispose of contaminated soil according to local, State and federal laws. The Developer/Contractor shall be responsible for any damages resulting from the Developer/Contractor's actions in promptly cleaning up said spills.

### **1.5 REMOVAL OF UTILITIES, FACILITIES AND CONTROLS**

- A. Developer/Contractor shall remove temporary above grade or buried utilities, equipment, facilities and materials prior to application for Warranty Inspection. Clean and repair damage caused by installation or use of temporary work. Restore existing facilities used during construction to their original condition.

\*\*\* END OF SECTION \*\*\*

## SECTION 01554A

### TRAFFIC CONTROL (Private Development Projects)

#### **PART 1 -- GENERAL**

##### **1.01 SCOPE OF WORK**

- A. General. The work shall consist of establishing traffic control and maintaining safe, convenient use of public roads and rights-of-way.
- B. This section covers Traffic Control Plan requirements and materials and labor necessary for its implementation. It also includes issues related to Traffic Control Maintainer and flagging, work zone traffic control devices, advance warning arrow panels and pilot cars.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 01558 – Temporary Pavement Markings
- B. Section 02842 – Delineators.
- C. Section 02891 – Traffic Signs.
- D. Section 02765 – Pavement Marking Paint.

##### **1.03 REFERENCES**

- A. AASHTO Roadside Design Guide, current edition.
- B. Manual of Uniform Traffic Control Devices (MUTCD), current edition.
- C. ATSSA: American Traffic Safety Services Association.
  - 1. Quality Standards for Work Zone Traffic Control Devices
- D. NCHRR – Report 350: Recommended Procedures for the Safety Performance Evaluation of Highway Features.
- E. OSHA Construction Industry Standards (29 CFR Part 1926), Subpart G, Signs, Signals, and Barricades.

##### **1.04 SUBMITTALS**

- A. Submit traffic control plan in accordance with the Special Conditions and UDOT State Specifications. The traffic control concept shown on the plans is for bidding purposes and is intended to serve as a guideline only. The Developer/Developer/Contractor shall be responsible for the preparation and adequacy of any traffic control plan utilized, including this suggested plan, and shall submit the final traffic control plan (prepared, signed and sealed by a Utah licensed professional City Engineer) in drawing form to the City Resident Project Representative.
- B. Submit to the City Resident Project Representative a detailed signing and traffic detouring plan in drawing form for each phase for approval. Post detour routes to provide clear guidance to traffic as approved by the City Resident Project Representative.

## **1.05 GENERAL**

- A. Control traffic at those locations indicated and in conformance with the plans approved by the City Resident Project Representative.
- B. Furnish, install, construct, maintain, and remove detours, road closures, lights, temporary signals, signs, barricades, K-rail, fences, flares, miscellaneous traffic devices, flagmen, drainage facilities, paving, and such other items and services as are necessary to adequately safeguard the public from hazard and inconvenience. All such work shall comply with the ordinances, directives, and regulations of authorities with jurisdiction over the public roads in which the construction takes place and over which detoured traffic is routed by the Developer/Developer/Contractor.
- C. After devices have been installed, maintain and keep them in good repair and working order until no longer required. Replace such devices that are lost or damaged, to such an extent as to require replacement, regardless of the cause of such loss or damage.
- D. Prior to the start of construction operations, notify the City Resident Project Representative, City of West Jordan, UDOT, police and fire departments of the City, giving the expected starting date, completion date, and the name and telephone number of a responsible person who may be contacted at any hour in the event of a condition requiring immediate correction.

## **1.06 TRAFFIC CONTROL DEVICES AND SIGNS**

- A. Construction signing, striping, barricades, and other traffic control devices used for handling traffic and public convenience shall conform to the latest edition of the Federal Highway Administration "Manual on Uniform Traffic Control Devices for Streets and Highways" (MUTCD).
- B. Signs shall be reflectorized when they are used during hours of darkness. Provide cones, pylons, barricades, or posts used in the diversion of traffic with flashers or other illumination if in place during hours of darkness.
- C. Maintain a 24-hour emergency service to remove, install, relocate, and maintain warning devices and furnish to the authority having jurisdiction names and telephone numbers of three persons responsible for this emergency service. In the event these persons do not promptly respond or the authority having jurisdiction deems it necessary to call out other forces to accomplish emergency service, the Developer/Contractor will be held responsible for the cost of such emergency service.
- D. During the duration of a detour, cover all signs not in accordance with the traffic control plan. Relocate existing signs to provide visibility from all relocated traffic lanes.
- E. Temporary traffic striping, where used, shall be removable pavement marking tape. Pavement markings shall be white or yellow, weather and traffic resistant reflective film on conformable backing and pre-coated with a pressure-sensitive adhesive that does not require an activation process.

Temporary pavement markings shall conform to the following minimum reflective values as specified. Express reflective values as candlepower per foot-candle per square foot measured on a 1 foot by 2 foot panel at 86 degrees incidence.

| Divergence Angle | White | Yellow |
|------------------|-------|--------|
| 0.20             | 0.20  | 0.18   |
| 0.50             | 0.18  | 0.16   |

Supply striping tape in rolls ready for application. Use pavement message tape 20 to 30 mils thick, that does not shrink or release prematurely, and that has an easily removable liner.

- F. At the end of each workday, place temporary pavement markers on any roadway surfaces open to traffic. Apply pavement markers to a clean and dry surface during daylight hours. During winter shutdown, place permanent paint striping and pavement messages.
- G. Press the tape into the surface until it adheres to the pavement surface.

**1.07 VEHICULAR TRAFFIC CONTROL**

- A. Obtain a City Encroachment Permit through the Engineering Department for any activity being contemplated for City dedicated right-of-ways.
- B. Reduce speed limit through the construction zone to 25 mph and post accordingly.
- C. Traffic lane transitions from permanent lanes to construction zone patterns shall be transitioned in accordance with the requirements for the normal posted speed limit and as shown on the plans.
- D. Where traffic is directed around or adjacent to the construction area, the Developer/Developer/Contractor shall provide, lights, signs, and other devices required for the control of traffic as required by the UDOT traffic regulations and said "Manual of Uniform Traffic Control Devices." The City Resident Project Representative shall have the right to relocate or direct the Developer/Contractor to relocate traffic control devices.
- E. In the event the City Resident Project Representative finds the worksite to be improperly barricaded or delineated and the Developer/Developer/Contractor is either unavailable or unresponsive to requests for improvement, the City Resident Project Representative will furnish and set up barricades and delineators as required. Two hundred dollars (\$200) will be charged the Developer/Developer/Contractor for each set-up event plus five dollars (\$5) "rental" for each barricade or delineator for each day's or partial day's use.
- F. All roadways and sidewalks shall be returned to unrestricted vehicle and pedestrian usage when construction is not underway.
- G. Truck operations in and out of construction and staging areas shall be controlled by flagmen at all times.
- H. The maximum delay to the public due to Developer/Contractor construction activities is four hours.
- I. Construction in Intersections: Maintain at least one through lane in each direction on the following intersecting streets during working hours while constructing within the intersection

J. Detour Routing: Notify the City Resident Project Representative at least 2 calendar days in advance and complete coordination prior to the detouring of traffic along the affected streets.

### **1.08 ACCESS TO ADJACENT PROPERTIES**

A. General: Maintain reasonable access from the project to all adjacent properties at all times during construction. Prior to restricting normal access from public streets to adjacent properties, notify each property owner or responsible person, at least three working days prior to the disruption, informing him of the nature of the access restriction, the approximate duration of the restriction, and the best alternative access route for that particular property.

### **1.09 SUBMITTAL REQUIREMENTS**

- A. The Developer/Contractor shall submit the following to the City Engineer for review:
1. Submit three copies of the Traffic Control Plan to the City Engineer at the preconstruction meeting. Submit plans in 11x17 format prepared using AutoCAD software. All plans must be signed and sealed by a professional City Engineer licensed in the State of Utah.
  2. Attend a mandatory meeting at the time and location as directed by the City Engineer with City staff and the following:
    - a. Developer/Contractor's traffic control designer
    - b. Developer/Contractor's traffic control maintainer
    - c. Resident City Engineer
    - d. City's Traffic Engineer or designated representative
  3. Ensure compliance with the plans and specifications. Modify plan if necessary to meet all applicable requirements.
  4. Do not begin work. Do not implement traffic control until written authorization is received from the City Engineer.

### **1.10 CERTIFICATIONS**

- A. After April 1, 2002, use devices and systems which meet NCHRP-350 Report crash test requirements as defined in the four categories by the Federal Highway Administration. Some exceptions will be acceptable as stated below.
1. Category 1: Cones, tubular marker, delineators, and drums without lights must be certified by the manufacturer as meeting NCHRP-350 Report requirements.
  2. Category 2: portable sign stands with signs, Type I, II, and III barricades, vertical panels, Category 1 devices with light attachments and devices not expected to cause significant vehicle velocity change. These devices and systems must be certified by FHWA as meeting NCHRP-350 Report test requirements.
  3. Category 3: Portable/temporary precast concrete barrier manufactured after October 1, 2002 must be certified as meeting NCHRP-350 Report test requirements.
    - a. Manufactured date to be stamped into top of each barrier section using a numeric format (ex: 10/2002) with 75 mm x 50 mm numerals, 6 mm deep).
    - b. Portable/temporary precast concrete barrier manufactured prior to October 1, 2002 and meeting NCHRP-230 may be used until they are no longer serviceable.
  4. Category 3: Crash cushions and truck mounted attenuators must be certified by FHWA as meeting NCHRP-350 Report test requirements

- a. The appropriate GREAT CZ, manufactured by Energy Absorption Systems, may be used until they have completed their normal service life.
5. Category 4: Advanced warning arrow panels and portable variable message signs do not have to meet NCHRP-350 Report test requirements.

### **1.11 TRAFFIC CONTROL PLAN REQUIREMENTS**

A. Traffic Control Plan (TCP) Checklist and Guidelines – In preparing the Traffic Control Plan, the design professional will need to address the following items:

1. The Traffic Control Plan (TCP) shall be drawn on 24" x 36" or 11" x 17" sheets, unless otherwise approved by the City's Traffic City Engineer. TCPs prepared for work occurring on all streets shown on the Circulation Element of the General Plan shall be prepared by a Registered Civil City Engineer or Registered Traffic City Engineer.
2. Draw the TCP with ink using legible lettering and symbols.
3. Indicate Developer/Contractor's name, address and telephone number. Include name and telephone number of the 24-hour contact person presenting the Developer/Contractor.
4. Indicate a north arrow and scale on the drawings. If the drawing is NOT-TO-SCALE (N.T.S.), indicate so on the drawing.
5. Show all nearby streets with street names to assure proper orientation.
6. Show existing traffic signals and regulatory signs, as appropriate.
7. Show existing striping, pavement markings, painted crosswalks and bike lanes.
8. Show existing curbs, gutters, sidewalks, driveways and intersections in the construction work zone including areas affected by taper transition.
9. Indicate total roadway widths. Dimension existing striping from edges of pavement.
10. Indicate posted speed limits.
11. Show location and dimensions of the construction work zone.
12. Show staging areas and materials storage area, as appropriate.
13. Indicate locations of construction signs, barricades, and delineators.
14. Label all taper lengths and widths, delineator spacing and sign spacing.
15. Use a legend to define all symbols and designate them with UDOT nomenclature.
16. Show all parking restriction zones and signs, as appropriate.
17. Road closures will require approval from the City Engineering and the City Council.
18. Signs and barricades will be required to direct pedestrians through or around the construction work zone and shall be shown on the TCP.
19. Indicate the encroachment permit number or improvement plans number on the traffic control plan.
20. Indicate on the plan the duration of the construction work and subsequent traffic control

B. Traffic Control Plan General Notes – The following notes need to be attached to and adhered to in preparing and implementing the Traffic Control Plan.

1. All traffic control devices shall conform to the latest edition of the UDOT's Traffic Manual of Traffic Control Devices for Construction and Maintenance Work Zones and the Standard Specifications for Public Works Construction.
2. The City Engineer or his representative has the authority to initiate field changes to assure public safety.
3. All traffic control devices shall be removed from view when not in use.
4. Work hours shall be restricted to between 7:00 a.m. and 10:00 p.m. unless otherwise approved.
5. Trenches must be back filled or plated during non-working hours.
6. Pedestrian controls shall be provided as shown on the plans.

7. Temporary "NO PARKING" signs will be posted 24-hours prior to commencing work.
  8. Access to driveways will be maintained at all times unless other arrangements are made.
  9. The Developer/Contractor shall replace all traffic signal loop detectors damaged during construction within 72-hours of them being damaged.
  10. All striping removed or damaged, will be replaced by the Developer/Contractor within 24-hours (or replaced with temporary tape).
  11. All Workers shall be equipped with an orange vest (or a reflective vest at night). All flaggers shall also be equipped with a hard hat, C28 "Stop/Slow" paddle, shall be trained in the property fundamentals of flagging traffic, and be certified as indicated in this section
  12. Any work that disturbs normal traffic signal operations shall be coordinated with the City of West Jordan's Traffic City Engineer, 48-hours prior to beginning construction.
  13. The Developer/Contractor shall maintain all traffic control devices 24-hours per day and 7-days per week.
  14. A minimum of twelve (12) foot travel lanes must be maintained unless otherwise approved by the City Engineer.
  15. All night work will require written approval from the City Engineer. Lane closures, road detours, road closures, and traffic signal modifications associated with overnight construction activities will require warning signs be placed at least one week in advance of starting construction.
  16. A solar powered flashing arrow board shall be required on all arterial street land closures.
- C. Design the traffic control plan resolving discrepancies between the various standards for traffic control in accordance with Section 00727 – Control of Work paragraph 1.5.B and the following:
1. UDOT Standard Traffic Control Drawings 745-2 Series. UDOT Standards Drawing 745-60, 745-60A, 745-60B, and 745-60D for post mounted signs.
  2. Manual of Uniform Traffic Control Devices (MUTCD), latest edition.
- D. Follow the requirements and limitations identified in the Traffic Control Special Provision (if included), Section 00555, Prosecution and Progress, paragraph 1.11. Limitation of Operations, Section 00725, Scope of Work, paragraphs associated with the maintaining of traffic and Section 00820 – Legal Relations and Responsibility to Public, paragraph 1.10 "Public Convenience and Safety – Traffic and Pedestrians".
- E. Consider the safe and efficient movement of traffic when land closures are proposed.
1. Open lanes to traffic wherever and whenever practical.
  2. Minimize and restrict land closures to the locations and times essential for prosecution of work.
- F. Provide for concrete barriers and attenuation to satisfy hazard mitigation according to UDOT Standard Drawing 745-2 Detail AA, and 745-2E Detail E-1.
- G. Provide for delineation and temporary pavement markings and/or removal as needed for traffic control or as required in accordance with this section, paragraph 1.6, lines H and I.
- H. Provide protection for all hazards (i.e.: bridge parapets, barrier blunt ends, poles, large equipment to include but not limited to cranes, pile drivers, etc.) when hazard is within AASHTO clear zone requirements for approach traffic.
- I. Use the following format and provide the following documentation:
1. Section I: Description of each phase

- a. List phases, and corresponding bid items and elements of work to be accomplished in each phase.
  - b. Accounting for each contract bid item and element of work, reference the traffic control detail designed to provide for the safe and efficient movement of traffic and safety of workers.
  - c. All contract bid items and elements of work must be identified and included in the phasing.
2. Section II: CAD generated drawings showing detailed Traffic Control Plan for each phase:
- a. Adapt Standard Drawings and work zone traffic control examples contained in the MUTCD to reflect actual project conditions such as curves, grades, presence of ramps, intersections and accesses.
  - b. Use basemap CAD files when supplied by the City as a basis for the Traffic Control Plan drawings.
  - c. Use the same level of detail as in the MUTCD and UDOT Standard Traffic Control Drawings.
  - d. Include the anticipated duration of the traffic control setup used in each phase.
  - e. Provide for the safe passage of pedestrians and bicyclists through the work zone in accordance with the Americans with Disabilities Act and the MUTCD.
  - f. Indicate clearly, the following:
    - i. Proposed regulatory speed reductions in accordance with this Section, paragraph 3.6.
    - ii. For all tapers; length of taper, device spacing, land or shoulder closures, amount of land shift in accordance with this Section, paragraph 3.3.A.
    - iii. Length of buffer zone, in accordance with this Section, paragraph 3.3.A.
    - iv. Device spacing used in tangents in accordance with this Section, paragraph 3.3.B.
    - v. Lengths of work zones, land and shoulder widths and area available for vehicle recovery.
    - vi. Proposed changes to be made to existing traffic signals including: timing changes, phase changes, etc.
    - vii. Sign locations for required and existing signs.
    - viii. Existing signs that are to be removed, covered, relocated or otherwise changed from the original configuration.
    - ix. Worker parking, work vehicle and equipment access to and from work area, staging and material sites.
3. Section III: Emergency and Special Situations
- a. Identify procedures for dealing with emergencies and special situations.
- J. Provide temporary pavement markings on newly constructed asphalt pavement and refresh as needed until the final surfacing is placed in accordance with Section 01558: Temporary Pavement Markings, as directed by the City Engineer.
- K. Completely remove all existing traffic marking that conflict with the Traffic Control Plan, in accordance with Section 02765. Do not use paint or other material to cover markings.

## **1.12 TRAFFIC CONTROL MAINTAINER**

- A. Certified by the City or by the American Traffic Safety Services Association (ATSSA) as a Traffic Control Technician. Certifications are available through:
  - 1. Associated General Developer/Contractors  
1135 South West Temple  
Salt Lake City, Utah

Telephone: (801) 363-2753

2. American Traffic Safety Services Association (ATSSA)  
15 Riverside Parkway, Suite 100  
Fredericksburg, Virginia 22406-1022  
Telephone: (800) 272-8772  
Internet: www.atssa.com

**B. Authority:**

1. Obtains and uses all labor, equipment, and materials necessary to maintain traffic control.
2. Changes traffic control operations per the traffic control plan.

**C. Responsibility and Duties:**

1. Oversees all traffic control operations.
2. Implement the Traffic Control Plan.
3. Remains available 24-hours a day, 7-days a week and can be on-site within 30-minutes of notification.
4. Corrects deficiencies immediately upon verbal or written notification from the City Engineer or representative.
5. Inspect and document inspections of traffic control on a from acceptable to the City Engineer at least four times each day as follows:
  - a. Before beginning of shift.
  - b. At mid-shift.
  - c. Half-hour after evening shift ends.
  - d. At the midpoint of the off-shift period.
6. Coordinates project traffic control with emergency services and local law enforcement agencies.
7. Inspect and document inspections of traffic control twice each day when no construction work is being done.
  - a. One during light hours and one during nighttime hours.
  - b. Conduct inspections a minimum of 8-hours apart.
8. Completes a daily record of traffic control activities using a form acceptable to the City Engineer.
9. Submit to the City Engineer, inspection and activities forms each week on a day and time acceptable to the City Engineer.
10. Provide a daily report of all planned traffic control activities to the City Engineer by 7:00 AM each day. Provide the report each day during the contract.

**1.13 TRAFFIC AND ACCESS**

- A. The Developer/Contractor's operations shall not cause unnecessary inconvenience to the public. The public right-of-way shall be maintained at all times unless the City authorizes interruption. The Developer/Contractor's desire to close and/or detour traffic is to be authorized through the preparation of the required plans, which will then be approved by the City's Engineer or authorized representative.
- B. Safe and adequate access shall be provided and maintained to all public protection devices and to all critical utility locations. Facility access shall be continuous and unobstructed unless other approved by the City's Engineer.

#### **1.14 STORAGE OF EQUIPMENT AND MATERIALS IN PUBLIC STREETS AND RIGHTS-OF-WAY**

- A. Construction materials and equipment shall not be stored or parked on public streets, roads, or highways. During any material or equipment loading and/or unloading activities that may temporarily interfere with traffic, acceptable detour(s) will be provided for the duration of the activity. Any associated expense for this activity will be the responsibility of the Developer/Contractor.
- B. Excavated material, including suitable material that is intended for adjacent trench backfills or other earth backfill as specified in Section 5 of this specification, shall not be stored in the public streets, roads, or highways that remain in service for the public. Any waiver of this requirement must be obtained from the proper local authority and approved by the City Engineer. All excess and unsuitable material shall be removed from the site as soon as possible. Any spillage shall be removed from roadways prior to use by the public.

#### **1.15 STREET CLOSURES, DETOURS, AND BARRICADES**

- A. The Developer/Contractor shall comply with the requirements of all applicable responsible units of government for closure of any street, road, or highway. The Developer/Contractor shall provide the required barriers, guards, lights, signs, temporary bridges, and flaggers together with informing the public of any detours and construction hazards by the most suitable means available such as local newspapers, local radio stations, etc. The Developer/Contractor shall also be responsible for compliance with additional public safety requirements that may arise during construction. The Developer/Contractor shall furnish and install, and upon completion of the work, promptly remove all signs, warning devices, and other materials used in the performance of this work.
- B. Unless otherwise specified, not less than seven (7) days prior to closing, or partially closing, or reopening any street, road, or highway, the Developer/Contractor shall notify in writing, the Fire Chief, Police Chief, County Sheriff, State Highway Patrol, schools that operated school buses, or any other government official as may be appropriate.
- C. Unless otherwise specified, the Developer/Contractor shall furnish to the City Engineer a written plan showing the proposed method of signing, barricading for traffic control, and safety for the street detours and closures.
- D. All temporary detours will be maintained to ensure use of public rights-of-way is provided in a safe manner. This may include dust control, grading, graveling, etc., as required by the City's project manager and this specification.

#### **1.16 MAINTENANCE OF WORK ZONE TRAFFIC CONTROL**

- A. Implement and maintain traffic control per the Traffic Control Plan. Implement changes to traffic control required in order to meet UDOT Standard Specifications. Drawings and MUTCD at no additional cost to the City. Coordinate changes to traffic control and the Traffic Control Plan with the City Engineer prior to implementation.
- B. Meet all requirements of this Section, paragraph 1.7 when traffic control devices are required to be in place overnight or on weekends.

- C. Meet the acceptable classification as identified by *Quality Standards for Work Zone Traffic Control Devices* published by American Traffic Safety Services Association (ATSSA) for traffic control devices.
  - 1. Wash devices weekly unless conditions warrant more frequent cleaning.
- D. Maintain traffic control devices during and after all snow plowing operations at no additional cost to the City. Clear snow away from all traffic control devices so that the devices function as intended.

## **PART 2 -- PRODUCTS**

### **2.01 PILOT CAR**

- A. Equip with a reflectorized sign:
  - 1. Comply with Section 02891: Traffic Signs.
  - 2. MUTCD sign G20-4
- B. Equip with a minimum two rotating lights or strobe lights.
  - 1. Minimum 100-mm diameter and minimum 1830 mm mounting height
  - 2. Yellow color

### **2.02 FLAGGER EQUIPMENT AND CLOTHING**

- A. Comply with UDOT's "Flagger Training Handbook".
- B. Comply with Standard Drawings 745-1.
- C. Clothing:
  - 1. Flagger vest and hard hat: Orange, red-orange, or fluorescent version of these colors with:
    - a. Minimum 83870 mm<sup>2</sup> each on the front and back of strong yellow-green reflective tape, or
    - b. Minimum of 41935 mm<sup>2</sup> each on the front and back of strong yellow-green non-reflective tape, with 41935 mm<sup>2</sup> white reflective tape placed on both sides of the non-reflective tape on the front and back.
    - c. Orange or fluorescent orange hardhat with 6450 mm<sup>2</sup> of white or strong yellow-green reflective tape placed around the base of the hard had and visible to traffic.

### **2.03 TRAFFIC CONTROL SIGNING AND DEVICES**

- A. Signs:
  - 1. Comply with paragraph 1.5.
  - 2. Comply with Section 02891 – Traffic Signs.
  - 3. Comply with Standard Drawing 745-1.
  - 4. Comply with Standard Drawings 745-60, 745-60A, 745-60B, and 745-60D when using post mounted signs.
- B. Channelizing Devices:
  - 1. Comply with paragraph 1.5.
  - 2. Comply with Standard Drawing 745-1.
    - a. Comply with Section 02891, paragraph 2.1.E. – Reflective Sheeting.

- b. Use construction orange tubular markers and cone during daylight hours only.
- C. Precast Concrete Barrier:
- 1. Comply with paragraph 1.5.
  - 2. Comply with UDOT Standard Drawings 745-2, Detail AA, and 745-2E, Detail E-1.
  - 3. Use an approved construction zone attenuator or permanent style end sections, as listed in UDOT Guidelines for Attenuators and End Section.
    - a. Use a construction zone attenuator when approach ends of temporary precast barrier are within AASHTO clear zone.
      - i. Use AASHTO Roadside Design Guide to determine proper clear zone distance requirements.
      - ii. Install attenuators or end sections as per UDOT Standard Drawings 735-1 series and manufacturer's recommendations.
  - 4. Do not use a truck-mounted attenuator (TMA) to protect temporary precast barrier end for more than 24-hours. Use properly rated TMA as directed in this Section, paragraph 2.3.D.
- D. Use properly rated truck-mounted attenuator for the posted speed limit prior to construction.
- 1. NCHRP-350 Test Level 2 for speeds 45 mph or less.
  - 2. NCHRP-350 Test Level 3 for speeds greater than 45 mph.

#### **2.04 ADVANCE WARNING ARROW PANEL**

- A. Advance Warning Device:
- 1. Meet all standards as specified in the MUTCD, Section 6F.53 – Arrow Panels.
  - 2. Perform all functions as specified in UDOT Standard Drawing 745-1 and the MUTCD.

### **PART 3 -- EXECUTION**

#### **3.01 MODIFICATION OF TRAFFIC CONTROL PLANS**

- A. Each phase of construction must use an authorized Traffic Control Plan. If a construction phase is proposed that is not covered by the Traffic Control Plan, submit a proposed plan to the City Engineer for review.
- 1. Submit proposed plans to the City Engineer 10 working days before the Traffic Control Plan is to be implemented.
  - 2. Do not begin work until the new Traffic Control Plan is authorized for use and has been fully implemented.
  - 3. Implement changes required to meet UDOT Standard Specifications, Standard Drawings and MUTCD at no additional cost to the City.
    - a. Comply with this Section, paragraph 1.4.A.1.

#### **3.02 FLAGGING**

- A. Flaggers must have a current flagging certificate and must present proof of certification upon request by the City.
- 1. Acceptable certifications
    - a. UDOT Developer/Contractor Certification (Utah Valley State College).
    - b. American Traffic Safety Service Association (ATSSA).

### **3.03 TRAFFIC CONTROL SIGNING AND DEVICES**

- A. Use posted speed limit prior to construction to compute sign spacing, taper lengths, buffer zones and construction clear zone.
  - 1. Use plastic drums for land closure taper devices for speeds 50 mph and greater.
  - 2. Do not use cone or tubular markers at night.
- B. Use posted speed during construction to compute the tangent spacing for channelizing devices.
- C. Remove all traffic control from site of work when not required within 24-hours.
  - 1. Remove traffic control devices from the roadway a distance twice that of the Construction Clear Zone (Table 1 – Standard Drawing TC 2A) if they will be used within 24-hours of the daily work stoppage and are not required for immediate traffic control.
    - a. Obtain written permission from property owner prior to storing traffic control devices on private property.
  - 2. Cover post mounted signs when directed by City Engineer.
    - a. Cover signs completely with an opaque and durable covering.

### **3.04 ADVANCE WARNING ARROW PANEL**

- A. May substitute Type C units for Type B units.
  - 1. Comply with UDOT Standard Drawing 745-1.
- B. Do not substitute Type B units for Type C units.
- C. Remove Advance Warning Arrow Panel from the site of work when not needed for the control of traffic within a 4-hour period.

### **3.05 TRAFFIC SIGNALS**

- A. Use uniformed police officers when construction activities are impacting an operating signalized intersection.
- B. Use of flaggers at traffic signals is permitted when the signals have been turned to red flash mode.
  - 1. Each approach is to be controlled by a separate flagger(s).
    - a. Flaggers can control only two lanes of approach traffic.
      - i. Third land control permitted when left or right turn bays are present.
- C. Changes to traffic signal operations will be done by the City.

### **3.06 CONSTRUCTION ZONE SPEED LIMIT REQUIREMENTS**

- A. Obtain approval from the City Engineer for regulatory speed reductions.
  - 1. See Standard Drawing 745-2, General Note 9.
  - 2. Use speed reduction only when construction activities impact traffic.

3. Restore regulatory speed limit at locations where construction activities are not impacting traffic.
4. See Standard Drawing 745-60, 745-60A, 745-60B, 745-60D for post-mounted sign requirements.

\*\*\* END OF SECTION \*\*\*

## **SECTION 02005**

### **DIVERSION AND CARE OF STREAM DURING CONSTRUCTION**

#### **1.00 DESCRIPTION**

- A. This section describes materials for, and construction and maintenance of temporary diversion and protective works necessary for diversion and care of the stream during construction, including, but not limited to cofferdams, drains, diversion pipe, and sumps.

#### **1.01 RELATED WORK SPECIFIED ELSEWHERE**

- A. Clearing, grubbing, and stripping: 02110.
- B. Earthwork: 02200.
- C. Trenching, backfilling and compacting: 02224.
- D. Riprap: 02271.
- E. Installation of cement - coated pipe: 15051.

#### **1.02 SUBMITTALS**

- A. At least 40-days prior to beginning any work on the diversion and care of the stream, submit, for approval by the City Resident Project Representative, a water control plan showing the diversion features and plans for caring for the stream and its tributaries during construction, as well as describing the measures to be taken to meet the Clean Water Act permit requirements and water quality standards required in the general conditions. The water control plan shall show scour protection, and requirements for handling side drainages.
- B. The water control plan may be placed in operation upon approval, but nothing in this paragraph shall relieve the Contractor from full responsibility for the adequacy of the diversion and protective works.
- C. Water control plan shall include the following information at a minimum:
  - 1. Proposed diversion method (a general statement) to include the location of diversion dams, type and location of water conveyance facilities and outlet work.
  - 2. Explicit written explanation of sequence of operations.
  - 3. Complete equipment/materials list.
  - 4. Explicit written explanation and drawings showing types of installations (i.e., culverts, trenches), installation procedures, spacing, depths, capacities, etc., to be used for each component of the system.

#### **1.03 GENERAL**

- A. Furnish all materials for and construct and maintain all cofferdams, channels, flumes, pipes, drains, sumps, and/or other temporary diversion and protective work; furnish all materials required therefor; furnish, install, maintain, and operate all necessary pumping and other equipment for removal of

water from the various parts of work; and be responsible for maintaining the foundations and other parts of work free from water as required for constructing each part of the work.

- B. Except as otherwise provided below, do not interrupt and do not interfere with the natural flow of the creek through the worksite for any purpose without the prior written approval of the City Resident Project Representative.
- C. The temporary diversion shall at all times pass the full flow of the stream through the stream inlet site, except that the Contractor will be permitted to reduce such flow by the amount of water used for construction purposes.

## **PART 2 -- MATERIALS**

### **2.01 DIVERSION PIPE**

- A. Pipe for the diversion of the creek shall be submitted for approval by the City Resident Project Representative.

### **2.02 RIPRAP**

- A. Riprap shall be placed for erosion protection at the inlet and outlet of the diversion pipe(s). Riprap requirements shall be in accordance with Section 02271 except that bedding will not be required.

## **PART 3 -- EXECUTION**

### **3.01 UPSTREAM CUTOFF**

- A. An upstream cutoff or diversion shall be provided for each structure to be constructed which crosses or encroaches on the creek in accordance with the requirements of the general conditions.

### **3.02 DIVERSION PIPE COFFERDAMS**

- A. Construct embankment cofferdams at the upstream and downstream ends of the diversion pipe(s) flume(s), channels, etc. Materials shall be selected from required excavation for the pipeline such that the material contains from 15 to 30 percent of material passing the No. 200 sieve. The embankments shall be compacted to maintain the diversion throughout the diversion period. Material placed around the diversion pipe shall be placed in accordance with the requirements of Section 02200 – Earthwork.

### **3.03 CLEANUP**

- A. Any damage to the foundations, structures, or any other part of the work caused by floods, water or failure of any part of the diversion or protective works shall be repaired by, and at the expense of the Contractor.

### **3.04 EXCAVATION FOR DIVERSION PIPING/WEIRS**

- A. Excavation for the diversion pipe(s), weir(s), or channel(s), handling of the diversion pipe (etc.), and backfilling shall be in accordance with the requirements of Section 02200 - Earthwork.

\*\*\* END OF SECTION \*\*\*

## **SECTION 02105**

### **DUST CONTROL**

#### **PART 1 -- GENERAL**

##### **1.01 SCOPE OF WORK**

- A. Furnish all labor, materials and equipment as required to provide dust control for the project.
- B. All materials and services shall comply with the requirements of the State of Utah, Department of Environmental Quality, Division of Air Quality and the City's Municipal Code.

##### **1.02 REFERENCE DOCUMENTS**

- A. Commercial Specifications.

#### **PART 2 -- PRODUCTS**

##### **2.01 MATERIALS**

- A. Water: Water shall be applied as required to meet UDEQ requirements.
- B. Calcium chloride shall be added to the water used to provide dust control if required by the City.

#### **PART 3 -- EXECUTION**

##### **3.01 WATER PLACEMENT FOR DUST CONTROL**

- A. The Contractor is responsible for placement of sufficient water to control dust on the project. Dust control is defined by the permit requirements of the State of Utah, Division of Environmental Quality, Division of Air Quality permit obtained by the Developer of the project. The Contractor is also responsible for meeting the dust control requirements of the City's Municipal Code. As a guide, the Contractor shall have one, 10,000-gallon water truck available for 3-acres of land disturbed.

##### **3.02 WATER AND CALCIUM CHLORIDE MIXTURE FOR DUST CONTROL**

- A. In lieu of providing one, 10,000-gallon water truck available for every 3 acres of land disturbed, the Contractor may also use a water and calcium chloride solution to abate the dust for the project. The mixture of calcium chloride per 10,000-gallon truck shall be 10-pounds. The calcium chloride shall be added to the water truck container as the water is being put into the water truck in order to provide sufficient mixing.
- B. In the absence of providing the water and calcium chloride mixture, the Contractor shall meet the

requirements of Subsection 3.01 of this document.

\*\*\* END OF SECTION \*\*\*

## SECTION 02112

### CLEARING, GRUBBING, AND STRIPPING

#### PART 1 -- GENERAL

##### 1.01 SCOPE OF WORK

- A. This section describes the work included in clearing, grubbing, stripping and preparing the project site for construction operations.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02200 - Earthwork
- B. Section 02222 - Protecting Existing Underground Utilities
- C. Section 02224 - Trenching, Backfilling and Compacting
- D. Section 02900 - Revegetation Plan
- E. State of Utah, Department of Environmental Quality, Division of Solid and Hazardous Waste, Solid Waste Permitting and Management Rules, R315-301 Through 320

##### 1.03 CLEARING

- A. Remove and dispose of only those trees, snags, stumps, shrubs, brush, limbs, and other vegetative growth not shown to be protected which are necessary for construction of the project. Remove all evidence of their presence from the surface including sticks and branches greater than 1-inch in diameter or thickness. Remove and dispose of trash piles, and rubbish, and fencing. Protect structures and piping above and belowground, trees, shrubs, and vegetative growth and fencing which are not designated for removal.
- B. Preserve and protect the existing vegetation not required, or otherwise authorized, to be removed. Vegetation specifically shown on the drawings to be protected shall be protected from damage or injury caused by Contractor's construction operations, personnel, or equipment by the use of protective barriers or other methods approved by the City Resident Project Representative. Removal of existing vegetation within the designated R/W not specially required to be removed will require approval of the City Resident Project Representative.
- C. Trees shall not be used for anchorages. If tree climbing is necessary, safety ropes shall be used, and the use of climbing spurs will not be permitted.
- D. The Contractor shall be responsible for injuries to vegetation caused by Contractor's operations, personnel, or equipment. The term "injury" shall include, without exceptions, bruising, scarring, treating, and breaking of roots, trunks, or branches. Injured vegetation shall be repaired or treated without delay. Repairs or treatment shall be as recommended by and under the direction of, an experienced horticulturist or licensed tree surgeon provided by the Contractor and approved by the City Resident Project Representative. If vegetation cannot be treated or repaired, the Contractor will be responsible for replacing the damaged vegetation. The City Resident Project Representative must approve replacement vegetation. No noxious or non-native vegetation shall be planted or introduced

into the construction areas.

#### **1.04 GRUBBING**

- A. After clearing, remove and dispose of wood or root matter, including stumps, trunks, roots, or root systems greater than 1-inch in diameter or thickness to a depth of 12-inches below the ground surface. Options available for disposal include burning (with appropriate permits and approvals), gathering and hauling material to an approved disposal site, or chipping and shredding the material according to City standards and mixing it with the topsoil. Further discussions of this item are included in the Land Disturbance Design and Construction Standards, Section 2.2.

#### **1.05 TOPSOIL**

- A. Existing soil material containing sod, grass, or other vegetation and topsoil shall be removed to the existing topsoil depth or 12-inches, whichever is less, from all construction areas except existing pavement and slopes steeper than 1:1.
1. Strip, segregate, and stockpile existing topsoil from the following areas:
    - a. Wetland areas
    - b. Pipeline excavations and stockpile areas
    - c. Road excavations
    - d. All staging, service, and storage areas
  2. Stripping shall be to the existing topsoil depth or 12-inches, whichever is less. All suitable topsoil materials, which are stripped, shall be used in accordance with the 'Released for Construction Drawings' and may be placed directly or else shall be stockpiled in areas designated by the City Resident Project Representative. Topsoil stripped from wetland areas and areas known to be occupied by endangered plant species will be stockpiled in separate areas designated by the City City Resident Project Representative and will be respread in the wetland and habitat areas from which they were removed to the depth of 12-inches.
  3. Topsoil that has been stripped shall be placed at an approximate thickness of 6-inches or as directed by the City City Resident Project Representative, on all other areas which have been excavated or otherwise disturbed by construction activities except slopes greater than 1:1 unless otherwise instructed by the City Resident Project Representative. Areas to receive topsoil are as follows:
    - a. Roadway excavation and embankment slopes
    - b. Pipeline alignment
    - c. Disturbed areas within staging, service and storage areas
    - d. Other areas as directed by the City Resident Project Representative
    - e. Disturbed Ute ladies-tresses habitat and wetlands areas shall receive topsoil removed from the original habitat, as described in 1.05.B.2 above.
  4. Topsoil, which cannot be placed directly in the final location, shall be stockpiled temporarily in designated areas and later placed in the final location as directed by the City Resident Project Representative. The area over which topsoil is to be placed shall be clean of debris. The surface shall generally conform to smooth lines, slopes, and grades so that adequate control of thickness of topsoil placed can be maintained.

## **PART 2 -- PRODUCTS**

### **2.01 TREES AND SHRUBBERY**

- A. Existing trees, shrubbery, and other vegetative material may not be shown in the 'Released for Construction Drawings'. Inspect the site as to the nature, location, size, and extent of vegetative material to be removed or preserved, as specified herein. Preserve in place, trees that are specifically shown in the drawings and designated to be preserved.

### **2.02 PRESERVATION OF TREES, SHRUBS, AND OTHER PLANT MATERIAL**

- A. Save and protect plant materials (trees, shrubbery, and plants) beyond the limits of clearing and grubbing from damage resulting from the work. No filling, excavating, trenching, or stockpiling of materials will be permitted within the drip line is defined as a circle drawn by extending a line vertically to the ground from the outermost branches of a plant or group of plants. To prevent soil compaction within the drip line area, no equipment will be permitted within this area.
- B. When trees are close together, restrict entry to area within drip line by fencing. In areas where no fence is erected, protect the trunks of trees 2 inches or greater in diameter by encircling the trunk entirely with boards held securely by 12-gage wire and staples. This protection shall extend from ground level to a height of 6-feet. Cut and remove three branches where those required to affect the work to provide balanced appearances of any tree. Treat cuts with a tree sealant.

## **PART 3 -- EXECUTION**

### **3.01 CLEARING AND GRUBBING LIMITS**

- A. Prior to actual, in-the-field clearing and grubbing efforts, the Contractor shall have a licensed land surveyor survey the clearing and grubbing limits for the project and mark the limits clearly. Once the surveying has been completed, the Contractor shall then install the silt fence prior to the main effort of clearing and grubbing the project. Clear and grub excavation and embankment areas associated with new structures, slabs, and roadways. Do not intrude into those areas designated as habitat for endangered plant species.

### **3.02 DISPOSAL OF CLEARING AND GRUBBING DEBRIS**

- A. Remove cleared and grubbed material from the worksite and dispose of in accordance with these design and construction standards, local laws, codes, and ordinances.

### **3.03 AREAS TO BE STRIPPED**

- A. Strip excavation and embankment areas associated with the project, new structures, slabs, walks, and roadways. Strip stockpile areas.

\*\*\* END OF SECTION \*\*\*

## **SECTION 02140**

### **DEWATERING**

#### **PART 1 -- GENERAL**

##### **1.01 THE REQUIREMENT**

- A. The Contractor shall at all times during construction provide and maintain proper equipment and facilities to remove all water entering excavations, and shall keep such excavation dry so as to obtain a satisfactory undisturbed subgrade foundation condition until the fills, structures or pipes to be built thereon have been complete to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural levels.

##### **1.02 CONTRACTOR SUBMITTALS**

- A. Prior to commencement of excavation, the Contractor shall submit a detailed plan and operation schedule for dewatering of excavations. The Contractor may be required to demonstrate the system proposed and to verify that adequate equipment, personnel and materials are provide to dewater the excavations at all the headings planned. The Contractor's dewatering plan is subject to the acceptance of the Engineer.

#### **PART 2 -- PRODUCTS (Not Used)**

#### **PART 3 -- EXECUTION**

- A. At all times, site grading shall promote drainage. After a storm all depressions shall be pumped out immediately and filled.
- B. Surface runoff shall be diverted from excavations.
- C. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.
- D. The Contractor shall maintain the water level below the bottom of excavation is all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance.
- E. Excavation subgrade shall be shaped and sealed to promote drainage to points where water can be pumped out.
- F. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.

\*\*\* END OF SECTION \*\*\*

## **SECTION 02160**

### **EXCAVATION SUPPORT SYSTEMS**

#### **PART 1 -- GENERAL**

##### **1.01 SCOPE OF WORK**

- A. The Contractor shall supply, place, and remove all sheeting, shoring and bracing necessary to safely support all excavations. All materials and methods shall conform with applicable rules, regulations and laws of the State of Utah.
- B. The Contractor's attention is directed to the provisions of Subpart P, Section 1926.652 of the OSHA Safety and Health Standards for Construction which require that all banks and trenches over 5 feet high shall be shored or sloped to the angle of repose.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 02140 - Dewatering
- B. Section 02200 - Earthwork

##### **1.03 CONTRACTOR SUBMITTALS**

- A. The Contractor, prior to beginning any trench or structure excavation 5 feet deep or over, shall submit to the Owner and shall be in receipt of the Owner's written acceptance of the Contractor's detailed plan showing design of all shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation of such trenches or structure excavation. Such plan shall conform to the shoring system standards established by the State of Utah and shall be prepared by a civil or structural engineer licensed in the State of Utah.

#### **PART 2 -- PRODUCTS (Not Used)**

#### **PART 3 -- EXECUTION (Not Used)**

\*\*\* END OF SECTION \*\*\*

**SECTION 02161**  
**CARE OF WATER**

**PART 1 -- GENERAL**

**1.01 SCOPE**

- A. The work of this Section includes the furnishing, use, and care of water and all appurtenant work, during construction, all in accordance with the requirements of the 'Released for Construction Drawings'.

**1.02 GENERAL**

- A. The Contractor shall construct and maintain in a satisfactory condition any dikes, channels, drains, sump, and/or other temporary protective works necessary and required to divert and handle water during the performance of the work under the Contract. Before final acceptance of the work, the Contractor, at its expense, shall remove all dikes and other temporary facilities as necessary and required so as to present a neat and orderly appearance.

**1.03 CARE OF WATER**

- A. Runoff: All local runoff from adjoining areas shall be interrupted and disposed of to prevent interference with construction, or damage to partially completed excavations and structures.
- B. Seepage: All seepage encountered in the foundation and other excavated areas, shall be dewatered to the extent necessary for placement of embankment materials and concrete in the dry.

**PART 2 -- PRODUCTS (Not Used)**

**PART 3 -- EXECUTION (Not Used)**

\*\*\* END OF SECTION \*\*\*

## SECTION 02200

### EARTHWORK

#### PART 1 -- GENERAL

##### 1.01 SCOPE OF WORK

- A. The work of this Section includes all earthwork required for construction of the Work. Such earthwork shall include, but not be limited to, the loosening, removing, loading, transporting, depositing, and compacting in its final location of all materials wet and dry, as required for the purposes of completing the work specified in the Contract Documents, which shall include, but not be limited to, the furnishing, placing, and removing of sheeting and bracing necessary to safely support the sides of all excavation; all pumping, ditching, draining, and other required measures for the removal or exclusion of water from excavation; the supporting of structures above and below the ground; all backfilling around structures and all backfilling of trenches and pits; the disposal of excess excavated materials; borrow of materials to make up deficiencies for fills; and all other incidental earthwork, all in accordance with the requirements of the Contract Documents.

##### 1.02 CONTRACTOR SUBMITTALS

- A. The Contractor's attention is directed to the provisions for "Shoring and Bracing Contract Documents" in Section 6705 of the Utah Labor Code. The Contractor, prior to beginning any trench or structure excavation 5 feet deep or over shall submit to the Owner and shall be in receipt of the Owner's written acceptance of the Contractor's detailed plan showing design of all shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation of such trenches or structure excavation. If such plan varies from the shoring system standards established in the Construction Safety Orders of the State of Utah, such alternative systems plans shall be prepared by a civil or structural engineer licensed in the State of Utah.

##### 1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of other requirements of the Contract Documents, all work specified herein shall conform to or exceed the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section.

1. Commercial Standards:

ASTM D 422-63(1972)

Method for Particle-Size Analysis of Soils.

ASTM D 698-78

Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5lb (2.49kg) Rammer and 12-in (304.8 mm) Drop.

ASTM D 1140-54(1971)

Test Method for Amount of Material in Soils Finer than the No. 200 (75 mm) Sieve.

|                      |  |
|----------------------|--|
| ASTM D 1556-82       | Test Method for Density of Soil in Place by the Sand Cone Method.                                |
| ASTM D 1663-84       | Test Method for Compressive Strength of Molded Soil-Cement Cylinders.                            |
| ASTM D 2419-74(1979) | Test Method for Sand Equivalent Value of Soils and Fine Aggregate.                               |
| ASTM D 2487-83       | Classification of Soils for Engineering Purposes.  |
| ASTM D 2901-82       | Test Method of Cement Content of Freshly-mixed Soil Cement.                                      |
| ASTM D 2922-81       | Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth). |
| ASTM D 4318-84       | Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.                      |

#### **1.04 QUALITY ASSURANCE**

- A. General: All soils testing will be done by a testing laboratory of the Owner's choice at the Contractor's expense.
- B. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with ASTM D 698. Field density in-place tests will be performed in accordance with ASTM D 1556, ASTM D 2922, or by such other means acceptable to the Engineer.
- C. In case the tests of the fill or backfill show non-compliance with the required density, the Contractor shall accomplish such remedy as may be required to insure compliance. Subsequent testing to show compliance shall be by a testing laboratory selected by the Owner and shall be at the Contractor's expense.
- D. Particle size analysis of soils and aggregates will be performed using ASTM D 422.
- E. Determination of sand equivalent value will be performed using ASTM D 2419.
- F. Unified Soil Classification System: References in these specifications to soil classification types and standards set forth in ASTM D 2487 shall have to meanings and definitions indicated in the chart illustrated at the end of this Section. The chart is reproduced herein for the convenience of the Contractor only, and no limitation, amendment, or modification is intended thereby. The Contractor shall be bound by all applicable provisions of said ASTM D 2487 in the interpretation of soil classifications.

**PART 2 -- PRODUCTS**

**2.01 SUITABLE FILL AND BACKFILL MATERIAL REQUIREMENTS**

- A. General: Fill, backfill, and embankment materials shall be suitable selected or processed clean, fine earth, rock or sand, free from grass, roots, brush, or other vegetation.
- B. Fill and backfill materials to be placed within 6-inches of any structure or pipe shall be free of rocks or unbroken masses of earth materials having a maximum dimension larger than 3-inches.
- C. Suitable Materials: Soils not classified as unsuitable as defined in paragraph entitled, "Unsuitable Material" herein, are defined as suitable materials and may be used in fills, backfilling, and embankment construction subject to the specified limitations. In addition, when acceptable to the Engineer, some of the material listed as unsuitable may be used when thoroughly mixed with suitable material to form a stable composite.
- D. Suitable materials may be obtained from on-site excavations, may be processed on-site materials, or may be imported. If imported materials are required to meet the requirements of this Section or to meet the quantity requirements of the project the Contractor shall provide the imported materials at no additional expense to the Owner, unless a unit price item is included for imported materials in the bidding schedule.
- E. The following types of suitable materials are designated and defined as follows:
  - 1. Type A: Crushed rock, gravel, or sand with 100 percent passing a 1-inch sieve and a sand equivalent value not less than 50.
  - 2. Type B: Crushed rock, gravel, or sand with 100 percent passing a 1/2-inch sieve and a sand equivalent value not less than 50.
  - 3. Type C: Sand with 100 percent passing a 3/8-inch sieve, at least 90 percent passing a Number 4 sieve, and a sand equivalent value not less than 30.
  - 4. Type D: Crushed rock or gravel with 100 percent passing a 1-inch sieve and not more than 10 percent passing a Number 4 sieve.
  - 5. Type E: Crushed rock or gravel with 100 percent passing a 1/2-inch sieve and not more than 0 percent passing a Number 4 sieve.
  - 6. Type F: Crushed rock or gravel meeting the following gradation requirements:

| Sieve Size | Percentage Passing |
|------------|--------------------|
| 2-inch     | 100                |
| 1½-inch    | 94-96              |
| 1-inch     | 20-40              |
| ¾-inch     | 4-8                |

- 7. Type G: Crushed rock aggregate base material of such nature that it can be compacted readily

by watering and rolling to form a firm, stable base for pavements. At the option of the Contractor, the grading for either the 1½-inch maximum size or ¾-inch maximum size shall be used. The sand equivalent value shall be not less than 22, and the material shall meet the following gradation requirements:

| Sieve Size | Percentage  |            |
|------------|-------------|------------|
|            | 1½-inch Max | ¾-inch Max |
| 1½-inch    | 90-100      | -          |
| 1-inch     | -           | 100        |
| ¾-inch     | 50-85       | 90-100     |
| No. 4      | 25-45       | 35-55      |
| No. 30     | 10-25       | 10-30      |
| No. 200    | 2-9         | 2-9        |

8. Type H: Drainrock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The material shall be uniformly graded and shall meet the following gradation requirements:

| Sieve Size | Percentage Passing |
|------------|--------------------|
| 1-inch     | 100                |
| ¾-inch     | 90-100             |
| 3/8-inch   | 40-100             |
| No. 4      | 25-40              |
| No. 8      | 18-33              |
| No. 30     | 5-15               |
| No. 50     | 0-7                |
| No. 200    | 0-3                |

The drainrock shall have a sand equivalent value not less than 75. The surface of the drainrock immediately beneath reservoirs shall be stabilized with hot-applied asphalt after the surface of the drainrock has been finish-graded. The Contractor shall use, at its option, one of the asphalt types listed below:

|                               | <b>Type 1</b> | <b>Type 2</b> |
|-------------------------------|---------------|---------------|
| Designation                   | SC-70         | SC-250        |
| Spray Temperature (degrees F) | 135-175       | 165-200       |
| Coverage (gal/sq yd)          | 0.50          | 0.50          |

If the surface remains tacky, sufficient sand shall be applied to absorb the excess asphalt.

9. Type I: Any other suitable material as defined in Paragraph 2.01, herein.
10. Type J: Material which consists of Type H material, or any mixture of Types B, C, G, and H materials which has been cement-treated so that the cement content of the material is not less than 5 percent by weight when tested in accordance with ASTM D 2901. The ultimate compressive strength at 28 days shall be not less than 400 psi when tested in accordance with ASTM D 1633.
11. Type K: Stockpiled topsoil material which has been obtained at the site by removing soil to a depth not exceeding 2 feet. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris as specified.

## **2.02 UNSUITABLE MATERIAL**

- A. Unsuitable soils for fill material shall include soils which, when classified under the standard method for "classification of Soils, for Engineering Purposes," ASTM D 2487, fall in the classification of Pt, OH, CH, MH, or OL.
- B. In addition, any soil containing organic matter, having a plastic limit of less than 8-percent when tested in accordance with the requirements of ASTM D 4318 and containing more than 25 percent of material, by weight, passing the Number 200 sieve when analyzed according to the requirements of ANSI/ASTM D 1140; or any soil which cannot be compacted sufficiently to achieve the percentage of maximum density specified for the intended use, shall be classed as unsuitable material.

## **2.03 USE OF FILL, BACKFILL, AND EMBANKMENT MATERIAL TYPES**

- A. The Contractor shall use the types of materials as designated herein for all required fill, backfill, and embankment construction hereunder.
- B. Where these Specifications conflict with the requirements of any local agency having jurisdiction, or with the requirements of a material manufacturer, the Engineer shall be immediately notified. In case of conflict therewith, the Contractor shall use the most stringent requirement, as determined by the Engineer.
- C. Fill and backfill types shall be used in accordance with the following provisions:
  1. Embankment fills shall be constructed of Type I material, as defined in Paragraph 2.01E, herein, or any mixture of Type I and Type A through Type H materials.
  2. Pipe zone backfill, as defined under "Pipe and Utility Trench Backfill" herein, shall consist of the following materials for each pipe material listed below.

- a. Mortar coated pipe, concrete pipe, and asbestos-cement pipe shall be provided Type A, B, C, D, or E pipe zone backfill material.
  - b. Coal tar enamel coated pipe, polyethylene encased pipe, tape wrapped pipe, and other coated pipe shall be backfilled with Type C pipe zone backfill material.
  - c. Plastic pipe and vitrified clay pipe shall be backfilled with Types B, C, or E pipe zone backfill material.
3. Trench zone backfill for pipelines as defined under "Pipe and Utility Trench Backfill" shall be Type I backfill material or any of Types A through H backfill materials or any mixture thereof.
  4. Final backfill material for pipelines under paved areas, as defined under "Pipe and Utility Trench Backfill" shall be Type G backfill material. Final backfill under areas not paved shall be the same material as that used for trench backfill, except that Type K material shall be used for final backfill in agricultural areas unless otherwise noted on the Contract Documents.
  5. Trench backfill and final backfill for pipelines under structures shall be the same material as used in the pipe zone, except where concrete encasement is required by the Contract Documents.
  6. Aggregate base materials under pavements shall be Type G material constructed to the thicknesses shown or specified.
  7. Backfill around structures shall be Type I material, or Types A through Type H materials, or any mixture thereof.
  8. Backfill materials beneath structures shall be as follows:
    - a. Drainrock materials under reservoirs or other structures shall be Type H material.
    - b. Under concrete reservoirs, Types G or H materials shall be used, except where concrete encasement is required by the Contract Documents.
    - c. Under structures where groundwater must be removed to allow placement of concrete, Type F material shall be used.
    - d. Under structures other than concrete reservoirs, Type D, E, G, or H material shall be used, except where concrete encasement is required by the Contract Documents.
  9. Backfill used to replace pipeline trench over-excavation shall be Type F material for wet trench conditions or the same material as used for the pipe zone backfill if the trench conditions are not wet.
  10. The top 6-inches of fill on reservoir roofs, embankment fills around reservoirs, and all other embankment fills shall consist of Type K material, topsoil.
  11. Where required by the Contract Documents, pea gravel shall be Type E material.

### **PART 3 -- EXECUTION**

#### **3.01 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION**

- A. General: Except when specifically provided to the contrary, excavation shall include the removal of all materials of whatever nature encountered, including all obstructions of any nature that would interfere with the proper execution and completion of the work. The removal of said materials shall conform to the lines and grades shown or ordered. Unless otherwise provided, the entire construction site shall be stripped of all vegetation and debris, and such material shall be removed from the site prior to performing any excavation or shall be removed from the site prior to performing any excavation or placing any fill. The Contractor shall furnish, place, and maintain all supports and shoring that may be required for the sides of the excavations, and all pumping, ditching, or other approved measures for the removal or exclusion of water, including taking care of storm water, groundwater, and wastewater reaching the site of the work from any source so as to prevent damage

to the work or adjoining property. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable State safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).

- B. Excavation Beneath Structures and Embankments: Except where otherwise specified for a particular structure or ordered by the Engineer, excavation shall be carried to the grade of the bottom of the footing or slab. Where shown or ordered, areas beneath structures or fills shall be over-excavated. The subgrade areas beneath embankments shall be excavated to remove not less than the top 6-inches of native material and where such subgrade is sloped, the native material shall be benched at no additional cost to the Owner. When such over-excavation is shown on the Contract Documents, both over-excavation and subsequent backfill to the required grade shall be performed by the Contractor at its own expense. When such over-excavation is not shown but is ordered by the Engineer, such over-excavation and any resulting backfill will be paid for under a separate unit price bid item if such bid item has been established; otherwise payment will be made in accordance with a negotiated price. After the required excavation or over-excavation has been completed, the exposed surface shall be scarified to a depth of 6- inches, brought to optimum moisture content, and rolled with heavy compaction equipment to 95-percent of maximum density.
- C. Excavation Beneath Concrete Reservoir: Excavation under the reservoir shall extend to the bottom of the drainrock layer. After such excavation has been completed, the exposed surface shall be rolled with heavy compaction equipment to 95-percent of maximum density and then graded to provide a reasonably smooth surface for placement of the drainrock. Areas under the reservoir upon which fill is to be placed shall be scarified to a depth of 6-inches, brought to optimum moisture content, and compacted to 95-percent of maximum density.
- D. Excavation Beneath Paved Areas: Excavation under areas to be paved shall extend to the bottom of the aggregate base, if such base is called for; otherwise it shall extend to the paving thickness. After the required excavation has been completed, the exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to 95-percent of maximum density.
- E. Notification of Engineer: The Contractor shall notify the Engineer at least 3 days in advance of completion of any structure excavation and shall allow the Engineer a review period of at least one day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

### **3.02 PIPELINE AND UTILITY TRENCH EXCAVATION**

- A. General: Unless otherwise shown or ordered, excavation for pipelines and utilities shall be open-cut trenches. Trench widths shall be kept as narrow as is practical for the method of pipe zone densification selected by the Contractor, but shall be as shown on the typical trench detail.
- B. Trench Bottom: Except when pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe. The trench bottom shall be given a final trim, using a string line for establishing grade, such that each pipe section when first laid will be continually in contact with the ground along the extreme bottom of the pipe. Rounding out the trench to form a cradle for the pipe will not be required.

- C. Open Trench: The maximum amount of open trench permitted in any one location shall be 500- feet, or the length necessary to accommodate the amount of pipe installed in a single day, whichever is greater. Special care shall be taken in late fall, winter and early spring to ensure material put back in the trenches is not frozen. All frozen material shall be removed from the trench prior to backfilling with non-frozen, appropriate material. All trenches shall be fully backfilled at the end of each day or, in lieu thereof, shall be covered by heavy steel plates adequately braced and capable of supporting vehicular traffic in those locations where it is impractical to backfill at the end of each day. The above requirements for backfilling or use of steel plate will be waived in cases where the trench is located further than 100 feet from any travelled roadway or occupied structure. In such cases, however, barricades and warning lights meeting OSHA requirements shall be provided and maintained.
- D. Trench Over-Excavation: Where the Contract Documents indicate that trenches shall be over-excavated, they shall be excavated to the depth shown, and then backfilled to the grade of the bottom of the pipe. Work specified in this Paragraph shall be performed by the Contractor at its own expense.
- E. Over-Excavation: When ordered by the Engineer, whether indicated in the Contract Documents or not, trenches shall be over-excavated beyond the depth shown. Such over-excavation shall be to the depth ordered. The trench shall then be backfilled to the grade of the bottom of the pipe. All work specified in this Section shall be performed by the Contractor at its own expense when the over-excavation ordered by the Engineer is less than 6 inches below the limits shown. When the over-excavation ordered by the Engineer is 6-inches or greater below the limits shown, additional payment will be made to the Contractor for that portion of the work which is located below said 6-inch distance. Said additional payment will be made under separate unit price bid items for over-excavation and bedding if such bid items have been established; otherwise payment will be made in accordance with a negotiated price.
- F. Where pipelines are to be installed in embankment or structure fills, the fill shall be constructed to a level at least one foot above the top of the pipe before trench is excavated.

### **3.03 OVER-EXCAVATION NOT ORDERED, SPECIFIED, OR SHOWN**

- A. Any over-excavation carried below the grade ordered, specified, or shown, shall be backfilled to the required grade with the specified material and compaction. Such work shall be performed by the Contractor at its own expense.

### **3.04 EXCAVATION IN LAWN AREAS**

- A. Where excavation occurs in lawn areas, the sod shall be carefully removed and stockpiled to preserve it for replacement. Excavated material may be placed on the lawn; provided, that a drop cloth or other suitable method is employed to protect the lawn from damage. The lawn shall not remain covered for more than 72 hours. Immediately after completion of backfilling and testing of the pipeline, the sod shall be replaced in a manner so as to restore the lawn as near as possible to its original condition.

### **3.05 EXCAVATION IN VICINITY OF TREES**

- A. Except where trees are shown in the Contract Documents to be removed, trees shall be protected from injury during construction operations. No tree roots over 2-inches in diameter shall be cut without express permission of the Engineer. Trees shall be supported during excavation as may be directed by the Engineer.

### **3.06 ROCK EXCAVATION**

- A. Rock excavation shall include removal and disposal of the following: (1) all boulders measuring 1/3 of a cubic yard or more in volume; (2) all rock material in ledges, bedding deposits, and unstratified masses which cannot be removed without systematic drilling and blasting; (3) concrete or masonry structures which have been abandoned; and (4) conglomerate deposits which are so firmly cemented that they possess the characteristics of solid rock and which cannot be removed without systematic drilling and blasting.
- B. Said rock excavation shall be performed by the Contractor at its own expense; provided, that should the quantity of rock excavation be affected by any change in the scope of the work, an appropriate adjustment of the contract price will be made under a separate bid item if such bid item has been established; otherwise payment will be made in accordance with a negotiated price.
- C. Explosives and Blasting: Blasting will not be permitted, except by express permission of the Engineer on a case-by-case basis. The use of explosives will be subject to the approval and regulations of all agencies having jurisdiction. If blasting is utilized at the site of the Work, the Contractor shall take all precautions and provide all protective measures necessary to prevent damage to property and structures or injury to person. Prior to blasting, the Contractor shall secure all permits required by law for blasting operations and shall provide any additional hazard insurance required by the Owner. The Contractor shall have a fully qualified and experienced blasting foreman in charge of all blasting operations.
- D. The Contractor will be held responsible for all and shall make good any damage caused by blasting or resulting from its possession or use of explosives on the work.
- E. All operations involving the handling, storage, and use of explosives shall be conducted in accordance with the requirements of the OSHA Standards for Construction, and in accordance with all local laws and regulations.

### **3.07 DISPOSAL OF EXCESS EXCAVATED MATERIAL**

- A. The Contractor shall remove and dispose of all excess excavated material at its own expense.

### **3.08 BACKFILL - GENERAL**

- A. Backfill shall not be dropped directly upon any structure or pipe. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed. Backfill around water retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed.

- B. Except for drainrock materials being placed in over-excavated areas or trenches, backfill shall be placed after all water is removed from the excavation.

### **3.09 PLACING AND SPREADING OF BACKFILL MATERIALS**

- A. Backfill materials shall be placed and spread evenly in layers. When compaction is achieved using mechanical equipment, the layers shall be evenly spread so that when compacted each layer shall not exceed 6 inches in thickness. When compaction is achieved using flooding and jetting methods, each layer shall not exceed 3-feet in thickness after compaction.
- B. During spreading each layer shall be thoroughly mixed as necessary to promote uniformity of material in each layer. Pipe zone backfill materials shall be manually spread around the pipe so that when compacted the pipe zone backfill will provide uniform bearing and side support.
- C. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.
- D. Where the backfill material moisture content is too high to permit the specified degree of compaction the material shall be dried until the moisture content is satisfactory.

### **3.10 COMPACTION OF FILL, BACKFILL, AND EMBANKMENT MATERIALS**

- A. Each layer of Types A, B, C, G, H, I, and K backfill materials as defined in Paragraph 2.01E, herein, where the material is graded such that at least 10 percent passes a Number 4 sieve, shall be mechanically compacted to the specified percentage of maximum density. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content.
- B. Each layer of Type D, E, F, and J backfill materials shall be compacted by means of at least 2 passes from a flat plate vibratory compactor, except when such materials are used for pipe zone, backfill vibratory compaction shall be used at the top of the pipe zone or at vertical intervals of 24 inches, whichever is least.
- C. Fill on reservoir and structure roofs shall be deposited at least 30 days after the concrete roof slab has been placed. Equipment weighing more than 10,000 pounds when loaded shall not be used on a roof. A roller weighing not more than 8,000 pounds shall be used to compact fill on a roof.
- D. Flooding ponding, or jetting shall not be used for fill on roofs, backfill around structures, backfill around reservoir walls, for final backfill materials, or aggregate base materials.
- E. Pipe zone backfill materials that are granular, may be compacted by a combination of flooding and vibration using concrete vibrators or by jetting, when acceptable to the Engineer.
- F. Pipeline trench zone backfill materials, containing 5-percent or less of material passing a No. 200 sieve, may be compacted using flooding and jetting or vibration if the Contractor uses effective procedures that yield the specified compaction test results. Flooding and jetting shall not be done in such a manner that the pipe or nearby utilities are damaged, in areas of poorly draining or expansive soils, or where the use of the procedure is prohibited by any agency having jurisdiction over the

street or right-of-way. Approved jet pipes or immersible vibrators shall be used so that each backfill layer is saturated and consolidated to its full depth before the next layer is placed. Jet pipes shall be kept at least 6 inches away from the pipe where the backfill is being consolidated and 2-feet away from other pipes or utilities.

- G. Equipment weighing more than 10,000-pounds shall not be used closer to walls than a horizontal distance equal to the depth of the fill at that time. Hand operated power compaction equipment shall be used where use heavier equipment is impractical or restricted due to weight limitations.
- H. Compaction Requirements: The following compaction test requirements apply to Type A, B, C, G, H, I, and K materials. Type D, E, F, and J materials do not require testing. Where agency or utility company requirements govern, the highest compaction standards shall apply.

| Location or Use of Fill   | Percentage of Maximum Density |
|---|-------------------------------|
| Pipe zone backfill portion above bedding for flexible pipe                              | 90                            |
| Pipe zone backfill bedding and overexcavated zones under bedding/pipe for flexible pipe | 90                            |
| Pipe zone backfill portion above bedding for rigid pipe.                                | 90                            |
| Pipe zone backfill bedding and over-excavated zones under bedding/pipe for rigid pipe.  | 90                            |
| Final backfill, beneath paved areas or structures.                                      | 95                            |
| Final backfill, not beneath paved areas or structures.                                  | 90                            |
| Trench zone backfill.   | 90                            |
| Embankments   | 90                            |
| Embankments, beneath paved areas or structures.   | 95                            |
| Backfill beneath structures, reservoirs.  | 95                            |
| Backfill around structures, on reservoir or structure roof.                             | 95                            |
| Topsoil (Type K material)   | 90                            |
| Aggregate base (Type G material)  | 95                            |

- I. The Contractor shall maintain the indicated trench cross section up to a horizontal plane lying 6-inches above the top of the pipe.
- J. If, at any location, under said horizontal plane the Contractor slopes the trench walls or exceeds the maximum trench widths indicated in the Contract Documents, the pipe zone backfill shall be "improved" or the pipe class increased as specified herein, at no additional cost to the Owner. "Improved" backfill shall mean sand-cement backfill or other equivalent method acceptable to the Engineer.

- K. If the allowable deflection specified for the pipe is exceeded, the Contractor shall expose and reround or replace the pipe, repair all damaged lining and coating, and reinstall the pipe zone material and trench backfill as specified at no additional expense to the Owner.

### **3.11 PIPE AND UTILITY TRENCH BACKFILL**

- A. Pipe Zone Backfill: The pipe zone is defined as the trench cross-sectional area between a line 6-inches below the bottom of the pipe, i.e., the subgrade, to a level line 6 inches above the top of the pipe. The bedding for flexible pipe is defined as that portion of pipe zone backfill material between the subgrade and the bottom of the pipe zone backfill material between the subgrade and a level line which varies from the bottom of the pipe to the springline as shown on the Contract Documents.
- B. Bedding shall be provided for all sewers, drainage pipelines, and other gravity flow pipelines. For other pipelines the bedding may be omitted if all the following conditions exist:
1. The pipe bears on firm, undisturbed native soil which contains only particles that will pass a one-inch sieve.
  2. The trench excavation is not through rock or stones.
  3. The trench conditions match those specified by the pipe manufacturer for installation of pipe directly on the subgrade.
  4. The subgrade soils are classified as suitable fill and backfill materials per Paragraph 2.01.
  5. The subgrade soils have, as a maximum, a moisture content that allows compaction.
- C. Where bedding is required, after compacting the bedding the Contractor shall perform a final trim using a stringline for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe.
- D. The pipe zone shall be backfilled with the specified backfill material. The Contractor shall exercise care to prevent damage to the pipeline coating, cathodic bonds, or the pipe itself during the installation and backfill operations.
- E. Trench Zone Backfill: After the pipe zone backfill has been placed as specified above, and after all excess water has completely drained from the trench, backfilling of the trench zone may proceed. The inches above the top of the pipe to a level line 18 inches below finished surface grade, or if the trench is under pavement, 18 inches shall be filled with water to prevent flotation.
- F. Final Backfill: Final backfill is all backfill in the trench cross-sectional area within 18-inches of finished grade, or if the trench is under pavement, all backfill within 18-inches of the subgrade.

### **3.12 EMBANKMENT CONSTRUCTION**

- A. The area where an embankment is to be constructed shall be cleared of all vegetation, roots and foreign material. Following this, the surface shall be moistened, scarified to a depth of 6 inches, and rolled or otherwise mechanically compacted to 95 percent of maximum density under structures and paved areas, and 90 percent of maximum density elsewhere.
- B. Where embankment or structure fills are constructed over pipelines, the first 4-feet of fill over the pipe shall be constructed using light placement and compaction equipment that does not damage the

pipe.

\*\*\* END OF SECTION \*\*\*

## **SECTION 02222**

### **EXCAVATION AND BACKFILL FOR STRUCTURES**

#### **PART 1 -- GENERAL**

##### **1.01 SCOPE OF WORK**

- A. This section covers excavating, backfilling and compacting for inlet structures, emergency spillway retaining wall, PDPE liner and manholes. Other structures may also conform to this section as directed by the City.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 02292 – Embankment Construction
- B. Section 02712 – Storm Drainage System
- C. Section 02719 – Sanitary Sewer System
- D. Section 03300 – Cast-in-Place Concrete

##### **1.03 SUBMITTALS**

- A. If requested by the City, the Contractor shall furnish to the Soils Engineer, a certified test results from an approved laboratory showing that the free draining gravel material and structural fill material conforms to the Contract Document requirements. The test result will be paid for by the City.

#### **PART 2 -- PRODUCTS**

##### **2.01 RETAINING WALL BACKFILL**

- A. Retaining wall backfill material shall be native material or shall be embankment fill material.
- B. Wall backfill material shall be free from frozen lumps, rocks larger than 6-inches in the largest dimension, roots, trash, lumber and organic material. Suitability of material for wall backfill in accordance with these criteria will be as determined by the Soils Engineer.

#### **PART 3 -- EXECUTION**

##### **3.01 EXCAVATION**

- A. Excavation shall be performed to the lines and grades indicated in the Contract Documents. During excavation, material satisfactory for backfilling shall be stockpiled in a safe manner. Excavated material not required or not satisfactory for backfill shall be removed from the site.
- B. Excavations shall be so braced and supported as needed to prevent the ground, adjacent to the

excavation, from sliding or settling. Localized slides or settlements shall be promptly removed and corrected by the Contractor.

### **3.02 BACKFILL**

- A. Backfill material shall not be placed against concrete structure that has not been properly cured. No backfill material shall be placed until concrete has cured for a minimum of 7-days or until the compressible strength is 3,000-psi, whichever is greater.
- B. Backfill material shall be placed I no more than 6-inch loose lifts.
- C. All backfill material shall be placed and compacted to at least 95-percent of Standard Proctor Density at a moisture content within plus 2-percent to minus 2-percent of optimum as determined by ASTM D-698.
- D. Where the moisture content is not suitable and/or sufficient compaction has not been obtained, the fill shall be reconditioned to an approved moisture content and recompacted to the minimum required compaction, unless recommended otherwise by the Soils Engineer, prior to placing any additional fill material.
- E. Unless otherwise specified, the Contractor shall be responsible for arranging for the placing and compacting of approved fill material in accordance with the Contract Documents. If the Soils Engineer should determine that the Contractor is failing to meet the minimum requirements, the Contractor shall stop operations and make adjustments as necessary to produce a satisfactorily compacted fill at no additional cost to the City.
- F. Sufficient personnel, equipment, sumps or other means should be provided to maintain the site in an acceptable dry condition for the duration of construction and curing of the structure.

### **3.03 REMOVAL OF WATER**

- A. Dewatering shall be accomplished in accordance with Section 01525 and 01525A – Temporary Construction Aids and Environmental Controls. The Contractor shall provide and maintain at all times, ample means and devices with to remove promptly and to properly dispose of all water entering the excavation.
- B. Water shall be disposed of in a suitable manner without damage to adjacent property or without being a menace to public health and convenience. No water shall be drained into work built under construction without prior approval of the City.
- C. Dewatering shall be accomplished by well, points, sumping, or any other acceptable method, which will provide a dewatered excavation. Any dewatering method shall be subject to the approval of the City.

### **3.04 COMPACTION TESTS**

A. Field density tests shall be made in accordance with ASTM D 698.

B. The cost of field density tests shall be borne by the Contractor.

\*\*\* END OF SECTION \*\*\*

## SECTION 02224

### TRENCHING, BACKFILLING, AND COMPACTING

#### **PART 1 -- GENERAL**

##### **1.01 THE REQUIREMENT**

- A. This section covers all work associated with trenching for underground utilities including backfilling and compacting required for the project. Such trenching shall include, but not be limited, to the products required in trenching, materials to be used in its execution and execution of this effort for structures as shown on the drawings.
- B. Coordinate work with other trades on the site.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 02055 – Common Fill.
- B. Section 02060 – Select Fill.
- C. Section 02062 - Flowable Fill.
- D. Section 02075 – Geotextile Fabric.
- E. Section 02316 – Trench Backfill and Compaction.

##### **1.03 REFERENCES**

- A. Use the latest issue of the reference standards as of the date of the Project.
- B. American National Standards Institute (ANSI); Z535.1, Safety Color Code.
- C. American Public Works Association (APWA): Uniform Color Code for Temporary Marking of Underground Utility Locations.
- D. ASTM C33: Standard Specifications for Concrete Aggregates.
- E. ASTM C94: Specification for Ready-Mixed Concrete.
- F. ASTM C117: Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
- G. ASTM C136: Standard Test Method for Sieve Analysis of Fine and Course Aggregates; 1996a.
- H. ASTM C150: Standard Specification for Portland Cement.
- I. ASTM C 618: Standard Specifications for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.

- J. ASTM D 422: Standard Test Method for Particle-Size Analysis of Soils.
- K. ASTM D698: Test Method for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>(600 kN-m/m<sup>3</sup>)); 1991.
- L. ASTM D 1140: Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75 micrometer) Sieve.
- M. ASTM D 1556: Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 1990 (Reapproved 1996).
- N. ASTM D 1557: Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN m/m<sup>3</sup>)), 1991.
- O. ASTM D 2167: Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 1994.
- P. ASTM D 2487: Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System); 1993.
- Q. ASTM D 2922: Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 1991.
- R. ASTM D 3017: Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 1988 (Reapproved 1993).
- S. ASTM D 3776: Standard Test Method for Mass per Unit Area (Weight) of Fabric.
- T. ASTM D 4253: Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
- U. ASTM D 4264: Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
- V. ASTM D 4318: Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 1995a.
- W. ASTM D 4533: Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
- X. ASTM D 4832: Standard Test Method for Preparation and Testing of Soil-Cement Slurry Test Cylinders.
- Y. ASTM D 4991: Standard Test Method for Leakage Testing of Empty Rigid Containers by Vacuum Method.
- Z. ASTM D 5034: Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).

- AA. Specification for Excavating on State Highways, latest edition.
- BB. General Safety Orders Covering Utah Industries – Section 69, Trenches.
- CC. United States Department of Labor OSHA Publication 2085 – “Employer – Employee, Safe Practice for Excavation and Trenching Operations”.
- DD. Utah Occupational Safety and Health Rules and Regulations – General Standard (UOSHA).

#### **1.04 DEFINITIONS**

- A. Base Rock: Granular material upon which manhole bases and other structures are placed.
- B. Bedding: That surface of the excavation or portion of the pipe zone below the pipe.
- C. Bedding Zone: Granular material upon which pipes, conduits, cables, or duct banks are placed.
- D. Drawings: Released for Construction Drawings approved by the City’s Engineering Department.
- E. Finish Grade Elevations: Top of pavement in paved areas, as indicated on Drawings.
- F. Ground Elevations: Indicated on the Drawings.
- G. Imported Material: Material obtained by the Contractor from sources(s) off-site.
- H. Lift: Loose (uncompacted) layer of material.
- I. Pipe Line Grades and Elevations: Indicated on Drawings.
- J. Pipe Zone: Backfill zone that includes the full trench width plus 1-foot above the pipe barrel.
- K. Prepared Trench Bottom: Graded and refinished trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.
- L. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D 1557. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the City Engineer.
- M. Relative Density: As defined by ASTM D 4253 and ASTM D 4254.
- N. Resident Project Representative (City’s): Unless otherwise specified by the City, this will be the Engineering Department’s Project Inspector.
- O. Resident Project Representative (Developer’s): The Developer is responsible for notifying the City’s Engineering Department in writing, which will fill this role for the Developer.

- P. Subgrade Elevations: Bottom of road base in paved areas, as indicated on Drawings.
- Q. Trench Cross Sections: Indicated on standard drawings for trenches.
- R. Trench Stabilization: Granular material wrapped in 10-oz. Geotextile fabric used to stabilize the trench bottom. To be used as directed by the Engineer.
- S. Trench Zone: Granular backfill material that includes the full trench width and extends from the pipe zone top to either the bottom of landscaping or bottom of pavement section, as applicable.
- T. Well Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

### **1.05 SUBMITTALS**

- A. Shop Drawings: Manufacturer's descriptive literature for marking tapes.
- B. Samples:
  - 1. Base Rock – 0.028 cm with gradation.
  - 2. Trench stabilization material - 0.028 cm with gradation.
  - 3. Bedding and pipe zone material - 0.028 cm with gradation.
  - 4. Pipe zone material - 0.028 cm with gradation.
  - 5. Trench zone material - 0.028 cm with gradation.
  - 6. Top soil - 0.028 cm with analysis.
  - 7. CLSM – lab strength tests and gradation.
- C. Submit aggregate batch delivery tickets showing name of material source; serial number of ticket; date and truck number; name of supplier; job name and location; volume of material delivered; and aggregate classification.
- D. Submit samples of proposed imported borrow material for review by the Soils Engineer prior to delivery to the Site.
- E. Submit maximum laboratory dry density and optimum laboratory moisture content for:
  - 1. Subgrade material, and
  - 2. Each type of fill to be used in the Work.
- F. Upon City's Resident Project Representative's request, submit a written quality control inspection and testing report describing source and field quality control activities performed by Developer and its suppliers.
- G. Quality Control Submittals: Catalog and manufacturer's data sheets for compaction equipment.

1. Certified Gradation Analysis: Submit not less than 30-days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to the site.
2. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic meter for each component of mix.

#### **1.06 STORAGE AND PROTECTION**

- A. Stockpile backfill materials in sufficient quantities for the work.
- B. Separate differing materials, prevent mixing, and maintain optimum moisture content of backfill materials.
- C. Prevent erosion or deterioration of material.
- D. Use means necessary to avoid displacement of, and injury to work while compacting or operating equipment.
- E. Movement of construction machinery over work at any stage of construction is solely at the Contractors and Developer's risk.

#### **1.07 QUALITY ASSURANCE**

- A. Testing and Observation: Excavation, filling and compaction shall be performed under the direct supervision and testing of the Soils Engineer retained and paid for by the Developer. Tests shall be submitted to the City's Engineering Inspector for review for compliance. Developer's Contractor and Consultants are responsible for compliance with City specifications and submitting documents to the Engineering Inspector showing compliance.
- B. Allowable Tolerances:
  1. Excavations shall not exceed 1/10-foot variation from dimensions and elevations indicated.
  2. Place fill and backfill material within tolerance of plus or minus 1/10-foot.
- C. Do not change material sources, or aggregate without City's Resident Project Representative's knowledge.
- D. Reject backfill material that does not comply with requirements specified in this section.

#### **1.08 SITE CONDITIONS**

- A. Unsuitable Weather: Do not place, spread, or roll any fill material until moisture content of material is satisfactory. If necessary, remove and replace damaged materials.
- B. Existing Conditions – Maintain bench marks, monuments, and survey control references. If these are removed, the Developer is responsible for re-establishing and paying for these items.

C. Protection of Persons and Property

1. Conduct operations to prevent windblown dust and dirt from interfering with adjacent work.
2. Protect graded areas from traffic, erosion, and slides.
3. Control dust at the site by intermittent watering and sprinkling while the work is being performed.

D. Layout – If discrepancies are found between the Drawings and site conditions, the Engineer reserves the right to make minor adjustments in the work necessary to accomplish the intent of the Released for Construction Drawings.

E. Scheduling

1. Schedule operations to permit sufficient time for the Soils Engineer to take samples and perform laboratory work.
2. Notify the Soils Engineer and the City’s Resident Project Representative a minimum of 72-hours prior to commencement of earthwork operations.

F. Contractor shall continuously control dust and other emissions arising as a result of the work to the full and complete satisfaction of the City and the City’s Resident Project Representative.

**1.09 TESTING AND ACCEPTANCE**

A. One test per lot is required. The lot will not be accepted until the test criteria passes which is as follows:

**Table 1  
Lot Size for Trench Backfilling Operations**

| <b>Material</b> | <b>Test</b>                           | <b>Lot Size</b>   |
|-----------------|---------------------------------------|---|
| Subgrade        | Density<br>Section 02324              | Each 100-lineal feet of trench  |
| Common Fill     | Density<br>Section 02324              | One lift per 100-lineal feet of trench  |
| Select Fill     | Density<br>Section 02324              | One lift per 100-lineal feet of trench<br>One lift per 25-square feet of footing area |
| Flowable Fills  | Compressive Strength<br>Section 02062 | 50-cubic yards  |

NOTES: (a) Lift thickness above the pipe zone before compaction is 8-inches.

B. Refer to the following Sections for material acceptance:

1. Section 02055 – Common Fill.
2. Section 02060 – Select Fill.
3. Section 02062 – Cement Treated Fill.

**1.10 WARRANTY**

A. Any settlement noted in trench backfill or in structures built over the trench backfill will be

considered to be caused by improper compaction methods and shall be corrected at not cost to the City.

- B. Restore structures damaged by settlement at not additional cost to the City.

## **PART 2 -- PRODUCTS**

### **2.01 MATERIALS**

- A. General - All fill and backfill material shall be observed, tested and approved in writing by the Soils Engineer prior to use. Test results are to be submitted to the City's Resident Project Representative for his/her records and comment.
- B. Section 02055 – Common Fill.
- C. Section 02060 – Select Fill.
- D. Section 02062 – Flowable Fill.

### **2.02 ACCESSORIES**

- A. Water - Make arrangements for sources of water during construction and make arrangements for delivery of water to the site. Comply with City laws, ordinances and standards at not additional cost to the OWNER when securing water from the City.
- B. Geotextile Fabric - Section 02075
- C. Marking/Identification Tape: Permanent, bright colored, continuous-printed magnetic plastic type, intended for direct-burial service; not less than 6-inches wide by 4 mils thick. The tape shall read: "CAUTION: BURIED INSTALLATION BELOW". Color of tape shall be as follows:
  - 1. Color of tape:
    - a. Red: Electric power lines, cables, conduit and lighting cables.
    - b. Yellow: Gas, oil, steam, petroleum or gaseous materials.
    - c. Orange: Communications, alarm, signal lines, cables, or conduits.
    - d. Blue: Potable water.
    - e. Purple: Reclaimed or secondary water, irrigation and slurry lines.
    - f. Green: Sewer and storm drain lines.
  - 2. Plastic tape:
    - a. Inert polyethylene, impervious to know alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
    - b. Thickness: Minimum 4 mils.
    - c. Width: 0.1524 meters.
    - d. Identifying Lettering: Minimum 25 mm high, permanent black lettering imprinted continuously over entire length.
    - e. Manufacturers and Products:

- i. Reef Industries; Terra Tape.
  - ii. Allen: Markline.
- 3. Metallic tape:
  - a. Solid aluminum foil, visible on unprinted side, encased in a protective high visibility, inert polyethylene plastic jacket.
  - b. Foil Thickness: Minimum 5.5 mils.
  - c. Width: 0.1524 meters
  - d. Identifying Lettering: Minimum 2.5 cm high, permanent black lettering imprinted continuously over entire length.
  - e. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.
  - f. Manufacturer and Products:
    - i. Reef Industries; Terra “D”.
    - ii. Allen; Detectatape.

**2.03 TRENCH STABILIZATION MATERIAL**

- A. Trench Stabilization Material shall be imported foundation stabilization rock as defined in Section 02315 – Fill and Backfill.
- B. Trench stabilization material shall be wrapped in 10 oz. Geotextile fabric and overlapped at deges of 1-foot minimum.

**2.03 TRENCH BACKFILL MATERIAL**

- A. Unfrozen, friable, and no clay balls, roots, other inorganic material or debris.
- B. Rock refill shall be crushed or natural well-graded sands and gravel containing less than 1-percent asbestos by weight or volume, having the following gradations:

| Sieve Size   | Percent Passing by Weight |
|--------------|---------------------------|
| 3-inches     | 100                       |
| 1-1/2-inches | 70-100                    |
| ¾-inches     | 60-100                    |
| No. 4        | 25-50                     |
| No. 30       | 10-30                     |
| No. 200      | 0-10                      |

**2.04 IMPERVIOUS BARRIERS**

- A. Construct impervious barriers of concrete or soil cement slurry.
- B. Concrete barriers shall consist of Class C concrete per Section 03000. Each barrier shall be 12-inches thick and shall consist of a collar cast around the pipe embedded at least 1-foot into the trench bottom and sides as shown on the contract drawings.

## **2.05 CONCRETE FOR PIPE ENCASUREMENT AND THRUST BLOCKS**

- A. Concrete for pipe encasement shall be Class A per Section 03000, unless otherwise shown on the Drawings.

## **2.06 WATER FOR COMPACTION**

- A. Water used in jetting and compacting shall have a maximum chloride concentration of 500-mg/L, a maximum sulfate concentration of 500-mg/L, and shall have a pH of 7.0 to 9.0. Water shall be free of organic materials injurious to the pipe coatings.

## **PART 3 -- EXECUTION**

### **3.01 EXAMINATION**

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect utilities that remain and protect from drainage.
- C. Notify utility company to remove and relocate utilities, where and as required.

### **3.02 COMPACTION REQUIREMENTS**

- A. Unless otherwise shown in the Released for Construction Drawings or otherwise described in the Policies & Design Criteria Manual for the particular type of pipe installed, relative compaction in pipe trenches shall be as follows:

1. Pipe Zone: 95-percent relative compaction or 80-percent relative compaction.
2. Backfill in trench zone not beneath paving: 90-percent relative compaction.
3. Backfill in trench zone below road zone in paved areas: 95-percent relative compaction.
4. Backfill in road zone in paved areas: 95-percent relative compaction.
5. Rock refill for foundation stabilization: 95-percent relative compaction or 80-percent relative density.
6. Refill for overexcavation: 95-percent relative compaction or 80-percent relative density.
7. All backfill placed.

- B. Soil for compaction shall be at optimum moisture content, or within 2 percentage points above optimum moisture content.

### **3.03 MATERIAL REPLACEMENT**

- A. Remove and replace any trenching and backfilling material which does not meet the specifications, at the Developer's expense.

### **3.04 SHEETING, SHORING, AND BRACING OF TRENCHES**

- A. Trenches shall have sheeting, shoring, and bracing conforming to 29CFR1926, Subpart P--Excavations, OSHA requirements, and the Special Conditions.

### **3.05 PAVEMENT REMOVAL**

- A. Do not use for trench backfill.

### **3.06 TRENCH WIDTHS**

- A. Trench widths in the pipe zone shall be as shown in the contract drawings. If no details are shown, minimum width shall be 18-inches greater than the pipe outside diameter. Comply with 29CFR Part 1926 Subpart P--Excavations. Trench widths at the top of the trench will not be limited except where width of excavation would undercut adjacent structure and footings. In such case, width of trench shall be such that there are at least 2-feet between the top edge of the trench and the structure or footing.

### **3.07 TRENCH EXCAVATION**

- A. Excavate trenches as required to allow Project pipe to be installed to line and grade as indicated on the Drawings.
- B. Notify City's Resident Project Representative of unexpected subsurface conditions and discontinue affected Work in area until notified to resume Work.
- C. It is recommended that all trench excavation be done according to OSHA Standards and other applicable regulations.
- D. Do not interfere with adjacent foundations.
- E. Excavate the trench to the lines and grades shown in the drawings with allowance for pipe thickness, sheeting and shoring if used, and for pipe base or special bedding. If the trench is excavated below the required grade, refill any part of the trench excavated below the grade at no additional cost to the owner with foundation stabilization material. Place the refilling material over the full width of trench in compacted layers not exceeding 8-inches deep to the established grade with allowance for the pipe base or special bedding.
- F. Hand trim excavations. Remove loose matter.
- G. Remove large stones and other hard matter which could damage piping or impede consistent backfilling or compaction.
- H. Construct trenches in rock by over-excavating rock to a minimum of 6-inches and backfilling with foundation stabilization material.
- I. Potentially expansive materials, identified in Volume III as volcanic ashes, volcanic tuffs, claystones,

and their residual soils shall be prevented from drying upon excavation. Maintain excavated materials at their in-situ moisture condition.

- J. The use of explosives will not be allowed, unless specifically reviewed and accepted by the City's Resident Project Representative and City Engineer. All blasting shall be done by a reputable, licensed contractor specializing in the use of explosives, who is acceptable to the City Inspector and City Engineer.

### **3.08 DEWATERING**

- A. Provide and maintain means and devices to remove and dispose of all water entering the trench excavation during the time the trench is being prepared for the pipe laying, during the laying of the pipe, and until the backfill at the pipe zone has been completed. These provisions shall apply during the noon hour as well as overnight. Dispose of the water in accordance with Section 02200. Do not drain trench water through the pipeline under construction. Do not allow groundwater to rise around the pipe until jointing compound has set hard and the pipe is backfilled.
- B. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collection or run-off areas. Approval of these 'outside excavation or run-off areas' shall receive written prior approval of the Developer's Soils Engineer and the City's Resident Project Representative. Do not use trench excavations as temporary drainage ditches.

### **3.09 LOCATION OF EXCAVATED MATERIAL**

- A. During trench excavation, place the excavated material only within the working area. Do not obstruct any roadways or streets. Conform to federal, state, and local codes governing the safe loading of trenches with excavated material and equipment.
- B. Topsoil excavated from the wetlands shall be removed and stored separately. Replace wetland topsoils in the top 12-inches of the trench zone. Backfill is complete

### **3.10 LENGTH OF OPEN TRENCH**

- A. Limit the length of open trench to 600-feet in advance of pipe laying or amount of pipe installed in one working day, except in the creek crossings where 1,000-feet is the maximum length of open trench allowable. Complete backfilling and temporary or first layer paving not more than 600-feet in the rear of pipe laying.

### **3.11 TRENCH EXCAVATION IN BACKFILL AND EMBANKMENT AREAS**

- A. Construct trench excavation for pipe, pipes, or conduit in backfill or embankment areas in accordance with the following procedures:
  - 1. Construct and compact the embankment to an elevation of 1-foot minimum over the top of the largest pipe or conduit to be installed.
  - 2. For areas where pipelines or culverts cross, construct the lower conduit, then backfill the area to

a level 1-foot above the top of the higher conduit before excavating the trench for the higher conduit.

3. Excavate trench in the compacted backfill or embankment. Place pipe base material, install pipe or conduit, and backfill with pipe zone material. Compact backfill above the pipe zone to the same relative compaction as the adjacent embankment as specified in Section 02200.

### **3.12 FOUNDATION STABILIZATION**

- A. After the required excavation has been completed, inspect the exposed subgrade to determine the need for any additional excavation. It is the intent that additional excavation is conducted in all areas within the influence of the pipeline where unacceptable materials exist at the exposed subgrade. Areas identified on the drawings are estimated and may not identify the full extent of unacceptable foundation material.
- B. Overexcavation shall include the removal of all such unacceptable material that exists directly beneath the pipeline to a width 24-inches greater than the pipe outside diameter and to the depth required. Backfill the trench to subgrade of pipe base with rock refill material for foundation stabilization. Place the foundation stabilization material over the full width of the trench and compact in layers not exceeding 12-inches deep to the required grade.
- C. Estimate depths and locations of trench overexcavation are shown on the plans. These are shown for estimation and bid purposes only. The actual amount of overexcavation and refill shall be determined per paragraph A above, and may be different from quantity, depth, and location than that indicated on the drawings.
- D. The Proposal includes three items at a lumps sum cost of any quantity of additional rock refill differing as to total depth below the pipe foundation line, as shown by the bedding details on the drawings. Item (a) is for any additional bedding down to 12-inches and is estimated at 5,200 CY. Item (b) is for a total depth of 12-inches to 24-inches and is estimated at 400 CY. Item (c) is for a total depth of 24-inches to 36-inches and is estimated at 2,800 CY.
- E. These items have been included in the schedule of values for work that is estimated to be required to complete the project. The extent of these cannot be firmly anticipated at this time and the Contract is encouraged to verify the required quantity of overexcavation required before submitting a bid. The lump sum cost shall be for any quantity installed, complete in place, including all earthwork, disposal of all excess or waste material, and placing the refill material. The Owner's representative shall be the sole judge as to the necessity, the amount, and the depth of additional refill material that may be required in any given situation.
- F. Rock refill used by the Contractor for his convenience will not receive any additional payment.

### **3.13 INSTALLING BURIED PIPING**

- A. Backfill per the detailed piping specification for the particular type of pipe and per the following.
- B. Handle pipe in such a manner as to avoid damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.

- C. Inspect each pipe and fitting before lowering the buried pipe or fitting into the trench. Inspect the interior and exterior protective coatings. Patch damaged areas in the trench with material recommended by the protective coating manufacturer. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after installation.
- D. Grade bottom of the trench to the line and grade to which the pipe is to be laid, with allowance for pipe thickness and soil-cement slurry. Remove hard spots that would prevent a uniform thickness of bedding. Place the specified thickness of pipe base material over the full width of the trench. Grade the top of the pipe base ahead of the pipe laying to provide firm continuous, uniform support along the full length of pipe bedding, and compact to the relative compaction specified herein. Before laying each section of the pipe, check the grade with a straightedge and correct any irregularities. Provide "soil-pads" to support the pipeline before supply placement as shown on the drawings.
- E. Excavate bell holes at each joint to permit proper assembly and inspection of the entire joint. Fill the area excavated for the joints with the bedding material specified or detailed in the drawings for use in the pipe zone.
- F. When installing pipe, do not deviate more than 1 inch from line or 1/2-inch from grade. Elevation is reference to the pipe invert.
- G. After the pipe has been bedded, place pipe zone material simultaneously on both sides of the pipe, in maximum 8-inch lifts, keeping the level of backfill the same on each side. Carefully place the material around the pipe so that the pipe barrel is completely supported and that no voids or uncompacted areas are left beneath the pipe. Use particular care in placing material on the underside of the pipe to prevent lateral movement during subsequent backfilling.
- H. Compact each lift to the relative compaction specified herein.
- I. Push the backfill material carefully onto the backfill previously placed in the pipe zone. Do not permit free fall of the material until at least 2-feet of cover is provided over the top of the pipe. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe. Do not operate heavy equipment over the pipe until at least 3-feet of backfill has been placed and compacted over the pipe.
- J. When the pipe laying is not in progress, close the open ends of pipe. Do not allow trench water, animals, or foreign material to enter the pipe.
- K. Remove and dispose of all water entering the trench during the process of pipe laying. Keep the trench dry until the pipe laying and jointing are completed.

### **3.14 INSTALLING IMPERVIOUS BARRIERS**

- A. Construct impervious barriers in the pipe and trench zones at 100-foot intervals on slopes exceeding 30-percent (16.7 degrees) and within 50-feet of vertical points of inflection on slopes exceeding 30-percent.
- B. Construct concrete barriers such that the bottom of the collar extends at least 12-inches into the pipe

base, at least 12-inches into each side of the walls of the trench, and at least 12-inches above the top of the pipe zone.

- C. Construct clay barriers as shown on the drawings.

### **3.15 BACKFILL COMPACTION**

- A. Compact per the detailed piping specification for the particular type of pipe and per the following.
- B. Compact trench backfill to the specified relative compaction. Compact by using mechanical compaction, water jetting, or hand tamping. Do not use high impact hammer-type equipment except where the pipe manufacturer warrants in writing that such use will not damage the pipe. Do not use water jetting in areas where potentially expansive volcanic rock and soil are present.
- C. Compact material placed within 12-inches of the outer surface of the pipe by hand tamping only.
- D. Do not use any axle-driven or tractor-drawn compaction equipment within 5-feet of building walls, foundations, and other structures.

### **3.16 PLACEMENT OF CEMENT SLURRY**

- A. The aggregate, cement and water shall be proportioned either by weight or by volume. The water content shall be sufficient to produce a fluid, workable mix that will flow and can be pumped without segregation of the aggregate while be placed. Prepare cement slurry in accordance with ASTM C94.
- B. Provide batching equipment to obtain the proper weights of soil, cement, water and admixtures. All measuring devices should be sensitive to a 2 percent variation above or below the actual weights required. Volumetric batching may be used, provided the same accuracy required for weight batching is maintained.
- C. Design and operate the mixers used for mixing cement slurry bedding so that the cement slurry as discharged from he mixer is uniform in composition and consistency throughout each batch.
- D. Place the cement slurry such that it flows easily into all openings between the pipe and the excavated trench. In some cases, such as trenches on a slope, a stiffer mix of cement slurry may be required to prevent the cement slurry from flowing down the trench. In this case, use vibration to ensure that the cement slurry completely fills all spaces.
- E. Lay the pipe on the soil pads and place the cement slurry bedding as shown on the drawings. Cement slurry bedding shall be placed under pipe from one side and rodded or vibrated, as necessary, so that it flows under the pipe until it appears on the other side. Cement slurry shall then be added to both sides of the pipe and rodded or vibrated until it completely fills the space between the pipe and the excavated trench bottom. This operation shall follow as closely behind pipe laying operations as possible. Place slurry in such a sway as to prevent uplift or buckling of the pipe. Cement slurry shall be deposited as nearly as practicable in its final position and must in no way disturb the pipe trench or cause foreign material to become mixed with the cement slurry.
- F. Do not place backfill above the pipe until the soil-cement bedding has reached the initial set. Place

and maintain a 6-inch cover of moist backfill cover until additional backfill is placed. If the ambient temperature is 50 degrees Fahrenheit or less, an additional 6-inch cover of loose backfill must be placed over the 6-inch moist backfill cover prior to the end of the working day.

- G. Whenever freezing temperatures are imminent, maintain the soil-cement slurry at a temperature of not less than 50-degrees Fahrenheit for 24-hours after placement. The temperature of the soil-cement slurry mix must be 50-degrees Fahrenheit or greater at the time of placement. The temperature will be determined by placing a thermometer in the soil-cement slurry immediately after simply at the placement site. When freezing weather appears imminent, make ready at the placement site materials which may be required for protection of cement slurry. Placement of cement slurry shall be delayed until adequate provisions for protection against weather are made. No cement slurry bedding shall be placed in pipe trenches when the trench bottom or walls are frozen or contain frozen material. Backfill placed as cover over the cement slurry is prohibited from containing any frozen material.

### **3.17 FIELD QUALITY CONTROL**

- A. All on-site earthwork and excavation operations shall be observed by the Developer's Soil Engineer. The Soils Engineer will perform the following as a minimum:
1. Inspect the exposed subgrade in backfill areas and delineate areas requiring overexcavation.
  2. Perform field density tests to monitor the quality of compacted fill and backfill.
- B. Field Density Test
1. Based upon the project's geotechnical report, the Developer's Soil Engineer shall submit a proposed Field Density Test Program to the City's Resident Project Representative for his/her review.
  2. The location and frequency of tests will be at the Soil Engineer's discretion with agreement of the City's Resident Project Representative.
- C. Employ a licensed surveyor or civil engineer to lay out the work and establish the necessary markers, benchmarks, and stakes.

### **3.18 DISPOSAL OF EXCESS AND WASTE MATERIALS**

- A. Immediately remove excess excavated material, trash, debris and waste materials and dispose of it off the project site.

### **3.19 CLEANUP**

- A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
- B. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.
- C. The following shall be performed on a continuous basis to the full and complete satisfaction of the City's Resident Project Representative:

1. During progress of the work, keep premises free of debris and waste materials.
2. As directed during work progress, immediately remove all debris, rubbish, left over materials, tools and equipment from the site.

\*\*\* END OF SECTION \*\*\*

## SECTION 02227

### SAND-CEMENT SLURRY

#### PART 1 -- GENERAL

##### 1.01 SCOPE OF WORK

- A. The work of this Section includes the furnishing of all materials and mixing, for soil stabilization including the placing and curing of sand-cement slurry mix, and all appurtenant work, all in accordance with the requirements of the Contract Documents.

##### 1.02 QUALITY ASSURANCE

- A. General Inspection and Test Requirements: Sampling and preparation of sand-cement specimens shall be performed by the Contractor. Sand-cement tests will be performed by the [Engineer] and will be based upon obtaining not less than 150-psi at 7-days on 2 companion cylinders taken 2 times during each working shift. Material poured into cylinder molds shall not be vibrated or tamped.
- B. Forty-eight hours before testing, cylinders shall be totally immersed in water. Twenty-four hours before capping and testing, cylinders shall be removed from the water and allowed to drain and air dry. Cylinders will otherwise be tested in accordance with ASTM Designation C 39-72.
- C. Inspection: It is required that all sand-cement work specified herein shall be subject to full-time inspection, and no such work shall be scheduled or started without having made prior arrangements with said Inspector to provide for his required inspections. Not less than 24 hours' notice shall be provided to the [Engineer] for scheduling such inspections. Selection of the Inspector shall be by the [Engineer] and all costs therefor shall be paid by the Contractor.

#### PART 2 -- PRODUCTS

##### 2.01 MATERIALS

- A. All sand-cement materials shall conform to the following requirements:
1. Cement shall be portland cement conforming to the requirements of ASTM Designation C 150-74. Cement shall be Type [II] or [V].
  2. Water shall be fresh, clean, potable, and free of injurious amounts of mineral or organic substances.
  3. Sand for sand-cement shall meet the following criteria:
    - a. Not more than 10 percent of the material by weight shall be larger than 3/8-inch, and none of the material shall be larger than 3/4-inch.
    - b. The sand fraction passing the No. 200 sieve shall, in combination with the cement, be sufficient to insure that the sand remains in suspension while the mixture is being placed.
    - c. Sand which contain considerable amounts of organic matter shall not be used.

## **PART 3 -- EXECUTION**

### **3.01 PROPORTIONING AND MIXING**

- A. Sand, cement, and water shall be so portioned that the minimum compressive strength will be at least 150 psi in 7 days as determined on 2 companion cylinders taken 2 times during each working shift.
- B. Sand cement slurry shall be thoroughly mixed, and the presence of lumps, clods, or foreign matter shall be minimized. Water added in the mixer shall not exceed that required to insure a fluid, readily pumpable mixture.

### **3.02 PLACING**

- A. Sand-cement slurry mix shall be placed as indicated on the drawings.
- B. Curing of sand-cement slurry mix shall conform to the requirements for concrete curing in Section entitled, ["Minor Concrete"].

\*\*\* END OF SECTION \*\*\*

## SECTION 02228

### BLASTING

#### **PART 1 -- GENERAL**

##### **1.01 DESCRIPTION**

- A. This section describes procedures for blasting for excavation.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Earthwork: 02200.
- B. Trenching, Backfilling, and Compacting: 02224.

##### **1.03 PERMITS AND SAFETY ORDERS**

- A. Obtain blasting permits required by Salt Lake County, the State of Utah, and any applicable agency having jurisdiction.
- B. Comply with the requirements specified in the General Industry Safety Orders of the Utah Division of Industrial Safety.
- C. If the amount of explosives to be transported exceeds 1,000-pounds, secure a permit from the Utah Highway Patrol to transport.

##### **1.04 CONTRACTOR'S SUBMITTALS**

- A. Submit copy of Blaster's License for each blasting supervisor.
- B. Specific blasting plan.
- C. Seismic monitoring procedure.

##### **1.05 REPORTS AND RECORDS**

- A. The Contractor shall prepare and maintain on site all reports and records necessary for execution of the work, which shall be accessible to the Construction Manager during normal working hours, including the following:
  - 1. Blast reports for any blasting work.
  - 2. Ground motion vibration levels exceed specified limits of particle velocity or frequency.
  - 3. Existing structural conditions are aggravated or adjacent improvements are damaged as a result of blasting.
  - 4. Blasting methods endanger the stability of intact rock outside the prescribed limits of excavation.
  - 5. Skilled operators and/or licensed foreman is not present.
  - 6. All applicable health and safety reporting requirements.

Blasting operations shall not resume until modifications have been made to correct the conditions that resulted in the suspension. The Contractor shall not be entitled to any extension in time nor to any claim of damage nor excess costs by reason of the blasting suspension order.

## **PART 2 -- PRODUCTS**

### **2.01 MATERIALS**

- A. Furnish materials and equipment as required for blasting operations. Materials shall conform to all applicable regulatory agency requirements.

## **PART 3 -- EXECUTION**

### **3.01 BLASTING HOURS**

- A. Blast only between the hours of 9 a.m. and 4 p.m. during any weekday, Monday through Friday, unless special circumstances warrant another time or day and special approval is granted in writing by the Owner and the agency having jurisdiction.

### **3.02 BLASTING PROCEDURES**

- A. Control fly rock and debris to prevent damage to persons or structures. Use blasting mats in developed areas. Equipment used for drilling of holes shall have a positive means of dust control.
- B. Do not perform blasting closer than 10-feet to existing water, gas, sewer, or other buried utilities.
- C. Use controlled blasting techniques to keep the air blast overpressure, vibration, and noise within the limits herein specified.
- D. Notify the Owner at least two workdays before blasting with 1,000-feet of a structure or 500-feet of a paved road.
- E. Control fly rock and debris from blasting. Contain fly rock within the project rights of way so that it shall not represent a hazard to people, vehicles, existing improvements, or vegetation. Clean the blasting site of debris associated with the blasting operation at the end of each working day.
- F. Blasting operations may be suspended by the Owner for any one or more of the following reasons:
  - 1. Safety precautions are inadequate.
  - 2. Ground motion vibration levels exceed specified limits of particle velocity or frequency.
  - 3. Existing structural conditions are aggravated or adjacent improvements are damaged as a result of blasting.
  - 4. Blasting methods endanger the stability of intact rock outside the prescribed limits of excavation.
  - 5. Skilled operators and/or licensed foreman is not present.

- G. Blasting operations shall not resume until modifications have been made to correct the conditions that resulted in the suspension. The Contractor shall not be entitled to any extension in time nor to any claim of damage nor excess costs by reason of the blasting suspension order.

### **3.03 MAXIMUM PARTICLE VELOCITIES**

- A. The maximum particle velocity at the nearest point to the pipelines shall be 6.0-inches per second at a minimum frequency of 10 hertz. In the event neither of these limitations is met, perform excavations, repair as necessary, and backfill the excavations whether damage is discovered or it is determined no damage has been incurred.
- B. The maximum particle velocity at any other structure within 300-feet of the blast area shall be 0.5-inch per second at frequencies of 10 hertz or less and shall progress linearly to 2-inches per second at a frequency of 40 hertz or greater in accordance with the recommendations of the United States Bureau of Mines Publication RI 8507, Figure 11.14.

### **3.04 AIR BLAST OVERPRESSURE**

- A. Air blast overpressure at the property or right-of-way lines shall not exceed 0.03 psi and shall not exceed 0.03 psi at any structure within 300-feet of the blast area.

### **3.05 NOISE LEVELS**

- A. Impact or impulsive noise from blasting operations shall not exceed 140 dB measured at the nearest structure or property line.

### **3.06 FIELD MEASUREMENT**

- A. Measure peak particle velocity with a seismograph capable of producing a permanent record and capable of internal dynamic calibration. Record air blast overpressure with a peak impact recording instrument having linear frequency response. Place a seismograph at the nearest structure to the blast area to monitor the ground motion particle velocity and frequency during each blast.

\*\*\* END OF SECTION \*\*\*

## **SECTION 02276**

### **STABILIZED CONSTRUCTION ENTRANCE**

#### **PART 1 -- GENERAL**

##### **1.01 SCOPE OF WORK**

- A. Furnish all labor, materials and equipment as required to the site entrance as shown in the Contract Documents. This includes grading and compacting the area and placing the riprap.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 02275 - Riprap
- B. Section 02272 – Fabrics, Erosion Control Mats and Geotextiles
- C. Section 02112 – Clearing, Grubbing and Stripping
- D. Standard Drawing No. 5105 – Temporary Gravel Construction Entrance/Exit

#### **PART 2 -- PRODUCTS**

##### **2.01 STABILIZED CONSTRUCTION ENTRANCE**

- A. Riprap (No. 3) – Refer to Section 02275 – Riprap.
- B. Filer fabric per Section 02272 – Fabrics, Erosion Control Mats and Geotextiles.

#### **PART 3 -- EXECUTION**

##### **3.01 STANDARD PROCEDURES**

- A. Clear all vegetation, roots and all other obstructions in preparation for grading.
- B. Prior to placing filter fabric, make sure that the entrance is properly graded and compacted.
- C. To reduce maintenance and loss of aggregate, place filter fabric over the existing ground before placing the stone for the entrance.
- D. Place riprap as shown in the Contract Documents.

##### **3.02 MAINTENANCE**

- A. Inspect the entrance at the end of each shift, after significant truck traffic and after every storm event for riprap displacement and sediment buildup.
- B. Apply additional rip when required.

- C. Remove sediments from within the entrance when they prevent proper drainage of the facility.
- D. Provide a vehicle wash-down area with appropriate facilities for vehicles that leave the site. Ensure that all vehicles leaving the site have been properly washed-down and are not tracking dirt, mud or other debris onto existing City streets.
- E. Immediately remove sediment and other materials tracked off the site.
- F. Maintain associate temporary erosion control measures per Section 02271 – Temporary Erosion Control.

\*\*\* END OF SECTION \*\*\*

## SECTION 02313

### TRENCH EXCAVATION

#### **PART 1 -- GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Trench Excavation for Project sanitary sewer pipes and appurtenances.
- B. Trench Preparation for sanitary sewer pipe replacement.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 02224 – Trenching, Backfilling and Compacting

##### **1.03 REFERENCES**

- A. Use the latest issue of the reference standards as of the date of the Project.
- B. ASTM C 136 – Standard Test Method for Sieve Analysis of Fine and Course Aggregates; 1996a.
- C. ASTM D 698 – Test Method for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>(600 kN-m/m<sup>3</sup>)); 1991.
- D. ASTM D 1556 – Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 1990 (Reapproved 1996).
- E. ASTM D 1557 – Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN m/m<sup>3</sup>)), 1991.
- F. ASTM D 2167 – Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 1994.
- G. ASTM D 2487 – Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System); 1993.
- H. ASTM D 2922 – Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 1991.
- I. ASTM D 3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 1988 (Reapproved 1993).
- J. ASTM D 4318 – Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 1995a.
- K. Specification for Excavating on State Highways, latest edition.

- L. General Safety Orders Covering Utah Industries – Section 69, Trenches.
- M. United States Department of Labor OSHA Publication 2085 – “Employer – Employee, Safe Practice for Excavation and Trenching Operations”.
- N. Utah Occupational Safety and Health Rules and Regulations – General Standard (UOSHA)

#### **1.04 DEFINITIONS**

- A. Bedding: That surface of the excavation or portion of the pipe zone below the pipe.
- B. Drawings: Released for Construction Drawings approved by the City’s Engineering Department.
- C. Finish Grade Elevations: Top of pavement in paved areas, as indicated on Drawings.
- D. Ground Elevations: Indicated on the Drawings.
- E. Pipe Invert Elevations: Indicated on the Drawings.
- F. Pipe Line Grades and Elevations: Indicated on Drawings.
- G. Pipe Zone: That zone in backfilling operations which supports, and surrounds the pipe barrel, and extends to 1-foot above the top of the pipe barrel.
- H. Resident Project Representative (City’s): Unless otherwise specified by the City, this will be the Engineering Department’s Project Inspector.
- I. Resident Project Representative (Developer’s): The Developer is responsible for notifying the City’s Engineering Department in writing, which will fill this role for the Developer.
- J. Subgrade Elevations: Bottom of road base in paved areas, as indicated on Drawings.
- K. Trench Cross Sections: Indicated on standard drawings for trenches.

#### **1.05 PROJECT CONDITIONS**

- A. Verify that survey bench marks and intended elevations for the Work are as indicated.
- B. Verify locations and elevations of existing utility lines in the area of the Work. Protect all utility lines from excavating equipment and vehicular traffic.
- C. Protect plants, lawns, and other features to remain.
- D. Protect benchmarks, survey control points, existing structures, fences, sidewalks, paving, curbs, and other improvements from excavating equipment and vehicular traffic.

## **PART 2 – PRODUCTS – NOT USED**

## **PART 3 -- EXECUTION**

### **3.01 EXAMINATION**

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect utilities that remain and protect from damage.
- C. Notify utility company to remove and relocate utilities, where and as required.

### **3.02 TRENCH EXCAVATION**

- A. Excavate trenches as required to allow Project pipe to be installed to line and grade as indicated on the Drawings.
- B. Notify City Inspector of unexpected subsurface conditions and discontinue affected Work in areas until notified to resume Work.
- C. It is recommended that all trench excavation be done according to OSHA Standards and other applicable regulations.
- D. No not interfere with adjacent foundations.
- E. Excavate trenches to width, depth and cross section as indicated on the trench detail drawings.
- F. Hand trim excavations. Remove loose matter.
- G. Remove large stones and other hard matter which could damage piping or impede consistent backfilling or compaction.
- H. Remove excavated material that is unsuitable for re-use on the Project from site and dispose of in an acceptable manner.
- I. Where approved by the City Inspector, stockpile excavated material to be re-used in area designated on site.
- J. Remove excess excavated material from site and dispose of in an acceptable manner.
- K. During construction, provide and maintain sufficient means and devices to promptly remove and properly dispose of all water entering excavations or other parts of the Work.
  - 1. Dispose of water from work area in an acceptable manner, without damage to adjacent property.
  - 2. No pipe, concrete footings, foundations or floors shall be installed in water.
  - 3. Water shall not be allowed to rise over concrete until it has set for at least 24 hours.
  - 4. Water shall not be allowed to rise against walls and supporting beams for a period of 14-days

after completion of walls and beams.

5. Any damage to pipe work or concrete work caused by water shall be repaired by the Contractor, at Contractor's expense.
- L. The use of explosives will not be allowed, unless specifically reviewed and accepted by the City Engineer. All blasting shall be done by a reputable Contractor specializing in the use of explosives, who is acceptable to the City Engineer.
- M. Contractor shall provide, at no cost to the City, excavation and safety equipment for test holes used in quality assurance testing as directed by the City Engineer.

### **3.03 PREPARATION FOR WASTEWATER LINE REPLACEMENT**

- A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with bedding material, Fill Type III, or stabilization material, Type V, or other acceptable material, as directed by the City Inspector.
- B. Correct areas that are over-excavated.
  1. Fill Type II or Fill Type III flush to required elevation, compacted to at least 96-percent of the maximum dry density as determined by the standard Proctor method (ASTM D 698) or at least 91-percent of the maximum dry density as determined by the modified Proctor method (ASTM D 1557).
- C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

### **3.04 CLEANUP**

- A. Remove unused stockpiled materials; leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
- B. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.
- C. The following shall be performed on a continuous basis to the full and complete satisfaction of the City's Resident Project Representative:
  1. During progress of the work, keep premises free of debris and waste materials.
  2. As directed during work progress, immediately remove all debris, rubbish, left over materials, tools and equipment from the site.

\*\*\* END OF SECTION \*\*\*

## SECTION 02316

### TRENCH BACKFILL AND COMPACTION

#### **PART 1 -- GENERAL**

##### **1.01 THE REQUIREMENT**

- A. This section covers the materials and work associated with backfilling and compacting for Project pipe lines.
- B. Coordinate work with other trades on the site.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 02055 – Common Fill.
- B. Section 02060 – Select Fill.
- C. Section 02062 - Flowable Fill.
- D. Section 02075 – Geotextile Fabric.
- E. Section 02224 – Trenching, Backfilling and Compacting

##### **1.03 REFERENCES**

- A. Use the latest issue of the reference standards as of the date of the Project.
- B. ASTM C 136: Standard Test Method for Sieve Analysis of Fine and Course Aggregates; 1996a.
- C. ASTM D 698: Test Method for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>(600 kN-m/m<sup>3</sup>)); 1991.
- D. ASTM D 1556: Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 1990 (Reapproved 1996).
- E. ASTM D 1557: Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN m/m<sup>3</sup>)), 1991.
- F. ASTM D 2167: Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 1994.
- G. ASTM D 2321: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
- H. ASTM D 2487: Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System); 1993.
- I. ASTM D 2922: Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear

Methods (Shallow Depth); 1991.

- J. ASTM D 3017: Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 1988 (Reapproved 1993).
- K. ASTM D 4318: Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 1995a.

#### **1.04 DEFINITIONS**

- A. Bedding: That surface of the excavation or portion of the pipe zone below the pipe.
- B. Drawings: Released for Construction Drawings approved by the City's Engineering Department.
- C. Finish Grade Elevations: Top of pavement in paved areas, as indicated on Drawings.
- D. Ground Elevations: Indicated on the Drawings.
- E. Pipe Invert Elevations: Indicated on the Drawings.
- F. Pipe Line Grades and Elevations: Indicated on Drawings.
- G. Pipe Zone: That zone in backfilling operations which supports, and surrounds the pipe barrel, and extends to 1-foot above the top of the pipe barrel.
- H. Resident Project Representative (City's): Unless otherwise specified by the City, this will be the Engineering Department's Project Inspector.
- I. Resident Project Representative (Developer's): The Developer is responsible for notifying the City's Engineering Department in writing, which will fill this role for the Developer.
- J. Subgrade Elevations: Bottom of road base in paved areas, as indicated on Drawings.
- K. Trench Cross Sections: Indicated on standard drawings for trenches.

#### **1.05 SUBMITTALS**

- A. Submit aggregate batch delivery tickets showing name of material source; serial number of ticket; date and truck number; name of supplier; job name and location; volume of material delivered; and aggregate classification.
- B. Submit samples of proposed imported borrow material for review by the Soils Engineer prior to delivery to the Site.
- C. Submit maximum laboratory dry density and optimum laboratory moisture content for:
  - 1. Subgrade material, and

2. Each type of fill to be used in the Work.
- D. Upon City's Resident Project Representative's request, submit a written quality control inspection and testing report describing source and field quality control activities performed by Developer and its suppliers.

### **1.06 STORAGE AND PROTECTION**

- A. Stockpile backfill materials in sufficient quantities for the work.
- B. Separate differing materials, prevent mixing, and maintain optimum moisture content of backfill materials.
- C. Prevent erosion or deterioration of material.
- D. Use means necessary to avoid displacement of, and injury to work while compacting or operating equipment.
- E. Movement of construction machinery over work at any stage of construction is solely at the Contractors and Developer's risk.

## **PART 2 -- PRODUCTS**

### **2.01 GENERAL REQUIREMENTS**

- A. No frozen materials shall be used as backfill.
- B. Backfill materials shall be free of organic materials.
- C. No man made materials shall be used as backfill, unless otherwise approved by the City Engineer.

### **2.02 TRENCH BACKFILL MATERIALS**

- A. General Fill, Fill Type 1: Imported borrow or soil excavated on-site if acceptable to the City Engineer; conforming to Type A-2 of AASHTO Classification of Soils and Soil-Aggregate Mixtures.
  1. Graded.
  2. Free of lumps larger than 3-inches, rocks larger than 2-inches, and debris.
- B. Fill Type II: Native or imported material meeting the following requirements:
  1. Graded.
  2. Free from lumps larger than 3-inches, rocks larger than 2-inches, organic material and debris.
  3. No more than 20-percent of material passing No. 200 sieve.
- C. Fill Type III: Angular crushed washed stone; free of shale; clay, friable material, organic material

and debris, meeting the following requirements:

1. Graded.
  2. 100-percent passing the 2-inch sieve.
  3. Not more than 5-percent of material passing the No. 200 sieve.
- D. Fill Type IV: Natural stone; washed, free of clay, shale, and organic matter.
1. Graded in accordance with ASTM C 136, within the following limits:
    - a. Minimum Size: ¼-inch.
    - b. Maximum Size: 5/8-inch.
- E. Fill Type V: Free draining granular backfill material; natural or crushed aggregate.
1. Graded in accordance with ASTM C 136, within the following limits:
    - a. 2-inch sieve: 100-percent passing.
    - b. 1-inch sieve: 95 to 100-percent passing.
    - c. ½-inch sieve: 25 to 60-percent passing.
    - d. No. 4 sieve: 0 to 10-percent passing.
- F. Fill Type VI: Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter.
1. Graded in accordance with ASTM C 136; within the following limits:
    - a. No. 4 sieve: 100-percent passing.
    - b. No. 14 sieve: 10 to 100-percent passing.
    - c. No. 50 sieve: 4 to 30-percent passing.
    - d. No. 100 sieve: 4 to 30-percent passing.
    - e. No. 200 sieve: 0-percent passing.
- G. Fill Type VII: Topsoil excavated on-site.
1. Graded.
  2. Free of roots, rocks larger than ½-inch, subsoil, debris, large weeds and foreign matter.
  3. Acidity range (pH) of 5.5 to 7.5.
  4. Containing a minimum of 4-percent and a maximum of 25-percent inorganic matter.
  5. Conforming to ASTM D 2487 Group Symbol OL or OH.
- H. Fill type VIII: Material excavated during trenching operations, not conforming to Type II requirements.
1. May only be used as trench backfill if recommend by the geotechnical engineer of record and approved by the City Inspector and City Engineer.
  2. Geotechnical engineer of record shall define placement and compaction methods.
  3. Contractor and/or Developer shall employ and pay for full-time quality control services of the geotechnical engineer of record.
  4. Upon completion of the project, the geotechnical engineer of record shall prepare a letter

summarizing:

- a. Testing methods, test frequencies and observations.
- b. Any non-conforming condition(s) and corrective action(s) taken to remedy the non-conformity(ies).
- c. Compliance of the work to the project specifications.

I. Concrete for Fill: Lean concrete.

1. Conforming to Flowable Fill, Section 605 of the Utah Department of Transportation's Standard Specifications.

**2.03 QUALITY CONTROL**

- A. See Section 01400 – Quality Requirements, for general requirements for testing and analysis of soil material.
- B. If tests indicate materials do not meet specified requirements, promptly change material and retest.
- C. Provide materials of each type from same source throughout the Work.

**PART 3 -- EXECUTION**

**3.01 EXAMINATION**

- A. Identify required lines, levels, contours, and datum locations.
- B. Verify structural ability of unsupported walls to support imposed loads by the fill.

**3.02 TRENCH BACKFILL**

- A. Fill to finish contours and elevations indicated.
- B. Fill up to subgrade elevations where indicated.
- C. Employ a placement method that does not disturb or damage other work.
- D. Do not fill over porous, wet, frozen, or spongy subgrade surfaces.
- E. Maintain moisture content of fill materials within 2-percent of optimum moisture as determined by ASTM D 698 or ASTM D 1557 to attain required compaction density.
- F. Place and mechanically compact materials in equal continuous layers not exceeding 8-inches in compacted depth.
- G. Reshape and re-compact fills subjected to vehicular traffic.
- H. Pipe Zone

1. Use granular fill, Type III; or other acceptable material.
2. Fill under, around and over sewer pipe as indicated on the “Standard Sewer Trench Detail” drawing.
3. Use Lean Concrete fill material in areas of excessive cover over pipe, as directed by the City Inspector.
  - a. Excessive cover shall be determined by pipe manufacturer and approved by City Inspector
4. Compact to at least 96-percent of the maximum dry density as determined by the standard Proctor method (ASTM D 698) or to at least 91-percent as determined by the modified Proctor compaction method (ASTM D 1557).

I. Trench Backfill above Pipe Zone

1. Use Fill Type II, Type VIII or local governing entities’ specification if more stringent.
2. Fill up to subgrade elevations or finish grade, as indicated.
3. Compact at least 96-percent of the maximum dry density as determined by the modified Proctor compaction method (ASTM D 1557) or to local governing entities’ specification, if more stringent.

J. Under curb and gutter, sidewalks, slabs-on-grade, and other concrete work:

1. Use granular fill, Fill Type II or III.
2. Compact to at least 96-percent of the maximum dry density as determined by the standard Proctor method (ASTM D 698) or to at least 91-percent of the maximum dry density as determined by the modified Proctor compaction method (ASTM D 1557).

K. At Landscaped Areas

1. Use general fill, Fill Type I or Fill Type VIII.
2. Fill up to 4-inches below finish grade elevations.
3. Compact to at least 91-percent of the maximum dry density as determined by the modified Proctor compaction method (ASTM D 1557).

- L. After placement, compaction and testing of mechanically compacted backfill is completed, Contractor may utilize other compaction methods when accepted by the City Inspector and/or City Engineer.

**3.03 SURFACE RESTORATION**

- A. Where required, restore surface to as near original condition as is reasonably possible.

**3.04 QUALITY CONTROL**

- A. See Section 01400 – Quality Requirement, for general requirements for field inspection and testing.
- B. All testing is to be done by an independent testing company for the Contractor and/or Developer,

test results for all tests will be sent to the City Inspector within 24-hours after the tests have been completed.

- C. Perform compaction, moisture and density testing on compacted fill in accordance with ASTM D 1556, ASTM D2167, ASTM D 2922, or ASTM D 3017.
- D. Evaluate results in relation to compaction curve determined by testing material in accordance with ASTM D 698 (“standard Proctor”), ASTM D 1557 (“modified Proctor”).
- E. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.
- F. Frequency of Tests: As directed by the City’s Inspector with at least one test for each 200 CY of material.
- G. The City Inspector shall have the right to determine when and where all soil testing shall be performed.
- H. Contractor shall provide excavation and safety equipment for test holes used in quality assurance testing as directed by the City Inspector, at no cost to the City.
- I. The City may perform additional quality assurance testing to verify conformance with these specifications.
  - 1. Contractor shall provide excavation and safety equipment for test holes used in quality assurance testing as directed by the City Inspector.

### **3.05 CLEANUP**

- A. Remove unused stockpiled materials; leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
- B. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.
- C. The following shall be performed on a continuous basis to the full and complete satisfaction of the City’s Resident Project Representative:
  - 1. During progress of the work, keep premises free of debris and waste materials.
  - 2. As directed during work progress, immediately remove all debris, rubbish, left over materials, tools and equipment from the site.

\*\*\* END OF SECTION \*\*\*

## SECTION 02606

### MANHOLES

#### **PART 1 -- GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Cast-in-place concrete manholes with masonry or precast transition to lid frame, covers, anchorage, and accessories.
- B. Modular precast concrete manhole sections, with precast or cast-in-place bases, with tongue-and-groove joints, masonry or precast transition to lid frame, covers, anchorage, and accessories.

##### **1.02 RELATED SECTIONS**

- A. Section 03300 – Cast-in-Place Concrete
- B. Section 03302 – Concrete
- C. Section 02204 – Earthwork
- D. Section 02667 - Hydraulic Structures and Pipeline Testing
- E. Section 02617 - Reinforced Concrete Pipe

##### **1.03 REFERENCE DOCUMENTS**

- A. ASTM A 48: Standard Specification for Gray Iron Castings; 1994a.
- B. ASTM C 478: Standard Specification for Precast Reinforced Concrete Manhole Sections; 1996.
- C. ASTM C 923: Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals; 1996.

##### **1.04 SUBMITTALS**

- A. See Section 01300 – Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate manhole locations, elevations, piping sizes and elevations of pipe inverts.
- C. Product Data: Provide manhole covers, component construction, manhole steps, features, configuration, and dimensions.

##### **1.05 QUALITY ASSURANCE**

- A. Manufacturer – Company specializing in manufacturing products specified in this Section with at least three years of documented experience.

## **PART 2 -- PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Amcor, Inc.
- B. D&L Supply Company
- C. Geneva Pipe Company
- D. Olympic Foundry
- E. Substitutions – See Section 01600 – Product Requirements

### **2.02 PRECAST SECTIONS**

- A. Manhole Base: Precast concrete manhole base of appropriate size.
  - 1. Provide appropriate size flexible sleeves of synthetic rubber, with stainless steel clamps and bolts, for all pipe openings in base section.
  - 2. Construct poured-in-place manhole base where manhole is to be constructed over existing wastewater pipeline, as directed by the City Inspector. Manhole base shall be constructed as indicated on the Drawings.
- B. Manhole Rise Sections: Precast riser sections of appropriate size and length, extending from top of base section to bottom of top section.
- C. Manhole Sections: Reinforced Precast concrete in accordance with ASTM C 478 (ASTM C 478M), with gaskets in accordance with ASTM C 923 (ASTM C 923M).
- D. Manhole Top Section: Precast eccentric cone section of appropriate size, with 30-inch diameter top opening.
  - 1. Flat slab top sections can be used only where indicated on the plan drawings and accepted by the City Inspector; designed for H-20 live loading.
- E. Joints: Base section, riser sections, and top section shall have lipped male/female ends, which shall provide uniform and continuous interior wall surface.
  - 1. Joints shall be sealed with pre-lubricated rubber gaskets, conforming to requirements of ASTM C 443 and C 361; Forsheda No. 114 Seal, manufactured by Forsheda Pipe Seal Company, or approved equal.
- F. Grade Rings: Precast grade rings, as required, to adjust height of manhole lid and frame.
  - 1. Grade rings shall use mastic sealer to insure watertight installation.
- G. Lid and Frame: ASTM A 48 Class 30B Cast iron construction, machined flat bearing surface, removable lid with cleated surface and pick holes, lockable lid if indicated, vented lid design in improved areas and solid lid design in unimproved areas, H-20 highway load rating; lid molded with City of West Jordan imprinted on lid; Provide Model A-1180 manufactured by D & L Supply, or

approved equal.

- H. Manhole Steps: Formed, copolymer polypropylene-encased, steel rungs; ¾-inch diameter minimum. Cast-in-place or vibrate into green concrete. Model PSI-FF manhole steps, manufactured by M.A. Industries, Inc. or approved equal.
- I. Collars: Constructed of concrete or bituminous as indicated on the Drawings.
- J. In locations with pipes 18-inches in diameter and larger and in locations where required by the City Engineer, concrete materials shall be manufactured with Dynastone in conformance with applicable specifications and standards.

## **2.03 INTERIOR COATING**

- A. Manhole Interior Coating: Coating shall be a polymorphic resin as manufactured by Integrated Environmental Technologies, or approved equal. Such coating system shall be as detailed in "Specification 3000" for "Manhole Renovation & Protection" as published by Integrated Environmental Technologies, a copy of "Specification 3000" is appended at the end of this specifications. Coatings shall be installed as indicated on Drawings.

## **2.04 CONFIGURATION**

- A. Manholes shall be constructed as indicated on the Standard Manhole Drawing.
- B. Shaft Construction: Concentric with eccentric cone tope section; lipped male/female joints; sleeved to receive pipe sections.
- C. Shape: Cylindrical.
- D. Clear Inside Dimensions: 48-inch, 60-inch, or 72-inch diameter, as indicated.
- E. Design Depth: As indicated.
- F. Clear Lid Opening: 30-inch diameter, as indicated.
- G. Pipe Entry: Provide openings for all pipes entering manhole, as indicated.
- H. Steps: Install at 12-inches on center vertically, set into manhole wall directly under opening.

## **PART 3 -- EXECUTION**

### **3.01 EXAMINATION**

- A. Verify items provided by other sections of the Work are properly sized and located.
- B. Verify that built-in items are in proper location, and ready for roughing into Work.

- C. Verify excavation for manholes is correct.

### **3.02 PREPARATION**

- A. Where native material encountered at foundation depth of manhole is considered unsuitable, remove unsuitable material; and place and compact bedding material to limits shown on the Drawings.

### **3.03 MANHOLES**

- A. Install precast manhole base level on a compacted foundation.
- B. Construct cast-in-place manhole base over existing wastewater lines, as acceptable to the City Inspector. Manhole base shall be constructed as indicated on the Standard Drawings.
  - 1. After new manhole has been completed, saw-cut into top of existing wastewater pipe, remove section of pipe as required, and dispose of the removed material; construct watertight grout invert channels through new manhole between new pipe and existing pipe line, as directed. Invert channel shall be formed to direct wastewater flows through the manhole as directed.
  - 2. Divert existing wastewater flows around work area to allow connection to existing pipeline to be made.
- C. Place manhole rise sections plumb and level, from the manhole base to the top section, as indicated and according to manufacturer's instructions; anchor to base; align steps perpendicular to wastewater line, and seal joints.
- D. Place top section, cone section or flat slab, on top riser section, with opening positioned over steps. Top of cone section or flat slab shall be from 10-inches to 18-inches below final surface elevation, as directed by the City Inspector.
- E. Install grade rings, as required, to adjust top of lid and frame to match finish elevation. Maximum height of grade rings shall be 12-inches, unless otherwise approved by the City Engineer.
- F. Connect pipe to manhole with appropriate type flexible coupling as recommended by manufacturer. Provide pipe joint or flexible coupling on all pipes approximately 18-inches from outside of manhole. Grout around pipe after installation is complete. Make connections watertight.
- G. Provide wastewater pipe stubs for future connections of the same type of pipe used on the Project, and of the size indicated on the Drawings.
  - 1. Alignment and grade of stub to be determined by the Design Engineer.
  - 2. Install permanent, watertight plug or cap on end of stub, outside of the manhole.
- H. Grout inside of manhole base sections to form channel between connected pipes, as indicated on the Drawings. Trowel smooth. Top of channel shall be the same elevation as top of outlet pipe.
- I. Set cover frames and lids to match street elevation and slope. After placement, grout around the exterior of frame from top of concrete top section to top of frame, as indicated, to ensure watertight

condition.

- J. After manhole base has been completed, furnish and install temporary pipe plugs to seal all interior pipe openings; plugs to be Brandt DuoSeal Pipe Plug by Burke Rubber Company, Cheme Pipe Plug by Cheme Manufacturing Company, or approved equal. Pipe plugs shall remain in place until final review and acceptance of completed wastewater system. Plugs shall then be removed; and shall be the property of the Contractor.
- K. In paved areas, collars shall be constructed around manhole covers as indicated. Collars shall be constructed of either concrete or bituminous asphalt; and shall be constructed after new pavement has been placed and accepted by the City Inspector and/or Governing Agency. Concrete collars shall contain synthetic fiber reinforcement as per Section 03300 – Cast-in-Place Concrete.
- L. Coordinate with other sections of Work to provide correct size, shape and location.
- M. Drop manholes shall not be designed or constructed without written approval of the City Engineer. Where approved, drop manholes shall be constructed as indicate in the Standard Drawings.
- N. One-foot manhole rise sections will not be allowed, unless previously approved by the City Engineer.

### **3.04 INTERIOR COATING**

- A. Manhole Interior Coating. The interior of all new manhole sections shall be lined with a polymorphic resin coating system. The application of this coating system shall be as detailed in "Specification 3000" for "Manhole Renovation & Protection" as published by Integrated Environmental Technologies, a copy of "Specification 3000" is appended at the end of this specifications. The specified mechanical application of the coating system may be waived providing skilled workmen, with prior experience in applications of polymorphic resin coatings, by other means, are used Documentation of workmen's' experience will be required.

### **3.05 QUALITY CONTROL**

- A. Manholes shall be tested, by an independent testing company, using vacuum test method to demonstrate the integrity of installed materials and construction procedures. Method and material for repair shall be as acceptable to the City Engineer.
  - 1. Each manhole shall be tested after assembly and backfilling.
  - 2. Plug all lift holes with an acceptable non-shrink grout.
  - 3. Plug all pipes entering manhole; securely brace plugs during test.
  - 4. Test head shall be placed at inside top of cast iron frame, or as accepted by the City Engineer; and the seal shall be inflated in accordance with manufacturer's recommendations.
- B. Testing shall conform to ASTM C 1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test.
- C. If manhole fails initial test, make all necessary repairs on the outside of manhole with non-shrink grout, or other acceptable material. Manhole shall be re-tested until satisfactory test is obtained.

- D. Pour-in-place manholes to be constructed of Dynastone shall be overseen by the City Inspector and a quality assurance representative from the manhole supplier and/or manufacturer.

\*\*\* END OF SECTION \*\*\*

**SECTION 02608**  
**DIVERSION STRUCTURES**

**PART 1 -- GENERAL**

**1.01 SECTION INCLUDES**

- A. Cast-in-place concrete diversion boxes.
- B. Pre-cast concrete diversion boxes.
- C. Heavy duty sluice gates.

**1.02 RELATED SECTIONS**

- A. Section 02312 – Trench Excavation
- B. Section 02316 – Trench Backfill and Compaction
- C. Section 02640 – Manholes and Covers.
- D. Section 03300 – Cast-in-Place Concrete

**1.03 SUBMITTALS**

- A. Product Data : Provide component construction data, configuration and dimensions.
- B. Operations and Maintenance Manuals: Submitted upon completion of the Project.

**1.04 QUALITY ASSURANCE**

- A. Manufacturer : Company specializing in manufacturing products specified in this Section with at least three years of documented experience.

**1.05 PROJECT CONDITIONS**

- A. Coordinate the Work on existing wastewater lines and connections with the City.

**PART 2 -- PRODUCTS**

**2.01 MATERIALS**

- A. Concrete: Specified in Section 03300.

B. Concrete Reinforcement: Specified in Section 03300.

## **2.02 COMPONENTS**

A. Manhole Steps: As specified in Section 02640.

B. Lid and Frame: As specified in Section 02640.

C. Hatch: Shall be Safe-Hatch as manufactured by Flygt. Size and load capacity as indicated on the Drawings.

D. Sluice Gates: Shall be Fresno Valves & Castings Series 8200 fabricated 316 stainless steel slide gates. Gates shall have poly bars, "J" seals, flush bottom seals, and geared lifts. Gates shall have non-rising stems, stems shall not be in the water flow. Gates shall include a lift torque arm bracket compatible with the Waterman GMH-12 hydraulic operator. Proper design shall be used to withstand head pressures required for the Project. Manufacturer shall be established for more than 5-years with proven capabilities of design and performance.

E. Miscellaneous Components: Other items shall be corrosion resistant as approved by the City Engineer.

F. Where required by the City Engineer, all concrete materials shall be manufactured by Dynastone®, or approved equal.

## **2.03 INTERIOR COATING**

A. Interior Coating: Coating shall be a polymorphic resin as manufactured by Integrated Environmental Technologies, or approved equal. Such coating system shall be as detailed in "Specification 3000" for "Manhole Renovation & Protection" as published by Integrated Environmental Technologies, a copy of "Specification 3000" is appended at the end of this specifications. Coatings shall be installed as indicated on Drawings.

## **2.04 CONFIGURATION**

A. Diversion Boxes shall be constructed as per the approved Drawings.

B. Channels shall be constructed to minimize turbulence in flows.

## **PART 3 -- EXECUTION**

### **3.01 EXAMINATION**

A. Verify items provided by other sections of the Work are properly sized and located.

B. Verify that built-in items are in proper location, and ready for roughing into Work.

- C. Verify excavation for diversion box(es) is correct.

### **3.02 PREPARATION**

- A. Where native material encountered at foundation depth of diversion box is considered unsuitable, remove unsuitable material; and place and compact bedding material to limits shown on the Drawings.

### **3.03 DIVERSION BOXES**

- A. Construct cast-in-place diversion box over existing wastewater lines, as shown on the Drawings.
- B. Install sluice gates as per manufacturer's instructions.
- C. Boxes shall be constructed to ensure the City can open and close gates easily with City's hydraulic operator.

### **3.04 INTERIOR COATING**

- A. Manhole Interior Coating: The interior of all new manhole sections shall be lined with a polymorphic resin coating system. The application of this coating system shall be as detailed in "Specification 3000" for "Manhole Renovation & Protection" as published by Integrated Environmental Technologies, a copy of "Specification 3000" is appended at the end of this specifications. The specified mechanical application of the coating system may be waived providing skilled workmen, with prior experience in applications of polymorphic resin coatings, by other means, are used Documentation of workmen's' experience will be required.

### **3.05 QUALITY CONTROL**

- A. Diversion Boxes shall be tested, by an independent testing company, using vacuum test method to demonstrate the integrity of installed materials and construction procedures. Method and material for repair shall be directed by the Design Engineer and acceptable to the City Engineer.
  - 1. Each box shall be tested after assembly and backfilling.
  - 2. Plug all lift holes with an acceptable non-shrink grout.
  - 3. Plug all pipes entering diversion box; securely brace plugs during test.
  - 4. Test head shall be placed at inside top of cast iron frame, or as accepted by the City Engineer; and the seal shall be inflated in accordance with manufacturer's recommendations.
- B. Testing shall conform to ASTM C 1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test.
- C. If diversion box fails initial test, make all necessary repairs on the outside of box with non-shrink grout, or other acceptable material. Box shall be re-tested until satisfactory test is obtained.

\*\*\* END OF SECTION \*\*\*

## SECTION 02617

### REINFORCED CONCRETE PIPE

#### **PART 1 -- GENERAL**

##### **1.01 SCOPE OF WORK**

- A. The Contractor shall furnish, install, and test all reinforced concrete sewer, culvert and storm drain pipelines, complete in place, including connection to existing and new structures, all in accordance with the requirements of the Contract Documents.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Construction of catch basins and headwalls shall conform to the requirements of Section 03300 entitled, "Cast-in-Place Concrete," Section 03304 "Minor Concrete," and Section 03480 "Precast Concrete Specialties," as applicable.
- B. Trenching and backfilling shall conform to the requirements of Section 02316 "Trench Backfill and Compaction."
- C. Manhole construction shall conform to the requirements of Section 02606 "Manholes."
- D. Field testing shall conform to the requirement of Section 02750 "Storm Drainage System Testing."

##### **1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS**

- A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publication are in conflict with the requirements specified herein, the more stringent requirement shall apply.

##### **1.04 CONTRACTOR SUBMITTALS**

- A. The Contractor shall furnish certificates to the Engineer guaranteeing that the pipe furnished hereunder is in compliance with the requirements of these Specifications.
1. Commercial Standards:
    - ASTM C33 Specifications for Concrete Aggregate
    - ASTM C76 Specification for Reinforced Concrete Culvert Storm Drain and Sewer Pipe
    - ASTM C150 Specifications for Portland Cement
    - ASTM C443 Specifications for Rubber Gaskets

## **PART 2 -- PRODUCTS**

### **2.01 PIPE MATERIALS**

- A. Reinforced Concrete Pipe: Reinforced concrete pipe shall conform to the requirements of ASTM Designation C 76-82b with Type V cement; provided that pipe shall have tongue and groove joint designated to be self-centering and to leave a recess on the inside of the pipe for pointing with mortar after jointing. Pipe shall be designated for an internal pressure of 25-feet of water, and an external load of 1500-D.
- B. Cement Mortar: Cement mortar shall consist of a mixture of portland cement, sand, and water. Cement and sand shall first be combined in the proper proportions, and then thoroughly mixed with the required amount of water.
- C. Cement mortar shall be designated by class and proportioned by loose volume in the proportion of 1 part cement and 2 parts sand.
- D. The quantity of water to be used in the preparation of mortar shall be only that required to produce a mixture sufficiently workable for the purpose intended.
- E. Mortar shall be used as soon as possible after mixing and shall show no visible signs of setting prior to use. Retempering of mortar will not be permitted.
- F. Cement, sand, and water for cement mortar shall conform to the requirements of Section entitled, "Cast-in-Place Concrete."
- G. Admixtures: No admixture shall be used in mortar unless otherwise specified or accepted by the Engineer.
- H. Quick Setting Grout: Quick setting grout shall be a high strength, non-staining grout approved by the Engineer prior to use. It shall reach an initial set within 90 minutes at 70 degrees F (21 degrees C) and shall reach minimum compressive strength of 2,500 psi (17mPa) within 24 hours. Shrinkage shall be less than 0.1 percent when tested, using the test procedures of ASTM C 596-82. The grout shall be mixed, handled, and placed in accordance with the manufacturer's written instructions.

## **PART 3 -- EXECUTION**

### **3.01 INSTALLATION**

- A. The pipe shall be placed with the minor axis of the reinforcement in a vertical position. Mortar for jointing pipe shall be composed of 1 part of cement and 2 parts of clean, well-graded sand of such size that all will pass a No. 8 sieve. The consistency of laying mortar shall be such that it will adhere to the ends of the pipe while being laid and be easily squeezed out of the joint when the pipe while being laid and be easily squeezed out of the joint when the pipe sections are pressed together. Pointing and bonding mortar shall be plastic and of such consistency that it will readily adhere to the pipe.

- B. In advance of jointing sections of concrete pipe, the ends of each section shall be washed clean with a wet brush and, immediately prior to placing mortar and jointing the sections, the ends shall be thoroughly wetted. After laying, the joints on the inside shall be swabbed smooth, and all excess mortar shall be removed from the pipe, after which backfilling shall be performed.
- C. Backfill over the pipe shall not be commenced within 16 hours of jointing pipe sections. Care shall be used to make sure that the bottom of the pipe is in contact with the bottom of the trench for the full length of each section.

\*\*\* END OF SECTION \*\*\*

## SECTION 02618

### REINFORCED CONCRETE PRESSURE PIPE

#### **PART 1 -- GENERAL**

##### **1.01 SCOPE OF WORK**

- A. The Contractor shall construct and test all reinforced concrete pressure pipe, ANSI/AWWA C302, non-cylinder type, complete in place, all in accordance with the requirements of the Contract Documents.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Trench excavation and backfill and appurtenant earthwork shall conform to the requirements of Section entitled, "Earthwork," and the requirements specified herein.
- B. Concrete for construction of anchor blocks and thrust blocks shall conform to the requirements of Section entitled, "Cast-in-Place Concrete," and "Minor Concrete," as applicable.
- C. Field testing and disinfection shall conform to the requirements of Section entitled, "Water Pipeline Testing."
- D. Fabricated pipe fittings, bends, and anchor bolts shall conform to the requirements of Section entitled, "Miscellaneous Metalwork."
- E. Valve supports, flange bolts, and anchor bolts shall be as specified in Section entitled, "Steel Pipe - Fabricated Specials."
- F. Valves and appurtenances shall conform to the requirements of the applicable Sections of Division 15.

##### **1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS**

- A. Without limiting the generality of other requirements of these specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced AWWA Standards to the extent that the requirements therein are not in conflict with the provisions of this Section.
- B. References in these specification to "AWWA Standards" shall be as published by the American Water Works Association, Incorporated, 2 Park Avenue, New York, New York, 10016.

##### **1.04 CONTRACTOR SUBMITTALS**

- A. The Contractor shall submit certificates, test reports, shop drawings and laying diagrams of all pipe, joints, and piping appurtenances in accordance with the requirements in Section entitled, "Contractor Submittals."

- B. A certified affidavit of compliance shall be furnished for all pipe and other products or materials furnished under this section of the specifications.
- C. If pipe is steam-cured, the Contractor shall furnish to the Engineer copies of recorder charts showing temperature and duration of the curing period.

### **1.05 QUALITY ASSURANCE**

- A. Shop Testing: All pipe shall be subject to a D-load test at the manufacturer's plant. The Engineer may select at random and test as specified one length of each class of pipe for the D-load test specified in ANSI/AWWA C302-81. The cost of the pipe and the tests shall be borne by the Contractor. Pipe will be acceptable under the test requirements specified herein when all test specimens conform to the test requirements. Should any of the test specimens fail to meet the test requirements, the manufacturer will be allowed to retest 2 additional specimens for each specimen that failed, and the pipe shall be acceptable only when all of the retest specimens meet the strength requirements.
- B. Field Testing: Field testing shall conform to the requirements of Section entitled, "Water Pipeline Testing."

## **PART 2 -- PRODUCTS**

### **2.01 REINFORCED CONCRETE PIPE**

- A. General: Reinforced concrete pressure pipe shall conform to ANSI/AWWA C302-81, "AWWA Standard for Reinforced Concrete Pressure Pipe, non-cylinder Type, for Water and Other Liquids," and the following provisions. Pipe shall have bell and spigot type joints with single rubber gaskets. Except where shorter lengths of special sections are required, pipe sections shall have a minimum length of 8 feet and a maximum length of 16 feet.
- B. Pipe Design: Pipe shall be designed for an internal pressure of not less than 50 feet of water, and an external load of 1500-D.
- C. Marking of Pipe: Each pipe section shall be identified by a stamp indicating:
  - 1. Name of manufacturer
  - 2. Date of manufacture
  - 3. Design pressure in feet of head
  - 4. D-loading in pounds.

### **2.02 PIPE MATERIALS AND FABRICATION**

- A. General: Materials used in the fabrication of reinforced concrete cylinder pipe shall conform to the following requirements:
- B. Cement: Cement shall conform to ASTM C 150-83a, Type II.

- C. Aggregate: All aggregates shall be obtained from approved pits, and shall conform to ASTM C 33-82.
- D. Rubber Gasket: Rubber gaskets, for use with bell and spigot pipe, shall conform to ANSI/AWWA C303-78.
- E. Cleanliness of Pipe: The interior of each pipe section and special shall be clean and free of foreign materials when they are delivered to the site of the work.

### **2.03 PIPE FITTINGS AND SPECIALS**

- A. Unless otherwise indicated in the Contract Documents, all pipe fittings and specials for reinforced concrete pipe shall meet the general requirements of Section entitled, "Steel Pipe Fabricated Specials."
- B. Specials are defined as bends, reducers, wyes, tees, crosses, outlets, and manifolds wherever located, and all piping above ground or in structures.

## **PART 3 -- EXECUTION**

### **3.01 PIPE HANDLING AND LAYING**

- A. General: All laying, jointing and testing for defects and for leakage under pressure shall be performed in the presence of the Engineer, and shall be subject to its approval before acceptance. All material found during the progress to have defects will be rejected and the Contractor shall promptly remove such defective material from the site of the work.
- B. Handling of Pipe and Accessories: Necessary facilities shall be provided for lowering and properly placing the pipe sections in the trench without damage. All handling of reinforced concrete pipe shall be done with fabric slings which will not damage the pipe. Slings shall bear uniformly against the pipe. When not being handled, all pipe shall be supported on timber cradles, sand bags, or mounds of earth.
- C. Alignment and Grade: The pipe shall be laid to the lines and grades shown on the drawings and the sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointing, the bedding for the pipe shall be checked for firmness and uniformity of surface.

### 3.02 INSTALLATION OF PIPING

- A. General: Unless otherwise provided, the Contractor shall furnish and install all pipe, closure pieces, supports, gaskets, jointing materials, and all other appurtenances as shown and as required to provide a complete and workable installation. Where pipe support details are shown, the supports shall conform thereto and shall be placed as indicated; provided, that the support for all exposed piping shall be complete and adequate regardless of whether or not supporting devices are specifically shown. Where shown, concrete thrust blocks shall be provided. At all times when the work of installing pipe is not in progress, all openings into the pipe and the ends of the pipe in trenches or structures shall be kept tightly closed to prevent entrance of animals and foreign materials. The Contractor shall take all necessary precautions to prevent the pipe from floating due to water entering the trench from any source, shall assume full responsibility for any damage due to this cause and shall at its own expense restore and replace the pipe to its specified condition and grade if it is displaced due to floating. The Contractor shall maintain the inside of the pipe free from foreign materials and in a clean and sanitary condition until its acceptance by the Owner.
- B. Handling Pipe: Pipe shall be lifted in such a manner as to minimize bending of the pipe section and prevent damage to the pipe. When being transported, pipe shall be supported in a manner that will prevent distortion or damage to the pipe. When not being handled, pipe shall be stockpiled on timber cradles or properly prepared ground with all rock points eliminated. Any pipe section that becomes damaged as a result of improper handling or stockpiling shall be repaired to the satisfaction of the Engineer or shall be replaced with a new unit at no additional cost to the owner.
- C. Laying: Trenches shall be in a reasonable dry condition when the pipe is laid. Necessary facilities including slings shall be provided for lowering and properly placing the pipe sections in the trench without damage. The pipe sections shall be laid to the line and grade shown and they shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointing, the bedding for the pipe shall be checked for firmness and uniformity of surface.
- D. Rubber Gasket Joints: The rubber gasket joint shall be made by properly lubricating the rubber gasket with a suitable vegetable compound soap before it is placed in the groove at the spigot end. The gasket shall be stretched over the spigot end of the pipe and carefully seated in the groove, with care taken to equalize the stress in the gasket around the circumference of the joint. The gasket shall not be twisted, rolled, cut, crimped, or otherwise injured or forced out of position during the closure of the joint. A feeler gage shall be used to check the position of the rubber gasket after the joint has been telescoped.
- E. With pipe smaller than 24 inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with mortar containing 1 part of a non-shrink, non-metallic cement to 3 parts sand. The spigot end then shall be forced to the bottom of the bell and excess mortar on the inside of the joint shall be swabbed out.
- F. With pipe 24 inches in diameter and larger, joints shall be pointed on the inside with mortar as specified above after the backfill has been placed.
- G. After the pipe has been laid, but before backfill has been completed, the outside annular space

between pipe sections shall be completely filled with grout. Grout shall consist of 1 part cement to 3 parts sand, by weight, and shall be sufficiently fluid to permit it to be poured into the joint space. The outside mortar joints shall be properly formed by the use of heavy-duty diapers.

- H. Curves, Angles, and Bends: Where curved alignments are indicated on the drawings, unsymmetrical closure of the spigot into the bell will be allowed up to  $\frac{3}{4}$  inch on one side of the joint. Where a smaller radius of curvature is required than can be accommodated by unsymmetrical closure, sections of pipe with bevelled ends may be laid on curved alignment unless fabricated bends are shown on the drawings. The spigot end of beveled pipe may have a maximum bevel of 5 degrees measured from a plane perpendicular to the pipe axis. The center of the short side of the bevel shall be marked on the pipe rings.

\*\*\* END OF SECTION \*\*\*

## SECTION 02621

### REINFORCED CONCRETE CYLINDER PIPE

#### **PART 1 -- GENERAL**

##### **1.01 SCOPE**

- A. The work of this Section, includes the construction and testing of reinforced concrete cylinder pipe, pretensioned type, complete in place, as indicated on the drawings and specified herein, all in accordance with the requirements of the Contract Documents.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Trench excavation and backfill and appurtenant earthwork shall conform to the requirements of Section entitled, ["Earthwork,"] and the requirements specified herein.
- B. Concrete for construction of anchor blocks and thrust blocks shall conform to the requirements of Section entitled, ["Cast-in-Place Concrete."]
- C. Field testing and disinfection shall conform to the requirements of Section entitled, ["Testing and Disinfection."]
- D. Protective coatings for exposed steel surfaces shall be as specified in Section entitled, ["Painting and Protective Coating."]
- E. Cadwelding shall conform to the requirements of Section entitled ["Insulated couplings and Test Stations."]
- F. Valve supports, flange bolts, and anchor bolts shall conform to the requirements of Section entitled, ["Miscellaneous Metalwork."]
- G. Valves and appurtenances shall conform to the requirements of Section entitled, ["Valves and Appurtenances."]

##### **1.03 REFERENCE SPECIFICATIONS AND STANDARDS**

- A. Without limiting the generality of other requirements of these specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced AWWA Standards to the extent that the requirements therein are not in conflict with the provisions of this Section.
- B. References in these specifications to "AWWA Standards" shall mean AWWA Standards as published by the American Water Works Association, Incorporated, 2 Park Avenue, New York, New York, 10016.

## **1.04 CONTRACTOR SUBMITTALS**

- A. The Contractor shall submit shop drawings and laying diagrams of all pipe, joints, bends, special fittings, and piping appurtenances in accordance with the requirements for ["Drawings Required to be Submitted by the Contractor"] in Section entitled, ["Contractor Submittals."]

## **1.05 QUALITY ASSURANCE**

- A. Shop Testing of Steel Plate Specials: Upon completion of the welding, but prior to lining and coating, each steel plate special shall be bulkheaded and tested under a hydrostatic pressure of 1½ times the design pressure; provided that if straight pipe used in fabricating the specials has been previously tested and meets the requirements of Paragraph 3.01(A), herein, no further hydrostatic testing will be required, provided that the transverse seams are tested by a dye-penetrant process using materials such as manufactured by Turco Products, Inc., Wilmington, California, or an approved equal. Any pin holes or porous welds which may be revealed by the test shall be chipped out and rewelded and the pipe fitting retested.
- B. No outside mortar shall be applied over a seam prior to testing; however, mortar lining may be applied over a seam prior to hydraulic testing, but under such conditions said pressure test shall be held on the pipe or fitting for a period of not less than 30 minutes.
- C. Shop Testing of Steel Pipe Cylinders: Each steel pipe cylinder, with joint rings welded to its ends but before lining and coating, shall be tested under hydraulic pressure to a stress of at least 22,000 psi, but not more than 25,000 psi and while under this stress the cylinder shall show no leaks, undue distortion, or other defects.
- D. After the pipe has been hydrostatically tested, longitudinal welds in the bell or spigot shall be tested by a dye-penetrant process such as Turco Dy-Check, or an approved equal. Any leaks shall be rewelded by hand and the pipe again tested. No caulking to stop leaks will be permitted.
- E. Field Testing: Field testing shall conform to the requirements of Section entitled, ["Testing and Disinfection."]
- F. A certified affidavit of compliance shall be furnished for all pipe, specials, fittings, and other products of materials furnished under this section of the specifications.

## **PART 2 -- PRODUCTS**

### **2.01 GENERAL**

- A. Reinforced concrete cylinder pipe shall conform to the requirements of AWWA Standard C303; except, that minimum cylinder wall thickness shall be 14 gage and shall conform to all the requirements specified herein and as indicated on the drawings. Minimum class of pipe shall be 150.
- B. The pipe shall be manufactured in sections having nominal lengths of 24 to 40 feet, except where

shorter lengths are required on curves, or where closure or special sections are required. The pipe shall consist of a welded steel mortar lining, continuous reinforcing rod helically wound, under measured tension, around the lined cylinder, and a cement mortar coating. Each end of each pipe section shall be provided with two 2-inch by 4-inch wood struts placed at right angles with each other to prevent the pipe from becoming out-of-round prior to installation. Bracing shall limit the deflection in any pipe section to not more than ½ of one percent of the pipe diameter during both manufacture and field installation of the pipe.

- C. While the pipe is stored in the manufacturer's yard and while in transit to the job site, the pipe ends shall be bulkheaded with heavy plastic or other suitable material to prevent the lining from drying out. The bulkheads shall remain in place until the pipe is installed. The pipe shall be furnished complete with rubber gaskets, buttstraps, and closure pieces where required.

## 2.02 MATERIALS

- A. Materials used in the fabrication of reinforced concrete cylinder pipe shall conform to the following requirements:
  - 1. Steel for pipe cylinders shall be hot-rolled carbon steel sheets conforming to the requirements of ASTM Designation A 36-74; or hot-rolled carbon steel sheets conforming to the requirements of ASTM Designation A 570-72, Grades, C, or D; or steel plates conforming to the requirements of ASTM Designation A 283-74, Grade D; except as modified herein. The minimum yield point of steel used for the fabrication of steel cylinders shall be 33,000 psi. The maximum carbon content of steel sheets shall be 0.25 percent.
  - 2. Cement for mortar coating and lining shall be portland cement conforming to the requirements of ASTM Designation C 150-74.
  - 3. Pipe coatings shall use Type V Cement; pipe linings shall use Type II or Type V cement.
  - 4. Aggregates for cement-mortar lining and coating shall conform to the requirements of ASTM Designation C 33-74 for fine aggregate.
  - 5. Water for use in cement mortar for lining and coating shall be potable, clean, fresh, and free from injurious amounts of mineral and organic substances.
  - 6. Gaskets and lubricant for pipe and fittings shall conform to the requirements of AWWA Standard C300-64 and shall be of the size and configuration recommended by the pipe manufacturer.

## 2.03 FABRICATION

- A. General: Pipe wall thickness to resist internal pressure shall be designed in accordance with the provisions of Chapter 6 of the AWWA M11 Steel Pipe Manual, "Steel Pipe Design and Installation": provided, that, unless otherwise shown on the drawings, wall thickness of the pipe shall be not less than the thickness required to resist an internal working pressure of 150 pounds per square inch or 14-gage, whichever is the greater. Pipe wall thickness shall also be designed to resist external pressures resulting from earth loads and HS-20-44 heavy trailer truck loads.
- B. Maximum stress due to the rated working pressure in the steel pipe shall not exceed 50 percent of the yield point of the material used, nor 16,500 psi, whichever is less.
- C. Fabrication of steel cylinder shall conform to the requirements of AWWA Standard C303 with the

following exceptions:

ASTM A 36-74 Plate  
ASTM A 283-74 Plate, Grade D  
ASTM A 570-72 Sheet, Grade C, or D

- D. The nominal diameter of the pipe shall be the inside diameter of the pipe after the lining has been installed.
- E. Steel Cylinders: One or more steel sheets may be used in fabricating each cylinder. Welds may be either straight or spiral. Full penetration welds will be required on butt welds. The welds when tested shall develop the full tensile strength of the adjoining sheets.
- F. Joints: Joints shall be the steel bell and spigot joint rings, rubber gasketed type conforming to the requirements of AWWA C303; flanged joints shall conform to the straps for field fillet welding, as indicated on the drawings. All joints not flanged or welded shall be bonded in conformance with the details shown on the drawings. Cadwelding method and materials and required cable shall conform to the applicable requirements of Section, entitled "Insulated Couplings and Test Stations." Subject to the approval of the Engineer the Cadwelded Connections may be welded to a blocked-out area, a chipped-out area, or other approved method. [Requirements for bonded joints and Cadwelding shall apply between the \_\_\_\_\_ as shown on the drawings.]
- G. The joints used shall have been thoroughly tested for water-tightness under pressure comparable to the design pressure. The pipe ends which have been formed to provide the bell and spigot ends necessary to accommodate the rubber gaskets or special joint or spigot rings may be welded to the ends of the pipe. The joint rings for rubber gasket joints shall be so designed that when the pipe is laid and the joint telescopes, the gaskets will be enclosed on all sides and will not be required to bear the weight of the pipe.
- H. Lining: Cement mortar lining applied at the time of fabrication shall conform to the requirements of AWWA Standard C303 and the following supplementary requirements:
1. All reinforced concrete cylinder pipe shall be lined with a minimum cement mortar ½-inch in thickness for pipe 10 inches to 16 inches; and ¾-inch for pipe larger than 16 inches.
  2. The thickness of the lining shall not vary more than 25 percent from that specified. The lining shall be applied centrifugally by a machine of a type that has been in approved commercial use for this purpose.
  3. After the mortar has been placed in the cylinder, it shall be revolved at a speed which will allow the mortar to level out to a uniform thickness throughout the pipe. This packing speed shall be maintained until the lining is thoroughly compacted and all surplus water removed from the mortar.
  4. The finished lining shall be smooth and uniform throughout. Gage rings shall be securely attached to the ends of the pipe to confine the mortar to the dimensions shown on the drawings.
  5. When the pipe is removed from the spinning machine, it shall be supported by slings around the pipe, or other suitable supports, so spaced that there will be no appreciable bending throughout the length of the section and the pipe shall be carried by these slings or other supports to the curing yards and set on properly spaced supports set level to prevent bending.

6. While the lining is attaining its initial set, sufficient stiffener rings shall remain on the pipe to keep the deviation from the mean diameter at any section from exceeding  $\frac{1}{2}$  of one percent.
  7. The lining shall be kept moist for a minimum period of 24 hours before applying the circumferential reinforcing rod and mortar coating. In the interim, the outside of the pipe shall be kept wet and the ends bulk headed. In lieu of water curing, steam curing may be used on a time-ratio basis of 4 hours water curing to 1 hour of steam curing.
- I. Exterior Coating of Piping for Buried Service: All pipe and fittings for buried service, including bumped heads, shall be coated with a  $\frac{3}{4}$ -inch, minimum, thickness of cement mortar over the circumferential reinforcing rod or 1-inch over the steel cylinder, whichever is greater. Unless otherwise shown on the drawings, exterior surfaces of pipe or fittings passing through valve structure walls shall be coated from the center of the wall or from the wall flange to the end of the underground portion of pipe or fitting.
  - J. Cement-mortar coating on the exterior of the pipe shall be applied by the brush-coating machine process or other approved process. The mortar shall consist of a mixture of cement and sand with not less than one part of cement to 3 parts of sand. The machine for applying the mortar to 3 parts of sand. The machine for applying the mortar coating shall have an adjustable speed of operation and shall travel along the length of the pipe as the mortar is applied. Immediately prior to the application of the mortar coating, a fluid mixture or neat cement shall be applied to the surface of the wire-wrapped cylinder. The machine shall apply the mortar in either a vertical or a horizontal direction.
  - K. The mortar shall strike the outside circumference of the pipe about midway of the diameter as the pipe revolves on its axis. Rebound may be reclaimed and reused as sand. The coating may be built as to the required thickness in one or more passes of the machine. The finished coating shall be firm, shall adhere tightly to the outside surface of the pipe, and shall be free from flaws, holidays, or other surface imperfections.
  - L. Handling of pipe after application of mortar coating shall be done with belt slings or other suitable support, and shall not be done until a minimum period of 8 hours has elapsed. All pipe shall be handled carefully, and the dropping or bumping of pipe will not be permitted. Pipe injured during handling shall be recoated or repaired in a manner satisfactory to the Engineer. After the pipe has been coated, the lining and coating shall either be kept moist by continuous sprinkling for a period of 6 days before being moved to the trench or it shall be steamcured for 36 hours, after which time it may be moved to the trench. During the curing period, the ends of the pipe shall be kept closed with plastic sheet or other suitable material.
  - M. Provision shall be made to protect the coating from erosion of the mortar during sprinkling. The date of coating shall be plainly marked on the inside of each pipe length.
  - N. Steel Plate Specials: Steel plate specials are defined as bends, reducers, outlets, and in structures and other specials. Except as otherwise provided herein, steel plate specials shall be fabricated from steel plate having a minimum wall thickness as determined by the following formula; except, that in no case unless otherwise shown on the drawings shall the wall thickness be less than  $\frac{3}{16}$ -inch or less than that required to resist an internal pressure of 150 pounds per square inch, or the external loads previously specified.

$$T = \frac{D \times P}{2 \times 10,000}$$

Where: T = Wall thickness in inches

D = Inside diameter of steel cylinder

P = Design pressure in pounds per square inch

- O. The design of all specials shall be submitted to the [Engineer] for review before fabrication is commenced. In all fabricated specials, a mark corresponding to the true vertical axis of the special shall be made on the top and bottom of each special.
- P. Fabrication and testing of steel plate specials shall conform to the following requirements:
1. Dimensions for steel pipe fittings shall conform to the requirements of AWWA Standard C208, except as modified herein.
  2. Outlets: Outlets shall be formed by welding cast or fabricated steel fittings, of suitable design, to the cylinder before the exterior mortar coating is placed around the fittings. Outlets 12-inch and smaller may at the option of the Contractor be fabricated from schedule 40 or heavier steel pipe in the standard outside diameters, i.e., 12¾ inch, 10¾ inch, 8\_ inch, 6\_ inch, and 4½ inch. Where so indicated, stiffener plates shall be provided designed according to the nomograph method described in the Journal of the American Water Works Association, Vol., 47, No. 6, June 1955, pp. 617 to 623. All other outlets shall be reinforced with steel collar pads designed for the specified pressure. The measurement from the outside of the pipe to the face of the flange shall be 12 inches, unless otherwise shown.
  3. Bends: Except as otherwise shown, where bends are specified the radius of bends shall be not less than 2½ times the pipe diameter. At the option of the Contractor, a bend may be welded to the adjacent pipe section.
  4. Materials: Except as otherwise provided herein, pipe material and methods of manufacture shall conform to the requirements of AWWA Standard C303 for "Reinforced Concrete Water Pipe - Steel Cylinder Type, Pretensioned."
  5. Steel Welding Fittings: Steel welding fittings shall conform to the requirements of ASTM Designation A 234-74.
  6. Flanges: Flanges shall be faced and drilled in accordance with ANSI dimensions, or in lieu thereof, shall meet the requirements of AWWA Standard C207 for the specific pressure rating of the adjacent pipe. All flanges shall be furnished with flat faces. All pipe flanges shall be attached such that the bolt holes will straddle the vertical axis of the pipe, unless otherwise shown on the drawings. Attachment of the flanges to the pipe shall conform to the applicable requirements of AWWA Standard C207, entitled, "Standard for Steel Pipe Flanges."
  7. Welding: All hand welding shall be done by welders certified in accordance with the provisions of Appendix II of the "American Standard Code for Pressure Piping" or in accordance with the requirements of AWWA Standard C206, "Standard for Field Welding of Steel Water Pipe Joints."
  8. Mortar Lining: Except as otherwise provided herein, steel plate specials, excepting bumped heads, shall be lined with cement mortar having a minimum thickness as specified for straight sections of pipe. A tolerance in the thickness of 25 percent, plus or minus, will be permitted.

Pipe shall be cleaned of all loose mill scale and rust and of all dirt, grease, or other objectionable matter. After cleaning the interior, the surface shall be coated with mortar. Wherever practicable, the plate specials shall be lined centrifugally. Fittings which are impracticable to line by the centrifugal process shall be coated by hand methods which will ensure a lining comparable to that obtained by the centrifugal process; the hand lining of such specials shall be reinforced with welded wire fabric as specified hereinafter. Cement, sand, and water meeting the requirements specified herein shall be mixed in the proportions of one part of portland cement to not more than 3 parts of sand. Just enough water shall be added for proper workability and to ensure uniform distribution around the circumference. The finished lining shall be smooth, dense, and uniform throughout. Immediately after lining, the pipe ends shall be bulkheaded and the pipe cured under sprinklers for not less than 7 days. The date of lining shall be plainly marked on the inside of each pipe length of pipe fitting.

9. Exposed Piping: Pipe and fittings which will be exposed to the atmosphere inside structures or above ground shall conform to the requirements of Section entitled, ["Mortar-Lined-and-Coated Steel Pipe,"] and shall be thoroughly cleaned and then given a shop coat of rust-inhibitive red lead primer and painted in conformance with the requirements of Section entitled, ["Painting and Protective Coating."]
10. Exterior Coating of Piping for Buried Service: All pipe and fittings for buried service, including bumped heads, shall be coated with a  $\frac{3}{4}$ -inch, minimum, unless otherwise shown on the drawings. Exterior surfaces of pipe or fittings passing through valve structure walls shall be coated from the center of the wall or from the wall flange to the end of the underground portion of pipe or fitting, unless otherwise shown on the drawings. The coating shall be reinforced with 2x4 inch - 12x12 gage welded wire fabric crimped so as to hold the wire approximately in the center of the mortar coating. The fabric shall be securely fastened to the pipe with welded clips or strips of steel. The wires spaced 2 inches on centers shall extend circumferentially around the pipe. The ends of reinforcement strips shall be lapped 4 inches and the free ends tied or looped to assure continuity of the reinforcement. Cement, aggregates, and water meeting the requirements of Section entitled, ["Cast-in-Place Concrete,"] shall be mixed in the proportions of one part of cement to not more than 3 parts of sand. No more than 4½ gallons of water shall be used per sack of cement. After the outside coating has been applied, the pipe shall be cured for 7 days after sprinkler. During the curing period, the ends of the pipe shall be kept closed with plastic sheet or other suitable material. Provision shall be made to protect the coating from erosion during sprinkling. The date of coating shall be plainly marked on the inside of each pipe length.

## **PART 3 -- EXECUTION**

### **3.01 PIPE HANDLING AND LAYING**

- A. General: All laying, jointing, testing for defects and for leakage under pressure, and disinfection, shall be performed in the presence of the [Engineer,] and shall be subject to this approval before acceptance. All material found during the progress to have defects will be rejected and the Contractor shall promptly remove such defective material from the site of the work.
- B. Handling of Pipe and Accessories: Necessary facilities shall be provided for lowering and properly placing the pipe sections in the trench without damage. All handling of reinforced concrete cylinder

pipe shall be done with fabric slings which will not damage the coating. Slings shall bear uniformly against the pipe. When not being handled, all pipe shall be supported on timber cradles, sand bags, or mounds of earth.

- C. Alignment and Grade: The pipe shall be laid to the lines and grades shown on the drawings and the section shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointing, the bedding for the pipe shall be checked for firmness and uniformity of surface.
- D. Minor changes of direction in the grade or alignment may be made by a deflection in the joint up to a maximum of  $\frac{3}{4}$ -inch on one side of the joint for pipe 20 inches in diameter and smaller, and up to a maximum of one inch on one side of the joint for pipe 24 inches in diameter and larger. For greater angular deflections, pipe with ends beveled up to a maximum of 5 degrees measured from a plane perpendicular to the pipe axis, may be used. Pipe lengths shorter than 40 feet may be used on curves. Where curves are required which have a shorter radius than can be accommodated by forming an angle in the joint sleeves, or where indicated on the drawings, special short-radius bends shall be provided.
- E. Trenching: Trenches shall have a maximum width equal to the outside diameter of the pipe plus 16 inches for pipes 12 inches in diameter and smaller, a maximum width equal to the outside diameter of the pipe plus 20 inches for pipe from 14 to 21 inches in diameter, and a maximum width equal to the outside diameter of the pipe plus 24 inches for pipe 24 inches and larger in diameter. The bottom of the trench shall be excavated uniformly to the grade indicated on the drawings, or as ordered by the [Engineer.]
- F. Laying: Exceptional care shall be taken in laying the pipe and making of field joints. Bumping of the pipe in the trench will not be permitted. Where indicated on the drawings, the joints shall be welded.

### **3.02 PIPE JOINTING**

- A. Field Welded Joints: All pipe shall have field welded joints where indicated on the drawings. All field welded joints shall conform to the requirements of AWWA Standard C206-62, and the following supplementary requirements:
  - 1. The bell end shall be circumferentially welded to the spigot end of the adjoining pipe. The weld shall be continuous, and ample bell holes shall be dug to permit proper welding.
  - 2. The field weld between the bell and spigot ends shall be made in 2 or more passes so as to build up a fillet weld having a minimum thickness of not less than the thickness of the steel cylinder. Size of filler rod shall be as indicated in the printed recommendations of the pipe fabricator.
  - 3. Prior to welding, the joints shall be made up by inserting the spigot into the bell.
  - 4. In the case of 20-inch pipe and smaller, before the spigot is inserted into the bell, the bell end of the pipe shall be daubed with mortar containing one part lumnite cement to not more than 3 parts of sand, inserting it into the bell, and forcing it to the bottom of the bell.
  - 5. In the case of 24-inch pipe and larger, the joints shall be pointed on the inside with mortar after the backfill has been placed.

- . Excess mortar on the inside shall be swabbed out.
  
- B. After the welding has been completed, inspected, and approved by the [Engineer,] the outside annular space between pipe sections shall be completely filled with grout. The grout shall be poured in such a manner that all exposed portions of the metal joint shall be completely protected with cement mortar. Grout used on the outside of the joints shall be a mixture of one part of cement to 3 parts of sand, by weight, and shall be sufficiently fluid to permit it to be poured into the joint space. The outside mortar joints shall be properly formed by the use of heavy-duty diapers. Grout shall be poured in one side of the top opening of the diaper only, until it completely surrounds the pipe joint and rises around the circumference of the pipe joint and begins to come out of the opposite side. Under on circumstances shall grout be allowed to enter on both sides of the pipe at the same time.
  
- C. Where buttstraps or closure pieces are used, both interior and exterior surfaces of the buttstraps, or closure pieces shall be given a coating equivalent to the factory-applied coating of the adjoining pipe sections. The exterior cement-mortar coating in such cases shall be similarly reinforced where the exposed length of the buttstrap or closure piece, as measured between the ends of the connected pipe sections, exceeds 4 inches. Pipes smaller than 24 inches in diameter shall have a 4-inch handhold provided at closure pieces so that the interior portions of the joints can be properly pointed.
  
- D. Rubber Gasket Joint: The rubber gasket joint shall be made by properly lubricating the endless rubber gasket after the joint has been telescoped.
  
- E. All pipe joints shall be pointed on the inside with mortar after the backfill has been placed. Excess mortar shall be removed from the inside of the pipe.
  
- F. After the pipe has been laid, but before backfill has been completed, the outside annular space between pipe sections shall be completely filled with grout. The grout shall be poured in such a manner that all exposed portions of the joint shall be completely protected with cement mortar. Grout used on the outside of the joints shall be a mixture of one part of cement and 3 parts of sand, by weight, and shall be sufficiently fluid to permit it to be poured into the joint space. The outside mortar joints shall be properly formed by the use of heavy-duty diapers. Grout shall be poured in one side of the top opening of the diaper only, until it completely surrounds the pipe joint out of the opposite side. Under no circumstances shall grout be allowed to enter on both sides of the pipe at the same time.
  
- G. Bonding: The pipe ends shall be carefully prepared for the bonding. Where pipe coating is removed, only enough to accommodate the welder shall be removed. Completed welds shall be tested for adherence after removing the slag. Connections to the pipe shall be thoroughly cleaned of slag and foreign material. The exposed metal shall be coated with epoxy putty and where required the mortar coating shall be repaired. All wiring shall be continuous without splices. Required length of slack shall be provided. Care shall be taken during backfilling to preserve bonding.

### **3.03 PIPE ANCHORAGE**

- A. Anchorage shall be by means of concrete thrust blocks (reaction backing) or welded joints at the Contractor's option. Anchorage shall be applied at all tees, dead ends, bends 11¼ degrees or greater, fire hydrants, and at points at reducers or in fittings where changes in pipe diameter occur.

Anchorage requirements shall be as indicated on the drawings.

\*\*\* END OF SECTION \*\*\*

## SECTION 02625

### DUCTILE IRON PIPE

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install ductile iron pipe and all appurtenant work, complete in place, all in accordance with the requirements of the Contract Documents.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Earthwork. 02200  
B. Cast-in-Place Concrete 03300 and Minor Concrete 03305 for construction of anchor blocks and thrust blocks as applicable.  
C. Water Pipeline Testing and Disinfection. 02666  
D. Protective Coating 09800 for exposed steel surfaces.  
E. Miscellaneous Metalwork 05500 for valve supports, flange bolts, and anchor bolts.  
F. Valves and Appurtenances. 15100, 15101, 15104, 15105, 15107, 15109, 15110, 15112, 15113, 15115

##### 1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of other requirements of these specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following documents to the extent that the requirements therein are not in conflict with the provisions of this Section.

1. Commercial Standards:

|                          |  |
|--------------------------|--|
| ANSI/AWWA C104/A21.4-80  | Lining for Ductile-Iron and Gray-Iron Pipe and Fittings for Water.                         |
| ANSI/AWWA C105/A21.5-82  | Polyethylene Encasement for Gray and Ductile Cast-Iron Piping for Water and Other Liquids. |
| ANSI/AWWA C110/A21.10-82 | Fittings, 3 in. Through 48 in. for Water and Other Liquids, Gray-Iron and Ductile-Iron.    |
| ANSI/AWWA C111/A21.11-80 | Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.            |
| ANSI/AWWA C115/A21.15    | Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges.                             |
| ANSI/AWWA C150/A21.50-81 | Thickness Design of Ductile-Iron Pipe.   |

|                          |   |
|--------------------------|---|
| ANSI/AWWA C151/A21.51-81 | Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds for Water and Other Liquids.          |
| ANSI/AWWA C209-84        | Cold Applied Coatings for the Exterior of Special Sections, Connections and Fittings for Steel Water Pipelines. |
| ANSI/AWWA C214-83        | Tape Coating Systems for the Exterior of Steel Water Pipelines.   |
| ANSI/AWWA C600-82        | Water Mains and Appurtenances, Installation of Ductile Iron.  |
| ASTM C150-85             | Specification for Portland Cement.  |

#### 1.04 CONTRACTOR SUBMITTALS

- A. Shop Drawings: The Contractor shall submit shop drawings of pipe and fittings in accordance with the requirements in Section entitled, "Contractor Submittals" 01300, the requirements of the referenced standards and the following supplemental requirements as applicable:
1. Certified dimensional drawings of all valves, fittings, and appurtenances.
  2. Line layout and marking diagrams which indicate the specific number of each pipe and fitting in the completed line. In addition, the line layouts shall include: the pipe station and invert elevation at all changes in grade or horizontal alignment; the station and invert elevation to which the bell end of each pipe will be laid; all elements of curves and bends, both in horizontal and vertical alignment; and the limits of each reach of restrained and/or welded joints, or of concrete encasement.
- B. Certification: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards and the following supplemental requirements:
1. Physical and chemical properties.
  2. Hydrostatic test reports.
- C. All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

#### 1.05 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.
- B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

- C. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.
- D. The Contractor shall perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.
- E. In addition to these tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

## **PART 2 -- PRODUCTS**

### **2.01 GENERAL**

- A. Mortar lined and polyethylene wrapped/tape coated ductile iron pipe shall conform to ANSI/AWWA C151, C104, C105, and C214, subject to the following supplemental requirements. The pipe shall be of the diameter and class shown, shall be furnished complete with rubber gaskets as indicated in the Contract Documents, and all specials and fittings shall be provided as required under the Contract Documents.
- B. Markings: The Contractor shall legibly mark all pipes and specials in accordance with the laying schedule and marking diagram. Each pipe shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. All special pipe sections and fittings shall be marked at each end with top field centerline. The word "top" shall be painted or marked on the outside top spigot end of each pipe section.
- C. Handling and Storage: The pipe shall be handled by use of wide slings, padded cradles, or other devices, acceptable to the Engineer, designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment which might injure the pipe coating/exterior will not be permitted. All other pipe handling equipment and methods shall be acceptable to the Engineer. Tape-coated pipe shall have the following additional requirements:
  - 1. It shall be the responsibility of the manufacturer of tape-coated ductile iron pipe to prevent damage of the coating which might be caused by handling and/or storage of the completed pipe at low temperature.
- D. The Contractor shall be fully liable for the cost of replacement or repair of pipe which is damaged.
- E. Stockpiled pipe shall be supported on sand or earth berms free of rock exceeding 3 inches in diameter. The pipe shall not be rolled and shall be secured to prevent accidental rolling.
- F. Strutting: Adequate strutting shall be provided on all specials, fittings, and straight pipe so as to avoid damage to the pipe and fittings during handling, storage, hauling, and installation.
- G. Laying Lengths: Maximum pipe laying lengths shall be 20 ft. with shorter lengths provided as required by the Drawings.

- H. Finish: The pipe shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing and roughness.
- I. Bonding and Electrical Conductivity: All pipe joints shall be bonded for electrical conductivity in accordance with the details shown on the Drawings.
- J. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing shown on the Drawings. The locations of correction pieces and closure assemblies are shown on the Drawings. Any change in location or number of said items shall be acceptable to the Engineer.

**2.02 PIPE DESIGN CRITERIA**

- A. General: Ductile iron pipe shall be designed in accordance with the requirements of ANSI/AWWA C150 as applicable and as modified in this Section.
- B. Pipe Wall Thickness for Internal Pressure: The pipe shall be designed with a net thickness to withstand the design pressure in accordance with the hoop stress formula.
- C. Pipe Wall Thickness for External Load: The pipe shall also be designed with a net thickness to withstand internal loads using ANSI/AWWA C150 Design Equation (2) with the following constants:

$E^1$  = modulus of soil reaction 500  
 $K_b$  = bending moment coefficient 0.128  
 $K_x$  = deflection coefficient 0.085

- D. The pipe deflection shall be checked using ANSI/AWWA C150 Design Equation (3) and the constants stated above. The allowable deflection shall not exceed 0.015 times the inside diameter.
- E. In lieu of ANSI/AWWA C150 Design Equation (4), the earth loads will be computed using the following 2 equations for trench or embankment loading as applicable:

- 1. Trench condition: (Not Applicable)

$W_b = C_d w B_d^2$ ,  
 Where:  $C_d$  = Calculation Coefficient  
 $K_u^1 = 0.13$   
 $w = 120 \text{ lb/ft}^3$   
 $B_d$  = Trench width at top of pipe, feet

- 2. Positive projecting embankment condition: (All Piping)

$W_c = C_c w B_c^2$ ,  
 Where:  $C_c$  = Calculation Coefficient (based on  $r_{sdP}$  of 0.75)  
 $K_u = 0.19$   
 $w = 120 \text{ lb/ft}^3$   
 $B_c$  = Outside diameter of pipe, feet

- F. The above 2 formulas are based on a depth of cover of 10 feet or greater. For depths of cover of less

than 10 feet, HS-20 live load shall be included. For depths of cover of 3 feet or less, HS-20 live load plus impact shall be included. The determination of live load and impact factors shall be as recommended by AASHTO in "Standard Specifications for Highway Bridges."

- G. If the calculated deflection,  $Defl_x$ , exceeds 0.015 times the inside diameter, the pipe class shall be increased.
- H. Minimum Pipe Wall Thickness: In addition to the requirements of this Paragraph 2.02, the minimum wall thickness shall be in accordance with Table 50.5 of ANSI/AWWA C150.

### **2.03 MATERIALS**

- A. Ductile Iron Pipe: Pipe materials shall conform to the requirements of ANSI/AWWA C150 and ANSI/AWWA C151.
- B. Cement: Cement for mortar lining shall conform to the requirements of ANSI/AWWA C104; provided, that cement for mortar lining shall be Type II or V. A fly ash or pozzolan shall not be used as a cement replacement.
- C. Prefabricated Multi-layer Cold-Applied Tape Coating: Except as described below, the coating system for straight line pipe shall be in accordance with ANSI/AWWA C214. The system shall consist of at least four layers consisting of the following:
  - 1. primer layer
  - 2. inner layer tape - corrosion protective tape (20 mils)
  - 3. outer layer tape - mechanical protective tape (30 mils) with white exterior
  - 4. outer later tape - mechanical protective tape (30 mils) with white exterior

The total thickness of the tape coating shall be at least 80 mils.

- D. Polyethylene Sleeve: Material for the polyethylene sleeve shall conform to the requirements of ANSI/AWWA C105.

### **2.04 SPECIALS AND FITTINGS**

- A. Fittings for ductile iron pipe shall conform to the requirements of ANSI/AWWA C110/A21.10 for diameters 3-inch through 48-inch and shall have a minimum pressure rating of 250 psi. Ductile iron fittings larger than 48-inch shall conform to the above referenced standard with the necessary modifications for the larger size.

### **2.05 DESIGN OF PIPE**

- A. General: The pipe furnished shall be ductile iron pipe, mortar-lined-and polyethylene wrapped/tape-coated, with rubber gasketed joints as shown. The pipe shall consist of a centrifugally cast ductile iron, shop-lined with portland cement-mortar with a polyethylene sleeve or tape coating.
- B. The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements previously stated and except as hereinafter modified, shall conform to ANSI/AWWA

C151.

- C. Pipe Dimensions: The pipe shall be of the diameter and class shown. The minimum wall thickness for each pipe size shall be as specified or shown.
- D. Fitting Dimensions: The fittings shall be of the diameter and class shown.
- E. Joint Design: Ductile iron pipe and fittings shall be furnished with mechanical joints, push-on joints, flanged joints, and restrained joints as required.
  - 1. Mechanical and push-on joints shall conform to ANSI/AWWA C111/A21.11.
  - 2. Flanged joints shall conform to ANSI/AWWA C115/A21.15.
  - 3. Restrained joints shall be "Lok-Ring" Restrained Joint by American Ductile Iron Pipe, "TR FLEX" Restrained Joint by U.S. Pipe, or equal.
- F. For bell-and-spigot ends with rubber gaskets, the clearness between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The Contractor shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactory under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.
- G. Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe as shown on the Drawings or as otherwise acceptable to the Engineer.

**2.06 CEMENT-MORTAR LINING**

- A. Cement-Mortar Lining for Shop Application: Except as otherwise provided herein, interior surfaces of all steel pipe, fittings, and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C104. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work and shall be approved by the Engineer. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at delivery site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications at no additional cost to the Owner.
- B. The minimum lining thickness shall be as follows:

| Nominal Pipe Diameter (inches) | Lining Thickness (inches) |
|--------------------------------|---------------------------|
| Less than 24                   | $\frac{3}{16}$            |
| 24 or larger                   | $\frac{1}{4}$             |

- C. Protection of Pipe Lining/Interior: For all pipe and fittings with plant-applied cement mortar linings,

the Contractor shall provide a polyethylene or other suitable bulkhead on the ends of the pipe and on all special openings to prevent drying out of the lining. All bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.

## **2.07 EXTERIOR COATING OF PIPE**

- A. Exterior Coating of Exposed Piping: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer conforming to the requirements of Section entitled "Protective Coating." 09800
- B. Exterior Coating of Buried Piping: Prefabricated multi-layer cold-applied tape coating of pipe for buried service shall be applied in accordance with ANSI/AWWA C214 as modified by Paragraph 2.03C herein.

## **2.08 GLASS-LINED DUCTILE IRON PIPE**

- A. Glass-lined ductile iron pipe shall consist of ductile iron pipe with a glass lining fused to the metal base by firing the entire pipe or fitting to a temperature above 1400°F and held at this temperature for a sufficient time to develop and smooth, vitreous lining which has a molecular bond with the metal. The lining shall be a minimum of 0.010-inch thick and shall withstand an instantaneous thermal shock of 350°F differential, without crazing, blistering, or spalling. The lining shall be free of pinholes, which substantially expose the metal. The pipe and fittings shall be as specified in this Section. Buried pipe and fittings shall have mechanical couplings as indicated.

Field installation of glass-lined pipe shall limit the cutting of the pipe to one cut per run of pipe. Field cut shall not spall back from the cut section greater than   -inch. All cutting of pipe shall be in accordance with the manufacturer's recommendations. Additional field cuts shall be subject to approval of the Resident Project Representative. Excessive spalling, splintering or other defects as determined by the Engineer shall be caused for rejection of the pipe materials.

## **PART 3 -- EXECUTION**

### **3.01 INSTALLATION OF PIPE**

- A. Handling and Storage: All pipe, fittings, etc., shall be carefully handled and protected against damage, impact shocks, and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground but shall be supported in a manner which will protect the pipe against injury whenever stored at the trench site or elsewhere. Pipe shall be handled and stored at the trench site in accordance with Paragraphs 2.01C and 2.01E, herein. No pipe shall be installed where the lining or coating show cracks that may be harmful as determined by the Engineer. Such damaged lining and coating shall be repaired, or a new undamaged pipe shall be furnished and installed.
- B. All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.
- C. The Contractor, shall inspect each pipe and fitting to insure that there are no damaged portions of the

pipe.

- D. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance, which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the Work.
- E. Pipe Laying: The pipe shall be installed in accordance with ANSI/AWWA C600.
- F. Pipe shall be laid directly on the imported bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.
- G. Each section of pipe shall be laid in the order and position shown on the laying schedule. In laying pipe, it shall be laid to the set line and grade, within approximately one inch plus or minus. On grades of zero slope, the intent is to lay to grade.
- H. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such changes shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed the maximum deflection recommended by the pipe manufacturer. No joint shall be misfit any amount which will be detrimental to the strength and water tightness of the finished joint. In all cases the joint opening, before finishing with the protective mortar inside the pipe, shall be the controlling factor.
- I. Except for short runs which may be permitted by the Engineer, pipes shall be laid uphill on grades exceeding 10 percent. Pipe which is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. All bends shall be properly installed as shown on the Drawings.
- J. Pipe struts shall be left in place until backfilling operations have been completed for pipe 42 inches in diameter and larger. Struts in pipe smaller than 42 inches may be removed immediately after laying, provided, that the deflection of the pipe during after backfilling does not exceed that specified. After the backfill has been placed, the struts shall be removed and shall remain the property of the Contractor.
- K. Cold Weather Protection: No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.
- L. Pipe and Specials Protection: The openings of all pipe and specials where the pipe and specials have been cement mortar lined in the shop shall be protected with suitable bulkheads to maintain a moist atmosphere and to prevent unauthorized access by persons, animals, water or any undesirable

substance. The bulkheads shall be so designed to prevent drying out of the interior of the pipe. The Contractor shall introduce water into the pipe to keep the mortar moist where moisture has been lost due to damaged bulkheads. At all times, means shall be provided to prevent the pipe from floating.

- M. Pipe Cleanup: As pipe laying progresses, the Contractor shall keep the pipe interior free of all debris. The Contract shall completely clean the interior of the pipe of all sand, dirt, mortar splatter and any other debris following completion of pipe laying, pointing of joints and any necessary interior repairs prior to testing and disinfecting the completed pipeline.

### **3.02 RUBBER GASKETED JOINTS**

- A. Rubber Gasketed Joints: Immediately before jointing pipe, the spigot end of the pipe shall be thoroughly cleaned, and a clean rubber gasket lubricated with an approved vegetable-based lubricant shall be placed in the spigot groove. The volume of the gasket shall be "equalized" by moving a metal rod between the gasket and the spigot ring around the full circumference of the spigot ring. The bell of the pipe already in place shall be carefully cleaned and lubricated with a vegetable-based lubricant. The spigot of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted. After the pipe units have been joined, a feeler gage shall be inserted into the recess and moved around the periphery of the joint to detect any irregularity in the position of the rubber gasket. If the gasket cannot be "felt" all around, the joint shall be disassembled. If the gasket is undamaged, as determined by the Engineer, it may be reused, but only after the bell ring and gasket have been relubricated.

### **3.03 JOINT COATING AND LINING**

- A. General: The interior and exterior recesses shall be thoroughly wiped clean and all water, loose scale, dirt and other foreign material shall be removed from the inside surface of the pipe.
- B. Joint Coating and Tape-Coated Pipe: Joints for tape-coated pipe shall be primed and wrapped with 2 thicknesses of 12 inch wide elastomeric joint tape, Type II per ANSI/AWWA C209. The total thickness of the tape wrap shall be at least 70 mils and shall be installed free of wrinkles with all laps bonded. All primer and joint tape shall be compatible with the line pipe coating.
- C. All tape-coated joints will be tested by the Engineer with an electrical flaw detector capable of at least a 12,000 volt output, furnished by the Contractor. The tests shall be made using a voltage of 6,000 to 7,000 volts. Any holidays found shall be repaired by the Contractor at no expense to the Owner.
- D. Coating Repair: Coating repair shall be made using tape and primer conforming to ANSI/AWWA C209. When visual inspection shows a portion of the tape-wrap system has sustained physical damage, the damaged area shall be subjected to an electrical holiday test of 6,000 to 7,000 volts.
- E. Following repair of the damaged area if the holiday test indicates a holiday still exists, the inner wrap shall be exposed and the exposed area shall be wiped clean with xylol solvent, or equal, and the area coated with tape primer. A patch of 35-mil thick cold-applied tape of sufficient size to cover the damaged area, plus a minimum lap of 2 inches in all directions, shall then be applied. The patched area shall again be tested for holidays. If none are detected, a second layer of 35-mil thick tape shall

then be applied over the first patch. The second layer of tape shall overlap the first layer a minimum of 2 inches in all directions.

- F. When the area tests showing no holiday, a notation shall be applied to the area indicating the test is satisfactory.
- G. Coating of Fittings and Specials: Fittings and specials shall be coated in accordance with ANSI/AWWA C209. Prefabricated tape shall be Type II and shall be completely compatible with the tape system used for straight line pipe. The system shall consist of three layers consisting of the following:
1. primer layer
  2. inner layer tape - corrosion protective tape (35 mils)
  3. outer layer tape - corrosion protective tape (35 mils)

The joint thickness of the tape coating shall be at least 70 mils.

- H. Joint Lining: After the backfill has been completed to final grade, the interior joint recess shall be filled with mortar of stiff consistency mixed in proportions of one part cement to 2 parts sand. The mortar shall be tightly packed into the joint recess and troweled flush with the interior surface, and all excess shall be removed. At no point shall there be an indentation or projection of the mortar exceeding  $\frac{1}{16}$  inch. With pipe smaller than 24 inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with mortar containing one part cement to 2 parts sand. The spigot end then shall be forced to the bottom of the bell and excess mortar on the inside of the joint shall be swabbed out.
- I. Polyethylene Sleeve: Where shown, buried pipe shall be polyethylene encased in accordance with the requirements of ANSI/AWWA C105/A21.5 in lieu of tape coating.

### **3.04 INSTALLATION OF PIPE APPURTENANCES**

- A. Protection of Appurtenances: Where the jointing pipe is tape-coated, buried appurtenances shall be coated with cold-applied tape in accordance with ANSI/AWWA C209, Type II.
- B. Installation of Valves: All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. The Contractor shall adjust all stem packing and operate each valve prior to installation to insure proper operation.
- C. All buried valves shall be coated and protected in accordance with Paragraph 3.05A, herein.
- D. All valves shall be installed so that the valve stems are plumb and in the location shown in the Drawings.
- E. Joint Bonding: Except where otherwise specified, all joints shall be bonded in accordance with the details shown on the Drawings. The pipe shall be cleaned to bare bright metal at the point where the bond is installed.

- F. Corrosion mitigation and testing materials, such as magnesium anodes, reference electrodes, and test lead wire shall be furnished and installed by the Contractor.

\*\*\* END OF SECTION \*\*\*

## SECTION 02645

### PVC SCHEDULE RATED PIPE

#### **PART 1 -- GENERAL**

##### **1.01 THE REQUIREMENT**

- A. The CONTRACTOR shall furnish and install all PVC schedule rated pipe complete in place, all in accordance with the requirements of the Contract Documents.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Trenching and backfill appurtenant to the work shall be as specified in Section 02316 entitled, "Trench Backfill and Compaction."
- B. Testing shall conform to the requirements shown on the piping schedule.
- C. Concrete for anchor blocks, if required, shall conform to the requirements of Section entitled, "Cast-in-Place Concrete," and "Minor Concrete," as applicable.

##### **1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS**

- A. Without limiting the generality of other requirements of these specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced Standards to the extent that the requirements therein are not in conflict with the provisions of this Section.
- B. References in these specifications to "AWWA Standards" shall mean AWWA Standards as published by the American Water Works Association, Incorporated, 2 Park Avenue, New York, New York, 10016.

##### **1.04 CONTRACTOR SUBMITTALS**

- A. Samples: The CONTRACTOR shall submit to the ENGINEER for approval, samples of all the materials proposed for use on the work. The samples shall be clearly marked to show the manufacturer's name and product identification and shall be submitted along with the manufacturer's technical data and application instructions. All sample submittals shall conform to the requirements for "Samples" in Section entitled, "Contractor Submittals."
- B. Shoring and Bracing Drawings: The CONTRACTOR's attention is directed to the provisions for the requirements for "Contractor Submittals," herein, which may require the submittal of shoring and bracing drawings by the CONTRACTOR.
- C. The CONTRACTOR's attention is further directed to the provisions of Subpart P, Section 1926.652 of the OSHA Safety and Health Standards for Constructions, which require that all banks and trenches over 5 feet high shall be shored or sloped to the angle of repose.

- D. Shop Drawings: The CONTRACTOR shall submit shop drawings and laying diagrams of all pipe, joints, bends, special fittings, and piping appurtenances in accordance with Section entitled, "Contractor Submittals."
- E. Certificates: The CONTRACTOR shall provide manufacturer's certificates for all materials indicating conformance to the Contract Documents.

### **1.05 QUALITY ASSURANCE**

- A. Testing: All materials testing will be based upon applicable ASTM Test Methods and AWWA Standards referenced herein for the materials specified.
- B. All costs of such inspection and tests shall be borne by the CONTRACTOR.
- C. Certificates: Manufacturer's notarized certificates of compliance shall be furnished by the CONTRACTOR.
- D. The pipe shall be subjected to the specified hydrostatic strength tests, flexure tests, and crushing tests. The crushing tests shall be made on samples taken from the center of full-length sections of pipe.

### **1.06 CLEANUP**

- A. In addition to the requirements of Section entitled, "Project Closeout," the CONTRACTOR, upon completion of backfilling and grading over trenches shall remove all excess materials and equipment from the site.

## **PART 2 -- PRODUCTS**

### **2.01 GENERAL**

- A. All PVC pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, and pressure rating in psi.
- B. The CONTRACTOR shall also require the manufacturer to mark the date of extrusion on the pipe. This dating shall be done in conjunction with records to be held by the manufacturer for 2 years, covering quality control tests, raw material batch number, and other information deemed necessary by the manufacturer.

### **2.02 PIPE**

- A. PVC pipe shall be made from all new rigid unplasticized polyvinyl chloride and shall be Normal Impact (Type I) Schedule 80 unless otherwise shown. Elbows and tees shall be of the same material as the pipe. Unless otherwise shown, joints shall be solvent-welded in accordance with the manufacturer's instructions. Expansion joints or pipe bends shall be provided to absorb pipe expansion over a temperature range of 100 degrees F.

## **2.03 FITTINGS**

- A. All fittings for PVC pipe shall conform to the requirements of ASTM D 2241-82. The ring groove and gasket ring shall be compatible with PVC pipe ends. The flanged fittings shall be compatible with cast-iron or ductile iron pipe fittings.
- B. The strength class of the fittings shall be not less than the strength class of any adjoining pipe.

## **2.04 BEDDING MATERIAL**

- A. All materials used for pipe bedding shall conform to the requirements for "Embedment Materials" as specified in ASTM D 2321-74 (1980).

## **PART 3 -- EXECUTION**

### **3.01 GENERAL**

- A. All laying, jointing, testing for defects and for leakage shall be performed in the presence of the ENGINEER, and shall be subject to his approval before acceptance. All material found during the progress to have defects will be rejected and the CONTRACTOR shall promptly remove such defective materials from the site of the work.
- B. Installation shall conform to the requirements of ASTM D 2774 and to the supplementary requirements or modifications specified herein. Wherever the provisions of this Section and the requirements of ASTM D 2774 are in conflict, the more stringent provision shall apply.

### **3.02 TRENCHING**

- A. Trench excavation and backfill shall conform to the requirements of the Section entitled, "Earthwork" and as specified herein.
- B. The maximum width of trenches shall be as specified in said ASTM D 2774, as supplemented or modified herein.
- C. The minimum depth of cover over the top of the pipe shall be 36 inches unless otherwise shown on the Drawings.

### **3.03 BEDDING**

- A. General: Pipe bedding shall apply to that portion of the vertical section of the trench lying between a plane 6 inches below the design grade of the pipe invert and a plane at a point 12 inches above the top surface of the pipe.
- B. Bedding Methods: Bedding of all PVC pipe hereunder shall conform to the requirements of ASTM

Designation D 2774 as supplemented or modified herein.

- C. Bell Holes for Joints: When the pipe being installed is provided with bell joints, bell holes shall be excavated in the bedding material to allow for unobstructed assembly of the joint. Care shall be taken to assure that the bell hole is not larger than necessary to accomplish proper joint assembly. When the joint has been made, the bell hole shall be carefully filled with bedding material to provide for adequate support of the pipe throughout its entire length.
- D. Use of Compaction Equipment: Care shall be taken to avoid contact between the pipe and compaction equipment. Compaction of initial backfill in the bedding area, and backfill material should generally be done in such a way so that impact type compaction equipment is not used directly above the pipe until sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe.
- E. Pipe Support: Couplings shall not be allowed to rest upon, nor settle down upon the original trench bottom, rocks, concrete, or underground structures.

### **3.04 LAYING PIPE**

- A. The pipe shall be installed in accordance with the requirements of ASTM D 2774 and as indicated on the drawings and the sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointings, the bedding for the pipe shall be checked for firmness and uniformity of surface.
- B. The radius of curvature of the trench shall determine the maximum length of pipe section that can be used without exceeding the allowable deflection at a coupling. The deflection at any flexible joint shall not exceed that prescribed by the manufacturer of the PVC pipe. The manufacturer's printed installation guide outlining the radii of curvature that can be negotiated with pipe sections of various lengths shall be followed.
- C. Proper implements, tools, and facilities as recommended by the pipe manufacturer's standard printed installation instructions shall be provided and used by the CONTRACTOR for safe and efficient execution of the work. All pipe, fittings, valves, and accessories shall be carefully lowered into the trench by means of derrick, ropes, or other suitable equipment in such a manner as to prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench.
- D. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures for this operation. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, nor any other method that may fracture the pipe or will produce ragged, uneven edges.
- E. The pipe and accessories shall be inspected for defects prior to lowering into the trench. Any defective, damaged or unsound pipe shall be repaired or replaced. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying. All openings in the pipe line shall be closed with water tight expandable type sewer plugs or PVC test plugs at the end of each day's operation or whenever the

pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.

- F. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the work shall be furnished by the CONTRACTOR at its own expense under the direction of the ENGINEER.
- G. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstructions shall be permanently supported, relocated, removed, or reconstructed by the CONTRACTOR in cooperation with owners of such utility structures. Unless otherwise indicated, this work shall be performed at the CONTRACTOR's expense.

### **3.05 HANDLING**

- A. Handling of the PVC pipe shall be done with care to insure that the pipe is not damaged in any manner during storage, loading, transit, unloading and installation.
- B. Pipe shall be inspected both prior to and after installation in the ditch and all defective lengths shall be rejected and immediately removed from the working area.

### **3.06 FIELD JOINTING**

- A. Each pipe compression type joint shall be joined with a lock-in rubber ring and a ring groove that is designed to resist displacement during pipe insertion.
- B. The ring and the ring seat inside the bell shall be wiped clean before the gasket is inserted. At this time a thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall be then forced into the ring to complete the joint.
- C. The pipe shall not be deflected either vertically or horizontally in excess of the printed recommendations of the manufacturer of the coupling.
- D. When pipe laying is not in progress, the open ends of the pipe shall be closed to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe which has floated shall be removed from the trench, cleaned, and relaid in an acceptable manner. No pipe shall be laid when, in the opinion of the ENGINEER, the trench conditions or weather are unsuitable for such work.

### **3.07 INSTALLATION OF BENDS, TEES, AND REDUCERS**

- A. Cast-iron and PVC fittings shall be installed utilizing standard installation procedures. Fittings shall be lowered into trench by means of rope, cable, chain, or other acceptable means without damage to the fittings. Cable, rope, or other devices used for lowering fitting into trench, shall be attached around exterior of fitting for handling. Under no circumstances shall the cable, rope or other device be attached through the fittings' interior for handling. Fittings shall be carefully connected to pipe or

other facility, and joint shall be checked to insure a sound and proper joint.

### **3.08 TESTING**

- A. Field testing of PVC schedule rated pipe shall conform to the requirements shown on the piping scheduled.

\*\*\* END OF SECTION \*\*\*

## SECTION 02648

### PVC SEWER FORCE MAINS

#### **PART 1 -- GENERAL**

##### **1.01 SCOPE**

- A. The work of this Section includes the construction of underground PVC pressure pipe for sewer force mains, complete in place, all in accordance with the requirements of the Contract Documents.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Trenching and backfill appurtenant to the work shall be as specified in Section entitled, "Trench Backfilling and Compacting."
- B. Testing shall conform to the requirements of Sections entitled, "Hydraulic Structures and Pipeline Testing, and Sanitary and Storm Drainage System Testing."
- C. Concrete for anchor blocks and thrust blocks, if required, as shown on the drawings, shall conform to the requirements of Section entitled, "Minor Concrete."
- D. Valves, valve boxes and other appurtenances are specified in the Section entitled, "Valves and Appurtenances."

##### **1.03 CONTRACTOR SUBMITTALS**

- A. Samples: The Contractor shall submit to the Engineer for approval, samples of all the materials he proposes to use on the work. The samples shall be clearly marked to show the manufacturer's name and product identification and shall be submitted along with the manufacturer's technical data and application instructions. All sample submittals shall conform to the requirements for "Samples" in Section entitled, "Contractor Submittals."
- B. Shoring and Bracing Drawings: The Contractor's attention is directed to the provisions for the requirements for "Shoring and Bracing Drawings" in Section entitled, "Contractor Submittals," herein, which may require the submittal of shoring and bracing drawings by the Contractor.
- C. The Contractor's attention is further directed to the provisions of Subpart P, Section 1926.652 of the OSHA Safety and Health Standards for Construction, which require that all banks and trenches over 5 feet high shall be shored or sloped to the angle of repose.
- D. Certificates: The Contractor shall provide manufacturer's certificates for all materials indicating conformance to these specifications.

##### **1.04 QUALITY ASSURANCE**

- A. Testing: All materials testing will be based upon applicable ASTM Test Methods and AWWA

Standards referenced herein for the materials specified.

- B. All costs of such inspection and tests shall be borne by the Contractor.
- C. Certificates: Manufacturer's notarized certificates of compliance shall be furnished by the Contractor.
- D. The pipe shall be subjected to the specified hydrostatic strength tests, flexure tests, and crushing tests. The crushing tests shall be made on samples taken from the center of full-length sections of pipe.

### **1.05 CLEANUP**

- A. In addition to the requirements of Section entitled, "Project Closeout," the Contractor, upon completion of backfilling and grading over trenches shall remove all excess materials and equipment from the site.

## **PART 2 -- PRODUCTS**

### **2.01 GENERAL**

- A. All PVC pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, and pressure rating in psi.
- B. The manufacturer shall also mark the date of extrusion on the pipe. This dating shall be done in conjunction with records to be held by the manufacturer for 2 years, covering quality control taxes, raw material batch number, and other information deemed necessary by the manufacturer.

### **2.02 PIPE**

- A. All PVC pipe shall be joined by compression joints unless otherwise indicated or specified, and shall conform to the following requirements:
  - 1. Polyvinyl chloride pipe (PVC) shall conform to the requirements of ASTM Designation D 2241-72, Class SDR 26. Material for PVC pipe shall conform to the requirements of ASTM Designation D 1784-69 for Class 12454-A as defined therein.
  - 2. Flexible rubber rings for compression type joints for PVC pipe fittings shall conform to the printed recommendations of the pipe manufacturer and ASTM Designation 1869.

### **2.03 FITTINGS**

- A. All fittings for PVC pressure pipe shall be PVC conforming to the requirements of ASTM Designation D 2241-72. The ring groove and gasket ring shall be compatible with PVC pipe ends. The flanged fittings shall be compatible with cast-iron or ductile-iron pipe fittings.
- B. The strength class of the fittings shall be not less than the strength class of any adjoining pipe.

## **2.04 LOCATOR WIRE**

- A. The locator wire shall be No. 14 wire gage, (0.064-inch), bare copper wire being the standard product of a manufacturer regularly engaged in the manufacture of such material.

## **2.05 BEDDING MATERIAL**

- A. All material used for pipe bedding shall conform to the requirements for "Embedment Materials" as specified in ASTM Designation D 2321-74.

## **PART 3 -- EXECUTION**

### **3.01 GENERAL**

- A. All laying, jointing, testing for defects and for leakage under pressure, shall be performed in the presence of the Engineer, and shall be subject to his approval before acceptance. All material found during the progress to have defects will be rejected and the Contractor shall promptly remove such defective material from the site of the work.
- B. Installation shall conform to the requirements of ASTM Designation D 2321-74 and to the Supplementary requirements or modifications specified herein. Wherever the provisions of this section and the requirements of ASTM Designation D 2321-74 are in conflict, the more stringent provision shall apply.

### **3.02 TRENCHING**

- A. Trench excavation and backfill shall conform to the requirements of the Sections entitled, ["Trench Excavation" and "Trench Backfill and Compaction" and as specified herein.
- B. The maximum width of trenches shall be as specified in ASTM Designation D 2321-74, as supplemented or modified herein.
- C. The minimum depth of cover over the top of the pipe shall be 48- inches unless shown otherwise on the drawings.

### **3.03 BEDDING**

- A. General: Pipe bedding shall apply to that portion of the vertical section of the trench lying between a plane [6] inches below the design grade of the pipe invert and a plane at a point [12] inches above the top surface of the pipe.
- B. Bedding Methods: Bedding of all PVC pipe hereunder shall conform to the requirements of ASTM Designation D 2321-74.
- C. Bell Holes for Joints: When the pipe being installed is provided with bell joints, bell holes shall be excavated in the bedding material to allow for unobstructed assembly of the joint. Care shall be taken to assure that the bell hole is not larger than necessary to accomplish proper joint assembly.

When the joint has been made, the bell hole shall be carefully filled with bedding material to provide for adequate support of the pipe throughout its entire length.

- D. Minimum Cover for Load Application: At least 30-inches of cover over the top of the pipe shall be provided before the trench is wheel-loaded, and 48-inches of cover before utilization of a hydrohammer during compaction.
- E. Use of Compaction Equipment: Care shall be taken to avoid contact between the pipe and compaction equipment. Compaction of initial backfill in the bedding area, and backfill material should generally be done in such a way so that impact type compaction equipment is not used directly above the pipe until sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe.
- F. Pipe Support: Couplings shall not rest upon, nor shall a coupling settle down upon the original trench bottom, rocks, concrete, or underground structures.

### **3.04 LAYING PIPE**

- A. The pipe shall be installed in accordance with the requirements of ASTM Designation D 2321-74 and as indicated on the drawings and the sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for joint, the bedding for the pipe shall be checked for firmness and uniformity of surface.
- B. The radius of curvature of the trench shall determine the maximum length of pipe section that can be used without exceeding the allowable deflection at a coupling. The deflection at any flexible joint shall not exceed that prescribed by the manufacturer of the PVC pipe. The manufacturer's printed installation guide outlining the radii of curvature that can be negotiated with pipe sections of various lengths shall be followed.
- C. Proper implements, tools, and facilities as recommended by the pipe manufacturer's standard printed installation instructions shall be provided and used by the Contractor for safe and efficient execution of the work. All pipe, fittings, valves, and accessories shall be carefully lowered into the trench by means of derrick, ropes, or other suitable equipment in such a manner as to prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench.
- D. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures for this operation. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, nor any other method that may fracture the pipe or will product ragged, uneven edges.
- E. The pipe and accessories shall be inspected for defects prior to lowering into the trench. Any defective, damaged, or unsound pipe shall be repaired or replaced. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying. All openings in the pipe line shall be closed with water tight expandable type sewer plugs or PVC test plugs at the end of each day's operation or whenever the pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.

- F. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the work shall be furnished by the Contractor at his own expense under the direction of the Engineer.
- G. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the Contractor in cooperation with owners of such utility structures. Unless otherwise indicated, this work shall be performed at the Contractor's expense.

### **3.05 HANDLING**

- A. Handling of the PVC pipe shall be done with care to insure that the pipe is not damaged in any manner during storage, loading, transit, unloading and installation.
- B. Pipe shall be inspected both prior to and after installation in the ditch and all defective lengths shall be rejected and immediately removed from the working area.

### **3.06 FIELD JOINTING**

- A. Each pipe compression type joint shall be joined with a lock-in rubber ring and ring groove that is designed to resist displacement during pipe insertion.
- B. The ring and the ring seat inside the bell shall be wiped clean before the gasket is inserted. At this time a thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall be then forced into the ring to complete the joint.
- C. The pipe shall not be deflected either vertically or horizontally in excess of the printed recommendations of the manufacturer of the coupling.
- D. When pipe laying is not in progress, the open ends of the pipe shall be closed by approved means to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe which has floated shall be removed from the trench, cleaned, and relaid in an acceptable manner. No pipe shall be laid when, in the opinion of the [Engineer,] the trench conditions or weather are unsuitable for such work.

### **3.07 INSTALLATION OF BENDS, TEES, AND REDUCERS**

- A. Cast iron and PVC fittings shall be installed utilizing standard installation procedures. Fittings shall be lowered into trench by means of rope, cable, chain, or other acceptable means without damage to the fittings. Cable, rope, or other devices used for lowering fitting into trench, shall be attached around exterior of fitting for handling. Under no circumstances shall the cable, rope or other device be attached through the fitting's interior for handling. Fittings shall be carefully connected to pipe or other facility, and joint shall be checked to insure a sound and proper joint.

### **3.08 THRUST AND ANCHOR BLOCKS**

- A. Thrust and anchor blocks shall be installed at all bends in accordance with the details shown on the drawings.
- B. Thrust blocks and/or anchor blocks shall be installed at all valves, hydrants, tees, crosses, ends of lines, and at all changes of direction of the main of greater than 10 degrees deflection either vertically or horizontally.
- C. Anchor blocks shall provide not less than the normal thrust bearing area to resist horizontal or downward thrust; and shall be of sufficient gross weight to resist upward thrust as tabulated on the drawings. The concrete shall be placed against wetted undisturbed soil, and the exterior of the fitting shall be cleaned and wetted to provide a good bond with the concrete. The concrete interface with the fitting shall be an area of not less than the projected area of the fitting normal to the thrust resultant and centered on the resultant.

### **3.09 INSTALLATION OF LOCATOR WIRE**

- A. All installations of PVC pipe shall have a locator wire laid on top of the pipe and fastened to the pipe at intervals of not more than 10-feet.
- B. Locator wire shall be installed after all pipe and fittings are in place but before any backfilling is done.
- C. The wire shall be continuous from valve to valve and shall be securely fastened to the body of each valve by welding.

\*\*\* END OF SECTION \*\*\*

## SECTION 02649

### PVC GRAVITY SEWERS

#### **PART 1 -- GENERAL**

##### **1.01 SCOPE**

- A. The work of this Section includes the construction of underground PVC sewer pipe for gravity mains and all appurtenant work, complete in place, all in accordance with the requirements of the Contract Documents.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Trenching and backfill appurtenant to the work shall be as specified in Section entitled, "Trench Excavation" and "Trench Backfill and Compaction".
- B. Testing shall conform to the requirements of Sections entitled, "Hydraulic Structures and Pipeline Testing" and "Sanitary and Storm Drainage System Testing".
- C. Concrete for anchor blocks and thrust blocks, if required, as shown on the drawings, shall conform to the requirements of Section entitled, "Minor Concrete."

##### **1.03 CONTRACTOR SUBMITTALS**

- A. Samples: The Contractor shall submit to the Engineer for approval, samples of all the materials he proposes to use on the work. The samples shall be clearly marked to show the manufacturer's name and product identification and shall be submitted along with the manufacturer's technical data and application instructions. All sample submittals shall conform to the requirements for "Samples" in Section entitled, "Contractor Submittals."
- B. Shoring and Bracing Drawings: The Contractor's attention is directed to the provisions for the requirements for "Shoring and Bracing Drawings" in Section entitled, "Contractor Submittals," herein, which may require the submittal of shoring and bracing drawings by the Contractor.
- C. The Contractor's attention is further directed to the provisions of Subpart P, Section 1926.652 of the OSHA Safety and Health Standards for Construction, which requires that all banks and trenches over 5-feet high shall be shored or sloped to the angle of repose.
- D. Certificates: The Contractor shall provide manufacturer's certificates for all materials indicating conformance to these specifications.

##### **1.04 QUALITY ASSURANCE**

- A. Testing: All materials testing will be based upon applicable ASTM Test Methods and AWWA Standards referenced herein for the materials specified.

- B. All costs of such inspection and tests shall be borne by the Contractor.
- C. Certificates: Manufacturer's notarized certificates of compliance shall be furnished by the Contractor.
- D. The pipe shall be subjected to the specified hydrostatic strength tests, flexure tests, and crushing tests. The crushing tests shall be made on samples taken from the center of full-length sections of pipe.

## **1.05 CLEANUP**

- A. In addition to the requirements of Section entitled, "Project Closeout," the Contractor, upon completion of backfilling and grading over trenches shall remove all excess materials and equipment from the site.

## **PART 2 -- PRODUCTS**

### **2.01 GENERAL**

- A. All PVC pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, and pressure rating in psi.
- B. The manufacturer shall also mark the date of extrusion on the pipe. This dating shall be done in conjunction with records to be held by the manufacturer for 2-years, covering quality control taxes, raw material batch number, and other information deemed necessary by the manufacturer.

### **2.02 PIPE**

- A. All PVC pipe shall be joined by compression joints unless otherwise indicated or specified, and shall conform to the following requirements:
  - 1. Polyvinyl chloride pipe (PVC) shall conform to the requirements of ASTM Designation D 3034-74, Class SDR 35. Material for PVC pipe shall conform to the requirements of ASTM Designation D 1784-69 for Class 12454-A as defined therein.
  - 2. Flexible rubber rings for compression type joints for PVC pipe fittings shall conform to the printed recommendations of the pipe manufacturer and ASTM Designation 1869.

### **2.03 FITTINGS**

- A. All fittings for PVC pressure pipe shall be PVC conforming to the requirements of ASTM Designation D 2241-72. The ring groove and gasket ring shall be compatible with PVC pipe ends. The flanged fittings shall be compatible with cast-iron or ductile-iron pipe fittings.
- B. The strength class of the fittings shall be not less than the strength class of any adjoining pipe.

## **2.04 LOCATOR WIRE**

- A. The locator wire shall be No. 14 wire gage, (0.064-inch), bare copper wire being the standard product of a manufacturer regularly engaged in the manufacture of such material.

## **2.05 BEDDING MATERIAL**

- A. All material used for pipe bedding shall conform to the requirements for "Embedment Materials" as specified in ASTM Designation D 2321-74.

## **PART 3 -- EXECUTION**

### **3.01 GENERAL**

- A. All laying, jointing, testing for defects and for leakage under pressure, shall be performed in the presence of the Engineer, and shall be subject to his approval before acceptance. All material found during the progress to have defects will be rejected and the Contractor shall promptly remove such defective material from the site of the work.
- B. Installation shall conform to the requirements of ASTM Designation D 2321-74 and to the Supplementary requirements or modifications specified herein. Wherever the provisions of this section and the requirements of ASTM Designation D 2321-74 are in conflict, the more stringent provision shall apply.

### **3.02 TRENCHING**

- A. Trench excavation and backfill shall conform to the requirements of the Section entitled, "Trench Excavation" and "Trench Backfilling and Compaction"] and as specified herein.
- B. The maximum width of trenches shall be as specified in ASTM Designation D 2321, as supplemented or modified herein.
- C. The minimum depth of cover over the top of the pipe shall be 48-inches unless shown otherwise on the drawings.

### **3.03 BEDDING**

- A. General: Pipe bedding shall apply to that portion of the vertical section of the trench lying between a plane 6-inches below the design grade of the pipe invert and a plane at a point 12-inches above the top surface of the pipe.
- B. Bedding Methods: Bedding of all PVC pipe hereunder shall conform to the requirements of ASTM Designation D 2321-74.
- C. Bell Holes for Joints: When the pipe being installed is provided with bell joints, bell holes shall be excavated in the bedding material to allow for unobstructed assembly of the joint. Care shall be taken to assure that the bell hole is not larger than necessary to accomplish proper joint assembly.

When the joint has been made, the bell hole shall be carefully filled with bedding material to provide for adequate support of the pipe throughout its entire length.

- D. Minimum Cover for Load Application: At least 30-inches of cover over the top of the pipe shall be provided before the trench is wheel-loaded, and 48-inches of cover before utilization of a hydrohammer during compaction.
- E. Use of Compaction Equipment: Care shall be taken to avoid contact between the pipe and compaction equipment. Compaction of initial backfill in the bedding area, and backfill material should generally be done in such a way so that impact type compaction equipment is not used directly above the pipe until sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe.
- F. Pipe Support: Couplings shall not rest upon, nor shall a coupling settle down upon the original trench bottom, rocks, concrete, or underground structures.

### **3.04 LAYING PIPE**

- A. The pipe shall be installed in accordance with the requirements of ASTM Designation D 2321-74 and as indicated on the drawings and the sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for joint, the bedding for the pipe shall be checked for firmness and uniformity of surface.
- B. The radius of curvature of the trench shall determine the maximum length of pipe section that can be used without exceeding the allowable deflection at a coupling. The deflection at any flexible joint shall not exceed that prescribed by the manufacturer of the PVC pipe. The manufacturer's printed installation guide outlining the radii of curvature that can be negotiated with pipe sections of various lengths shall be followed.
- C. Proper implements, tools, and facilities as recommended by the pipe manufacturer's standard printed installation instructions shall be provided and used by the Contractor for safe and efficient execution of the work. All pipe, fittings, valves, and accessories shall be carefully lowered into the trench by means of derrick, ropes, or other suitable equipment in such a manner as to prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench.
- D. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures for this operation. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, nor any other method that may fracture the pipe or will product ragged, uneven edges.
- E. The pipe and accessories shall be inspected for defects prior to lowering into the trench. Any defective, damaged, or unsound pipe shall be repaired or replaced. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying. All openings in the pipe line shall be closed with water tight expandable type sewer plugs or PVC test plugs at the end of each day's operation or whenever the pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.

- F. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the work shall be furnished by the Contractor at his own expense under the direction of the Engineer.
- G. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the Contractor in cooperation with owners of such utility structures. Unless otherwise indicated, this work shall be performed at the Contractor's expense.

### **3.05 HANDLING**

- A. Handling of the PVC pipe shall be done with care to insure that the pipe is not damaged in any manner during storage, loading, transit, unloading and installation.
- B. Pipe shall be inspected both prior to and after installation in the ditch and all defective lengths shall be rejected and immediately removed from the working area.

### **3.06 FIELD JOINTING**

- A. Each pipe compression type joint shall be joined with a lock-in rubber ring and ring groove that is designed to resist displacement during pipe insertion.
- B. The ring and the ring seat inside the bell shall be wiped clean before the gasket is inserted. At this time a thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall be then forced into the ring to complete the joint.
- C. The pipe shall not be deflected either vertically or horizontally in excess of the printed recommendations of the manufacturer of the coupling.
- D. When pipe laying is not in progress, the open ends of the pipe shall be closed by approved means to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe which has floated shall be removed from the trench, cleaned, and relaid in an acceptable manner. No pipe shall be laid when, in the opinion of the [Engineer,] the trench conditions or weather are unsuitable for such work.

### **3.07 INSTALLATION OF BENDS, TEES, AND REDUCERS**

- A. Cast iron and PVC fittings shall be installed utilizing standard installation procedures. Fittings shall be lowered into trench by means of rope, cable, chain, or other acceptable means without damage to the fittings. Cable, rope, or other devices used for lowering fitting into trench, shall be attached around exterior of fitting for handling. Under no circumstances shall the cable, rope or other device be attached through the fitting's interior for handling. Fittings shall be carefully connected to pipe or other facility, and joint shall be checked to insure a sound and proper joint.

### **3.08 THRUST AND ANCHOR BLOCKS**

- A. Thrust and anchor blocks shall be installed at all bends in accordance with the details shown on the Drawings.
- B. Thrust blocks and/or anchor blocks shall be installed at all valves, hydrants, tees, crosses, ends of lines, and at all changes of direction of the main of greater than 10-degrees deflection either vertically or horizontally.
- C. Anchor blocks shall provide not less than the normal thrust bearing area to resist horizontal or downward thrust; and shall be of sufficient gross weight to resist upward thrust as tabulated on the drawings. The concrete shall be placed against wetted undisturbed soil, and the exterior of the fitting shall be cleaned and wetted to provide a good bond with the concrete. The concrete interface with the fitting shall be an area of not less than the projected area of the fitting normal to the thrust resultant and centered on the resultant.

### **3.09 INSTALLATION OF LOCATOR WIRE**

- A. All installations of PVC pipe shall have a locator wire laid on top of the pipe and fastened to the pipe as intervals of not more than 10 feet.
- B. Locator wire shall be installed after all pipe and fittings are in place but before any backfilling is done.
- C. The wire shall be continuous from valve to valve and shall be securely fastened to the body of each valve by welding.

### **3.10 TESTING**

- A. Field testing of gravity sewer pipe shall conform to the requirements of Section 02667 – Hydraulic Structures and Pipeline Testing.

\*\*\* END OF SECTION \*\*\*

## SECTION 02667

### HYDRAULIC STRUCTURES AND PIPELINE TESTING

#### **PART 1 -- GENERAL**

##### **1.01 SCOPE OF WORK**

- A. The CONTRACTOR shall perform all cleaning, flushing, and testing, including conveyance of test water from source to point of use, and including all disposal thereof, complete and acceptable, for hydraulic and appurtenant piping all in accordance with the requirements of the Contract Documents.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Testing of pipeline except appurtenant piping to the hydraulic structure(s) shall be tested according to the applicable provisions of the pipe schedule in the Drawings and by this reference thereto, said provisions shall be a part of this Section. The CONTRACTOR shall provide all temporary closure fittings necessary to test pipelines. This shall include plugs, bulkheads, valves, caps or welded plates on steel pipes.
- B. Repair of hydraulic structures, as required, shall conform to the provisions of Section entitled, "Cast-in-Place Concrete."

##### **1.03 CONTRACTOR SUBMITTALS**

- A. The CONTRACTOR shall submit minimum 48-hour advance written notice of its proposed testing schedule for review and concurrence of the ENGINEER. The Contractor's proposed plans for water conveyance, control, and disposal shall also be submitted in writing.

#### **PART 2 -- PRODUCTS**

##### **2.01 MATERIALS REQUIREMENTS**

- A. Temporary valves, bulkheads, or other water control equipment and materials shall be as determined by the CONTRACTOR subject to the Engineer's review. No material shall be used which would be injurious to the construction or its future function.

#### **PART 3 -- EXECUTION**

##### **3.01 GENERAL**

- A. The CONTRACTOR shall make all necessary provisions for providing testing water for the project. CONTRACTOR shall also make all necessary provisions for conveying the water from

the source to points of use and for disposing of the water upon completion of testing.

- B. All hydraulic structures and appurtenant piping shall be tested. All testing operations shall be done in the presence of the ENGINEER.
- C. If industrial paint finishes or other protective coatings are to be applied to the surfaces of the hydraulic structure, such coatings shall be applied after all testing operations have been completed.
- D. Release of water from structures, after testing has been completed, shall be approved by the ENGINEER.

### **3.02 PRELIMINARY CLEANING AND FLUSHING**

- A. Prior to testing, all hydraulic structures shall be cleaned by thoroughly hosing down all surfaces with high-pressure hoses and nozzle of sufficient size to deliver a minimum flow of 50-gpm.

### **3.03 TESTING OF HYDRAULIC STRUCTURES**

- A. General. Testing shall be performed prior to backfilling, except where otherwise permitted by the ENGINEER. Testing shall not be performed sooner than 14-day after all portions of structure walls have been completed. The test shall consist of filling the structure with water to the maximum operating water surface. The rate of filling shall not exceed 24-inches of depth per day.
- B. Leakage Test and Repairs. After the structure has been filled, the leakage test shall be performed as follows: An initial water level reading shall be made. Seven days following the initial reading, a second reading shall be made. The structure shall be considered to have passed the test if water loss during the 7-day period, as computed from the 2 water level readings, does not exceed 0.7-percent of the total volume of water in the structure, after allowance is made for evaporation loss.

Should the structure fail to pass the test, the test shall be repeated for up to 3 additional 7-day test periods. If at the end of 28-days, the structure still fails to pass the leakage test, the CONTRACTOR shall empty the structure as approved by the ENGINEER and shall examine the interior for evidence of any cracking or other conditions that might be responsible for the leakage.

Any cracks shall be "vee'd" and sealed with rubber sealant in accordance with the manufacturer's recommendations. Any evidence of leakage through the joints shall be repaired. Following these operations, the CONTRACTOR shall again test the hydraulic structure.

### **3.04 TESTING OF APPURTENANT PIPING**

- A. Piping appurtenant to hydraulic structures shall be tested as specified in the Piping Schedule in the Contract Documents.

\*\*\* END OF SECTION \*\*\*

## SECTION 02719

### SANITARY SEWER SYSTEM

#### **PART 1 -- GENERAL**

##### **1.01 THE REQUIREMENT**

- A. This section covers the materials and work associated with the following:
1. Sanitary sewerage piping, fittings, and accessories.
  2. Casing pipe and accessories.
  3. Connection of Project pipe to existing manholes.

- B. Coordinate work with other trades on the site.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 02312 – Trench Excavation: Excavation of trenches.  
B. Section 02316 – Trench Backfill and Compaction: Pipe bedding and trench backfilling.  
C. Section 02606 – Manholes.  
D. Section 03300 – Cast-in-Place Concrete: Concrete for manhole base construction.

##### **1.03 REFERENCES**

- A. Use the latest issue of the reference standards as of the date of the Project.
- B. ASTM C 14: Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe; 1995.
- C. ASTM C 76: Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; 1995a.
- D. ASTM C 443: Standard Specifications for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets; 1994.
- E. ASTM C 891: Standard Practice for Installation of Underground Precast Concrete Utility Structures.
- F. ASTM C 923: Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
- G. ASTM F 1803: Standard Specification for Poly (Vinyl Chloride) (PVC) Closed Profile Gravity Pipe and Fittings Based on Controlled Inside Diameter.
- H. ASTM D 2321: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 1989 (Reapproved 1995).
- I. ASTM D 3034: Standard Specification for Type PSM Poly (Vinyl Chloride)(PVC) Sewer Pipe and

Fittings; 1996.

- J. ASTM F 477: Standard Specification for Elastometric Seals (Gaskets) for Joining Plastic Pipe.
- K. ASTM F 679: Standard Specification for Poly (Vinyl Chloride)(PVC) Large-Diameter Gravity Sewer Pipe and Fittings; 18-inch through 24-inch smooth solid wall sewer pipe.
- L. ASTM F 794: Standard Specification for Poly (Vinyl Chloride)(PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter; 21-inch through 48-inch ribbed or close profile sewer pipe with smooth interior wall.
- M. ASTM F 714: Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter; 2000.
- N. ASTM D 3350: Standard Specification for Polyethylene (PE) Plastic Pipe and Fittings Materials; 1999.
- O. ASTM D 2657: Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings; 1997.
- P. ASTM D 3262: Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
- Q. ASTM D 4161: Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced) Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.
- R. ASTM D2412: Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

#### **1.04 SUBMITTALS**

- A. See Section 01300 – Administrative Requirements, for submittal procedures.
- B. Traffic Control Plan, if existing City streets are impacted.
- C. Product Data: Provide data indicating pipe, pipe accessories, and fittings.
- D. Manufacturer’s Installation Procedures: Certify that products meet or exceed specified requirements.
- E. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.
- F. Project Record Documents:
  - 1. Record location of pipe lines, connections, manholes, sewer laterals, and invert elevations.
  - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

#### **1.05 REGULATORY REQUIREMENTS**

- A. Conform to applicable code for materials and installation of the Work of this Section.

## **1.06 PROJECT CONDITIONS**

- A. Coordinate the Work on sewer lines and connections to existing manholes with City.
- B. Minimize neighborhood traffic interruptions. Barricade stockpiles.
- C. Provide accesses to adjacent properties for local traffic and pedestrians.
- D. Repair public and private facilities damaged by Contractor.

## **PART 2 -- PRODUCTS**

### **2.01 SANITARY SEWER PIPE MATERIALS**

- A. Plastic Pipe: ASTM D 3034, Type PSM, Poly(Vinyl Chloride)(PVC) material inside nominal diameter larger than 4-inches, smooth solid wall sewer pipe, bell and spigot joint ends with gaskets.
- B. Plastic Pipe: ASTM F 679, Poly(Vinyl Chloride)(PVC) material inside nominal diameter of 18-inches through 30-inches, smooth solid wall sewer pipe, bell and spigot joint ends with gaskets.
- C. Plastic Pipe: ASTM F 794, Poly(Vinyl Chloride)(PVC) material, cell classification of 12454C or 12364A; ribbed pipe; inside nominal diameter of 21-inches through 48-inches, bell and spigot joint ends with gaskets.
- D. Plastic Pipe: ASTM F 1803, Poly(Vinyl Chloride)(PVC) material, minimum cell classification of 12364, closed profile pipe; inside nominal diameter of 21-inches through 54-inches, bell and spigot joint ends with gaskets.
- E. Centrifugally Cast Fiberglass Reinforced Polymer Mortar Pipe (CCFRPM): ASTM D 3262, minimum stiffness rating of 465-psi (SN 46), nominal pipe diameter of 18-inches through 110-inches with FWC coupling, HOBAS or approved equivalent.
- F. Joint Seals for Plastic Pipe: ASTM F 477 rubber compressing gaskets for positive seal.
- G. Fittings: Wye branches and other fittings shall be of the same material as the pipe, molded or formed to suite the pipe size and end-design, in required configurations. DFW Brand Non Shear Couplings shall be used for coupling differing pipe materials.
- H. Pipe Plugs: Burke Duo Seal Pipe Plugs as supplied by Burke Rubber Company or approved equivalent.
- I. HDPE Sewer Pipe: PE 3408 striped high density polyethylene pipe manufactured in accordance with, and conforming to all requirements of ASTM D 3350 and ASTM F 714; including ASTM standards for PE 3408, Type III, Category 5, Class C, Grade P 34. Minimum wall thickness to be SDR 17 for Sewer Main Lines and SDR 11 for pressure Sewer Laterals. Exact wall thickness for force mains and pressure Sewer Laterals shall be determined based upon operating pressures. All HDPE sewer pipes shall be color coded according to the color striping codes developed by the Utility

Location and Coordination Council of the American Public Works Association (APWA).

- J. HDPE Joints: HDPE pipe to be joined by butt fusion method conforming to ASTM D 2657 and manufacturer's recommendations; to provide heat weld as strong as pipe wall.
- K. Electronic Marker: Omni Marker model 162 Electronic Marker as produced by Industrial Technology.
- L. Geotextile Fabric: Non-biodegradable, non-woven, drainage fabric; Amoco No. 4547, Typar No. 3401, or approved equal.

## **2.02 CASING PIPE MATERIALS**

- A. Welded Steel Pipe: ASTM A53, Grade B or approved equivalent.
- B. Casing Insulators: Stainless steel casing insulators with 12-inch wide band and 2-inch wide glass reinforced plastic runner; Model S12G-2, manufactured by Pipeline Seal and Insulator, Inc., or approved equal.
- C. Casing End Seals: Flexible S-shaped seals fabricated of synthetic rubber with stainless steel bands and clamps; Model S Pull-On End Seals, manufactured by Pipeline Seal and Insulator, Inc., or approved equivalent.
- D. Casing End Seals: Flexible S-shaped seals fabricated of synthetic rubber with stainless steel bands and clamps; Model C Pull-On End Seals, manufactured by Pipeline Seal and Insulator, Inc., or approved equivalent.
- E. Casing Minimum Wall Thickness: The minimum wall thickness of casings shall be as follows:
  - 1. 12-inch and under – 0.188-inch
  - 2. 14 through 18-inch – 0.312-inch
  - 3. 20 through 22-inch – 0.375-inch
  - 4. 24 through 26-inch – 0.438-inch
  - 5. 28 through 32-inch – 0.500-inch
  - 6. 34 through 42-inch – 0.562-inch
  - 7. Larger casings as directed by the City Engineer.

## **2.03 BEDDING AND COVER MATERIALS**

- A. Pipe Bedding Materials: As specified in Section 02316.
- B. Trench Backfill Material: As specified in Section 02316.

## **PART 3 -- EXECUTION**

### **3.01 INSTALLATION – SANITARY SEWER MAIN LINE PIPE**

- A. Sanitary sewer main lines shall be installed in public right-of-ways or within City easements.
- B. Verify that trench cut is ready to receive Work and excavations, dimensions, and elevations are as indicated on Project Drawings.
- C. Where required by the City’s Resident Project Representative and/or City Engineer, install fabric encasement as indicated on Drawings and according to manufacturer’s written instructions and recommendations.
- D. Place spigots or groove ends facing upstream.
- E. Insulate dissimilar metals from direct contact with each other using neoprene gaskets or asphalt coatings.
- F. Install pipe, fittings, electronic markers and accessories, for sanitary sewer main lines, in accordance with appropriate ASTM standards and manufacturer’s instructions. Seal joints watertight.
- G. Install pipe to alignment and slope gradients noted on Drawings; with maximum variations from design alignment of 0.25-foot and from design elevations of 0.10-foot.
- H. A minimum of 4-feet of cover shall be required over all main sanitary sewer lines.
- I. Pipe plugs shall be installed during construction at the end of each length of pipe installed to prevent water and debris from entering pipe.
- J. Install electronic markers over all HDPE and curved sanitary sewer lines, at intervals as per the manufacturer’s recommendations and as directed by the City’s Resident Project Representative but not more than 20-feet, and at depths no greater than 4-feet.
- K. In locations with steep slopes (i.e. greater than 15-percent) concrete anchor restraints shall be installed on the pipe at a spacing and in a manner as indicated on the Standard Drawing No. SS-115.

### **3.02 INSTALLATION – SANITARY SEWER LATERALS**

- A. Sanitary sewer service lateral shall extend from a wye branch or other fitting as approved by the City’s Resident Project Representative, installed in the main line, to a point at least 10-feet inside the property line, as indicated on the Drawings and as directed by the City’s Resident Project Representative.
- B. Verify that the trench cut is ready to receive Work and excavations, dimensions, and elevations are as indicated on Project plan and profile Drawings, and as directed by the City’s Resident Project Representative.
- C. Install pipe, fittings, and accessories, for sanitary sewer laterals, in accordance with appropriate ASTM standards and manufacturer’s instructions. Seal joints watertight.

- D. Install a 22-1/2 or 45-degree bend, or combinations of bends as required, on the wye, rotated so the proper alignment and grade are established.
- E. Install pipe to alignment as directed by the City's Resident Project Representative and with uniform slope, free of low spots or adverse grades. Recommended minimum slope shall be 1/4-inch per foot (approximately 2.0-percent grade) where practical; but in no case less than 1/8-inch per foot (approximately 1.0-percent grade).
- F. Where laterals are to be connected to a manhole, the manhole wall shall be core-cut with the appropriate size machine and the lateral pipe shall be connected to the manhole with the appropriate type flexible coupling.
- G. Service laterals shall be cleaned, flushed and tested in accordance with applicable requirements of this Section. After flushing has been completed, the end of the service lateral shall be beveled and plugged, with a Burke Duo Seal Pipe Plug or approved equivalent. Prior to backfilling, a 2x4 shall be extended to the surface to indicate its location for future use.
- H. A brass lateral marker shall be installed in the curb, directly above each lateral crossing, as per the City's Resident Project Representative's instructions. If curb and gutter is not available in a subdivision, brass lateral markers shall be installed as per the City's Resident Project Representative's instructions.
- I. Four (4)-feet of cover is required over all sanitary sewer laterals, unless otherwise approved by the City Engineer.
- J. The City recommends that no trees be planted in the proximity of sanitary sewer laterals.
- K. Cleanouts shall be installed at no more than 100-foot spacing.
- L. No more than two bends in excess of 45-degrees shall be installed without a cleanout.
- M. Flows discharged from a sump shall be pumped, by automatic pumping equipment, via a pressure Sanitary sewer Lateral and discharged into a gravity flow Sanitary sewer Lateral, connected at a cleanout, or the Sanitary sewer Main, connecting in a manhole constructed of Dynastone with approved restrained coupling(s).
- N. Pumping equipment and pressure Sanitary sewer Laterals shall be designed to meet or exceed the anticipated use requirements. Unless otherwise approved by the City Engineer, pressure Sanitary sewer Laterals shall be constructed of HDPE and constructed on a constant reverse grade. Professional advice should be obtained prior to installing pumping equipment and shall be done per manufacturer's recommendations.

### **3.03 INSTALLATION – CASING PIPES**

- A. See Section 02313 and 02316 for trench excavation, backfill, and additional requirements.
- B. Install casing pipes by ramming process or open cut where indicated; method to be acceptable to the City's Resident Project Representative and any other governing authority. If open cut installation method is used under a canal, river or other applicable area, the impacted area shall be lined with concrete, conforming to the governing authority requirements.
- C. Install casing pipes at the line and grade as required to allow carrier pipes to be installed within the casing pipes at the design line and grade, as indicated on the Drawings.
- D. Place casing insulators on carrier pipes to properly center and position carrier pipe inside the casing pipes; space insulators as recommended by the pipe and/or insulator manufacturer.
- E. Seal each end of casing with appropriate size flexible end seals; install according to manufacturer's instructions and recommendations.
- F. Seal voids created by bore, around periphery of casing, with grout or impervious clay as approved by the manufacturer.
- G. Contractor shall be solely responsible for the accuracy, safety and adequacy of construction methods and procedures for installing casing pipes, and for any damage, which may result from their failure. All operations of the Contractor for installation of casing pipes shall be subject to approval by the agency having jurisdiction over the item being crossed, such as the County Flood Control Department, Utah Department of Transportation, canal companies, railroad companies, etc.
- H. Contractor shall enter any agreement with, and furnish any and all indemnity and other bonds that may be required by, the agencies listed above, for their protection against injury and interference with flow of water caused by the operations of the Contractor.
- I. Contractor shall secure required permission from the agencies listed above before commencing with the installation of casing pipes and related Work along and across the respective areas.

### **3.04 CONNECTIONS TO EXISTING SANITARY SEWER MANHOLES**

- A. Connection of Project Pipe into existing manhole includes:
  - 1. All excavating required for the connection; and backfilling excavations after the connections completed, and compacting backfill is required.
  - 2. Removing existing pipes where and if required.
  - 3. Cutting hole through wall and base of existing manhole with appropriate size coring machine, as required and as directed.
  - 4. Installing new pipe in place and connecting to manhole wall with appropriate type flexible coupling, as recommended by the coupling manufacturer.
  - 5. Reforming manhole floor and invert channel to provide smooth channel transitions to accommodate new connected pipes.
  - 6. Sealing around new pipe where it intersects manhole wall; make connection watertight.
  - 7. Perform all other operations necessary to restore existing manhole to condition acceptable to the

City's Resident Project Representative.

- B. If existing manhole does not have steps, connection shall also include furnishing and installing new manhole steps. Steps shall be installed as described in Section 02606 – Manholes.
- C. Connections to existing manholes shall not be completed until new pipelines have been cleaned, tested, and accepted by the City's Inspector.
- D. No debris and rubbish from new pipelines or manholes shall be flushed into existing City sanitary sewer pipelines.

### **3.05 CONNECT PROJECT PIPE TO STUB AT EXISTING SANITARY SEWER MANHOLE**

- A. Connection of Project pipe to stub at existing manhole includes:
  - 1. All excavating required for the connection; and backfilling excavations after the connections completed, and compacting backfill as required.
  - 2. Removing plug from end of existing pipe stub and cleaning end of pipe as required.
  - 3. Connecting new pipe to end of pipe stub with appropriate rigid type coupling; connection to be watertight.
  - 4. Perform all other operations necessary to restore existing manhole to condition acceptable to the City's Resident Project Representative.
- B. If existing manhole does not have steps, connection shall also include furnishing and installing new manhole steps. Steps shall be installed as described in Section 02606 – Manholes.
- C. Connections to existing manholes shall not be completed until new pipelines have been cleaned, tested, and accepted by the City's Resident Project Representative.
- D. No debris and rubbish from pipe lines or manholes shall be flushed into City's existing pipelines.

### **3.06 QUALITY CONTROL**

- A. Clean and flush new Sanitary sewer Main Lines as follows:
  - 1. Take every precaution to prevent dirt, grease, and all other foreign matter from entering each length of pipe before making connection in field.
  - 2. After each section of piping is installed, it shall be thoroughly cleaned to remove rocks, dirt, and other foreign matter by washing, sweeping, scraping or other methods that will not harm the pipe.
  - 3. For safety and to prevent rocks and other foreign matter from entering pipe, all open ends of pipe shall be plugged when workmen are not on the job or in the immediate area.
  - 4. All sections of sanitary sewer lines between manholes and sanitary sewer laterals extending from the sanitary sewer main shall be completely flushed.
    - a. Pipe 12-inch in diameter and larger shall be flushed at a rate of 3.0-feet per second.
    - b. Pipe under 12-inch diameter shall be flushed at a rate of 4.0-feet per second.
  - 5. The Contractor shall furnish water required for flushing and testing.

6. All temporary cross-connections for flushing and drainage shall be furnished, installed, and subsequently removed by the Contractor after completion of the operation.
  7. No debris and rubbish from pipe lines or manholes shall be flushed into existing City pipelines.
- B. Perform field inspection and testing in accordance with Section 01400.
- C. Prior to the backfilling of a trench, the City's Resident Project Representative shall inspect pipe installation; backfilling will be done only after the City's Resident Project Representative authorizes it.
1. The Contractor shall arrange for all inspections by calling the City's Engineering Department Inspection telephone number.
- D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to City.
- E. Test for Leakage: Test all pipe, fittings, and other items for leakage, in presence of City's Resident Project Representative, after items have been cleaned. Tests shall be done by independent testing company. All joints, couplings, and fittings shall be watertight.
1. Infiltration Test: Infiltration test required when pipe is below ground water level. Amount of water leaking into pipe shall be measured. Leakage of pipe shall not be more than 1-gallon per day per inch diameter per mile of pipe.
  2. Air Test: Low-pressure air test may be performed. Section of pipe being tested shall be sealed; line under test shall be pressurized to approximately 4.0-psi; and pressure allowed to stabilize for a minimum of two minutes. During this period air shall be added if the pressure drops below 4.0-psi. After this stabilization period, timing shall begin. The time of test, in minutes, shall be equal to the pipe diameter in inches. The maximum allowable pressure drop during the specified time period shall be 0.5-psi.
- F. Deflection Test, PVC Sanitary Sewer Pipe: After PVC sanitary sewer pipe has been cleaned, perform deflection test on each section of pipeline between manholes. The maximum allowable pipe deflection in vertical inside diameter, shall be 5-percent. Maximum allowable deflection shall be applied to the base inside diameters shown in Table 10.14, Base Inside Diameters For Deflection Measurements of ASTM D 3034 SDR35 PVC Sewer Pipe in the Uni-Bell "Handbook of PVC Pipe", to determine minimum permissible diameter, or other appropriate sources. Testing devices shall include deflectometer, calibrated television or photography, or properly sized mandrel.
- G. Televised Inspection: After the sanitary sewer pipe has been installed and cleaned; and the trench has been filled, the City will televise the sanitary sewer pipe to locate defects in the sanitary sewer pipe.
1. The Contractor shall arrange for television inspection.
  2. The Contractor shall ensure safe access to each manhole for the City's television trucks.
  3. If the City is called for a televised inspection and cannot perform such inspections due to defects in Work by Contractor, i.e. inaccessible manholes, dirty sanitary sewer pipe, etc., the Contractor shall be charged a call-back fee according to the current City Fee Schedule.
  4. Any Work not conforming to this Sanitary sewer Policies & Design Criteria Manual shall be

promptly removed, replaced and retested at not cost to the City.

H. Hydrostatic Test:

1. A hydrostatic test shall be performed on the following installed pipes:
  - a. Force Sanitary sewer Main Lines
  - b. Private pressure Sanitary sewer Laterals
2. Prior to the hydrostatic test, the line shall be flushed with an adequate flow volume and rate to remove any debris, silt, gravel or other material in the line.
3. Method of Test:
  - a. The lines to be tested shall be filled with clean water.
  - b. All air in the system shall be expelled before the test.
  - c. The test pressure shall be the greater of 150-percent of the maximum design pressure or 100-psi.
  - d. Leakage rate shall be less than determined by the formula:

$$Q = \frac{L \times D \times \text{square root of } P}{133,200}$$

Where:

- Q = allowable leakage rate, in gallons per hour
- L = length of pipe, in feet
- D = nominal diameter of pipe, in inches
- P = average test pressure, in psi (gauge)

- e. Locate and repair defective joints and retest until leakage rate is less than allowable.
- f. Repair any noticeable leakage even if total leakage is less than allowable.

**3.07 PROTECTION**

- A. Protect pipe and bedding material from damage or displacement until backfilling operation is in progress.

\*\*\* END OF SECTION \*\*\*

## **SECTION 02750**

### **SANITARY AND STORM DRAINAGE SYSTEM TESTING**

#### **PART 1 -- GENERAL**

##### **1.01 THE REQUIREMENT**

- A. The CONTRACTOR shall perform all pipeline flushing and testing, complete, for sanitary sewerage and storm drainage system piping as specified herein and in accordance with the requirements of the Contract Documents.
- B. The CONTRACTOR shall be responsible for conveying test water from the Owner-designated source to the point of usage and also for disposal, as required, of water used in the testing operations.

##### **1.02 CONTRACTOR SUBMITTALS**

- A. The CONTRACTOR shall submit minimum 48-hour advance written notice of its proposed testing schedule for review and concurrence of the ENGINEER. The CONTRACTOR's proposed plans for water conveyance, control, and disposal shall also be submitted in writing.

#### **PART 2 -- PRODUCTS**

##### **2.01 MATERIALS REQUIREMENTS**

- A. Temporary valves, bulkheads, or other water control equipment and materials shall be as determined by the CONTRACTOR subject to the ENGINEER's review. No materials shall be used which would be injurious to pipeline structure and future function.

#### **PART 3 -- EXECUTION**

##### **3.01 GENERAL**

- A. Unless otherwise provided herein, water for testing will be furnished by the OWNER; however, the CONTRACTOR shall make all necessary provisions for conveying the water from the OWNER-designated source to the points of use.
- B. Release of water from pipelines, after testing has been completed, shall be performed as reviewed by the ENGINEER.
- C. All testing operations shall be performed in the presence of the ENGINEER.

### 3.02 TESTING OF PIPING

- A. General: All gravity sewer pipes and service laterals shall be tested for exfiltration and/or infiltration and deflection as specified herein. All manholes shall be tested for leakage as required herein. Manholes shall be tested prior to backfill placement, whereas all pipe shall be backfilled prior to testing. Any pipe, lateral or manhole found to be defective shall be repaired or replaced to the satisfaction of the ENGINEER.
- B. Leakage Tests: All gravity sewer pipes shall be tested for leakage by one of the following three test methods as directed by the ENGINEER and following the specific procedures outlined in the referenced sections of the "Standard Specification for Public Works Construction" (SSPWC) 1985 edition:
1. Water Exfiltration Test      Section 306-1.4.2
  2. Water Infiltration Tes      Section 306-1.4.3
  3. Air Pressure Test            Section 306-1.4.4
- C. Deflection Test: All flexible and semi-rigid pipe shall be tested for deflection, joint displacement, or other obstruction by passing a rigid mandrel through the pipe by hand, not less than 30-days after completion of the trench backfill, but prior to any resurfacing. The mandrel test shall comply with the specific procedures required in Section 306-1.4.6 of the SSPWC, except for the additional provision that the mandrel shall be a full circle, solid cylinder, or a rigid, non-adjustable, odd-numbered leg (9 leg minimum) steel cylinder, approved by the ENGINEER as to design and manufacture.
- D. Manhole Leakage: Manholes shall be tested for leakage after installation, but prior to being backfilled. All pipes entering the manhole shall be sealed at a point outside the manhole walls so as to include testing of the pipe-manhole joints. The manhole shall be filled with water to a level 2 inches below the top of the frame. The water shall be allowed to equilibrate for 24 hours and then the level should be readjusted and marked. The water-filled manhole shall be allowed to sit for 3 days, after which the water level shall be measured. The water loss, adjusted for evaporative loss, shall not exceed 0.5 percent of the total volume. The exterior of the manhole shall be inspected daily during this period for visible evidence of leakage. Visible moisture, sweating, or beads of water on the exterior of the manhole shall not be considered leakage, but any water running across the surface will be considered leakage and shall be repaired to the satisfaction of the ENGINEER regardless of the volume of water lost.

\*\*\* END OF SECTION \*\*\*

## SECTION 03100

### CONCRETE FORMWORK

#### **PART 1--GENERAL**

##### **1.01 THE REQUIREMENT**

- A. The CONTRACTOR shall furnish all materials for concrete formwork, bracing, shoring, and supports and shall design and construct all falsework, all in accordance with the provisions of the Contract Documents.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Contractor Submittals. 01300
- B. Reinforcement Steel. 03200
- C. Joints in Concrete. 03290
- D. Cast-in-Place Concrete. 03300
- E. Grout. 03315
- F. Precast Concrete Specialties. 03480
- G. Sealants and Caulking. 07920

##### **1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS**

- A. Codes:  
The Building Code, as referenced herein, shall be the Uniform Building Code (UBC), as specified in section entitled, "Reference Standards." 01090
- B. Government Standards:  
PS 1-74 U.S. Product Standard for Concrete Forms, Class I.
- C. Commercial Standards:  
ACI 347-78 Recommended Practice for Concrete Formwork.

##### **1.04 CONTRACTOR SUBMITTALS**

- A. Falsework Calculations and Drawings: The CONTRACTOR's attention is directed to the provisions of Section 1717 of the Division of Industrial Safety, Construction Safety Orders, as revised November 1973, which requires that all falsework or vertical shoring installations where the height of the falsework or vertical shoring, as measured from the top of the sills to the soffit of the superstructure, exceeds 14-feet, or where individual horizontal span lengths exceed 16 feet, or provision for vehicular or railroad traffic through falsework or vertical shoring is made, shall be approved and signed by a civil engineer, registered in the State of California; provided further, that a copy of the falsework plan or shoring layout shall be available on the job site at all times.
- B. The CONTRACTOR shall, in accordance with the requirements in Section entitled "Contractor Submittals," 01300 submit detailed plans of the falsework proposed to be used. Such plans shall be

in sufficient detail to indicate the general layout, sizes and members, anticipated stresses, grade of materials to be used in the falsework, and typical soil conditions.

## **1.05 QUALITY ASSURANCE**

- A. Tolerances: The variation from established grade or lines shall not exceed 1/4-inch in 10 feet and there shall be no offsets or visible waviness in the finished surface. All other tolerances shall be within the "Suggested Tolerances" specified in Section 203 of ACI 347.

## **PART 2 -- PRODUCTS**

### **2.01 GENERAL**

- A. Except as otherwise expressly accepted by the ENGINEER, all lumber brought on the job site for use as forms, shoring, or bracing shall be new material. All forms shall be smooth surface forms and shall be of the following materials:
1. Walls - Steel or plywood panel
  2. Columns - Steel, plywood or fiber glass plywood
  3. Roof and floor
  4. Slabs - Plywood
  5. All other work - Steel panels, plywood or tongue and groove lumber

### **2.02 FORM AND FALSEWORK MATERIALS**

- A. Materials for concrete forms, formwork, and falsework shall conform to the following specifications:
1. Lumber shall be Douglas Fir or Southern Pine, construction grade or better, in conformance with U.S. Product Standard PS20.
  2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Pine plywood manufactured, especially for concrete formwork and shall conform to the requirements of PS 1 for Concrete Forms, Class I, and shall be edge sealed.
  3. Form materials shall be plywood or other approved material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line and grade as shown. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Exterior Grade.
- B. Unless otherwise shown, exterior corners in concrete members shall be provided with 3/4-inch chamfers. Re-entrant corners in concrete members shall not have fillets unless otherwise shown.
- C. Forms and falsework to support the roof and floor slabs shall be designed for the total dead load, plus a live load of 30 psf minimum.

### **2.03 FORM TIES**

- A. Form ties with integral waterstops shall be provided with a plastic cone or other suitable means of forming a conical hole to insure that the form tie may be broken off back of the face of the concrete.

The maximum diameter of removable cones for rod ties, or of other removable for-tie fasteners having a circular cross-section, shall not exceed 1-1/2 inches; and all such fasteners shall be such as to leave holes of regular shape for reaming.

- B. Form ties for water-retaining structures shall have integral water stops. Removable taper ties may be used when approved by the ENGINEER. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie.

### **PART 3 -- EXECUTION**

#### **3.01 GENERAL**

- A. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The CONTRACTOR shall assume full responsibility for the adequate design of all forms, and any forms which are unsafe or inadequate in any respect shall promptly be removed from the work and replaced at the CONTRACTOR's expense. A sufficient number of forms of each kind shall be provided to permit the required rate of progress to be maintained. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state, and Federal regulations. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by CONTRACTOR's personnel and by the ENGINEER and shall be in sufficient number and properly installed. During concrete placement, the CONTRACTOR shall continually monitor plumb and string line form positions and immediately correct deficiencies.
- B. Concrete forms shall conform to the shape, lines, and dimensions of members as called for on the Drawings, and shall be substantial, free from surface defects, and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

#### **3.02 FORM DESIGN**

- A. All forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Plywood, 5/8-inch and greater in thickness, may be fastened directly to stuffing of the studs are spaced close enough to prevent visible deflection marks in the concrete. The forms shall be tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Specifically, the bottom of the wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1 to 1-1/2 inch diameter polyethylene rod held in position to the underside of the wall form. Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable the ENGINEER.

#### **3.03 CONSTRUCTION**

- A. Vertical Surfaces: All vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is shown. Not less than 1-inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Such permission will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.
- B. Construction Joints: Concrete construction joints will not be permitted at locations other than those shown or specified, except as may be acceptable to the ENGINEER. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.
- C. Form Ties:
1. Embedded Ties: Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar as specified for "Finish of Concrete Surfaces" in Section entitled "Cast-in-Place Concrete." 03300 Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face of faces of the concrete.
  2. Removable Ties: Where taper ties are approved for used, the larger end of the taper tie shall be on the wet side of walls, in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plumb shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink or regular cement grout for above-grade walls which are dry on both sides. Exposed faces of walls shall have the outer 2-inches of the exposed face filled with a cement grout which shall match the color and texture of the surrounding wall surface.

### **3.04 REUSE OF FORMS**

- A. Forms may be reused only if in good condition and only if acceptable to the ENGINEER. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on all exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the ENGINEER.

### **3.05 REMOVAL OF FORMS**

- A. Careful procedures for the removal of forms shall be strictly followed, and this work shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted. In the case of roof slabs and above-ground floor slabs, forms shall remain in place until test cylinders for the roof concrete attain a minimum compressive strength of 75 percent of the 28-day strength specified in Section entitled, "Cast-in-Place Concrete"; 03300 provided, that no forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or until has attained 75 percent of the specified 28-day strength and has been in place for a minimum of 7 days. The time required to establish said strength shall be as determined by the ENGINEER who will make several test cylinders for this purpose from concrete used in the first group of roof panels placed. If the time so determined is more than the 7-day minimum, then that time shall be used as the minimum length of time. Forms for all vertical walls and columns shall remain in place at least 2 days after the concrete has been placed. Forms for all parts of the WORK not specifically mentioned herein shall remain in place for periods of time as determined by the ENGINEER.

### **3.06 MAINTENANCE OF FORMS**

- A. Forms shall be maintained at all times in good condition, particularly as to size, shape, strength, rigidity, tightness, and smoothness of surface. Forms, when in place, shall conform to the established alignment and grades. Before concrete is placed, the forms shall be thoroughly cleaned. The form surfaces shall be treated with a non-staining mineral oil or other lubricant acceptable to the ENGINEER. Any excess lubricant shall be satisfactorily removed before placing the concrete. Where field oiling of forms is required, the CONTRACTOR shall perform the oiling at least two weeks in advance of their use. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

### **3.07 FALSEWORK**

- A. The CONTRACTOR shall be responsible for the design, engineering, construction, maintenance, and safety of all falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, the requirements of the Construction Safety Orders of the California Division of Industrial Safety, and the requirements specified herein.
- B. All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time.
- C. Falsework shall be placed upon a solid footing, safe against undermining, and protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall not exceed 20 tons. When falsework is supported on any portion of the structure which already constructed, the load imposed by the falsework shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

\*\*\* END OF SECTION \*\*\*

## SECTION 03102

### GENERAL CONCRETE CONSTRUCTION

#### PART 1 -- GENERAL

##### 1.01 SCOPE OF WORK

- A. This section includes materials, installation, and testing of formwork, reinforcing steel, joints, concrete, insulation, and finishing and curing for general concrete construction.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 09820 - Crystalline Waterproofing
- B. Section 09900 - Painting and Coating
- C. Section 15142 - Wall Pipes, Seep Rings, and Penetrations

##### 1.03 SUBMITTALS

- A. Submit shop drawings in accordance with the Contract Documents.
- B. Submit manufacturer's catalog data and descriptive literature for form ties, spreaders, corner forms, form coatings and curing compound, bond breakers, joint sealant, backing rod, joint filler, control joints, epoxy bonding compound, and floor hardener.
- C. Submit mill test certificates identifying chemical and physical analyses of each load of reinforcing steel delivered. If mill test reports are unavailable and the quantity of steel for a structure exceeds 5 tons, provide a laboratory test to prove conformance with the specified ASTM standard.
- D. Submit reinforcing bending lists and placing drawings for all reinforcing. Placing drawings shall indicate all openings (mechanical, electrical, equipment, and architectural) including additional reinforcing at openings and corner bar arrangements at intersecting beams, walls, and footings indicated in the typical detail and structural drawings. Placing drawings shall be coordinated with the concrete placing schedule. Each bending list and placing drawing submitted shall be complete for each major element of a structure (grade slabs, footings, walls, deck, floor, or roof slabs) including dowels and corner bars. Furnishing such lists shall not be construed that the lists will be reviewed for accuracy. The Contractor shall be wholly and completely responsible for the accuracy of the lists and for furnishing and placing reinforcing steel in accordance with the details shown on the plans and as specified.
- E. Submit concrete mix design at least 15 days before placing concrete.
- F. Submit insulation manufacturer's product data sheets confirming compliance with the physical properties specified herein, CFC compliance certification and 15-year limited thermal warranty certificate, samples of specified insulation, and adhesive manufacturer's product information confirming compatibility with polystyrene insulation.

## **PART 2 -- PRODUCTS**

### **2.01 FORMWORK**

- A. Design forms according to ACI 347.
- B. Class I Forms. Use steel forms, ply form, or smooth-surface plywood 3/4-inch minimum thickness for straight surfaces and 1/2-inch minimum thickness for curved surfaces.
- C. Class II Forms. Use plywood in good condition, metal, or smooth-planed boards free from large or loose knots with tongue and groove or ship lap joints. Forms shall be oiled.
- D. Class II forms may be used for exterior concrete surfaces, which are 1-foot, or more below finished grade. Use Class I forms for all other surfaces.

### **2.02 BOND BREAKER**

- A. Bond breaker shall be a nonstaining type which will provide a positive bond prevention, such as Williams Tilt-Up Compound, as manufactured by Williams Distributors, Inc., Seattle, Washington; Silcoseal 77, as manufactured by SCA Construction Supply Division, Superior Concrete Accessories, Franklin Park, Illinois; or approved equal.

### **2.03 FORM RELEASE AGENT**

- A. Form release agent shall effectively prevent absorption of moisture and prevent bond with the concrete. Agency shall be nonstaining and nontoxic after 30 days.
- B. For steel forms, release agent shall prevent discoloration of the concrete due to rust.

### **2.04 REINFORCING STEEL**

- A. Reinforcement shall conform to ASTM A615, Grade 60.
- B. Fabricate reinforcing in accordance with the current edition of the Manual of Standard Practice, published by the Concrete Reinforcing Steel Institute. Bend reinforcing steel cold.
- C. Deliver reinforcing steel to the site bundled and tagged with identifying tags.

### **2.05 WELDED WIRE FABRIC**

- A. Welded wire fabric shall conform to ASTM A185.

### **2.06 TIE WIRE**

- A. Tie wire shall be 16-gauge minimum, black, soft, annealed.

## 2.07 BAR SUPPORTS

- A. Bar supports in beams and slabs exposed to view after form stripping shall be galvanized and plastic coated. Use concrete supports for reinforcing in concrete placed on grade.

## 2.08 BAR COUPLERS

- A. Reinforcing steel bar splicing couplers shall be a mechanical type as manufactured by Dayton Barsplice Inc. or approved equal. Use couplers, which do not reduce tensile or ultimate strength of bars.

## 2.09 JOINT SEALANT

- A. Joint sealant shall be a multipart, gray, nonstaining, nonsagging, polyurethane sealant, which cures at ambient temperature to a firm, flexible, resilient, tear-resistant rubber. Sealant shall be RC 270 of Products Research and Chemical Corporation, Mameco International Vulkem 227, Multi-Chem Mc287, or approval equal.

| Technical Requirements      |   |
|-----------------------------|---|
| Consistency                 | Gun grade   |
| Tack free time              | 24-hours at 75 degrees F and 50% R.H.             |
| Pot life                    | 1 to 3 hours                                      |
| Hardness                    | 35 Shore A,5                                      |
| Elongation                  | 700%  |
| Tensile strength, ASTM D412 | 300 psi   |
| Peel strength on concrete   | No loss of bond after 24 hours at 150% elongation |
| Temperature service range   | -40 degrees F to +175 degrees F                   |
| Immersion in water          | Continuous  |

## 2.10 BACKING ROD FOR EXPANSION JOINTS

- A. Backing rod shall be an extruded closed-cell polyethylene foam rod, such as Minicel backer rod, manufactured by Industrial Systems Department, Plastic Products Group of Hercules, Inc., Middletown, Delaware; Ethafoam SB, as manufactured by Dow Chemical Company, Midland, Michigan; or approved equal. The rod shall be 1/4-inch larger in diameter than the joint width. Where possible, provide full-length sections for the joint; minimize splices. Apply backup rod and bond breaker tape in expansion joints.

## **2.11 BOND BREAKER TAPE**

- A. Bond breaker tape shall be an adhesive-backed glazed butyl or polyethylene tape, which will adhere to the premolded joint material or concrete surface. The tape shall be the same width as the joint. The tape shall be compatible with the sealant.

## **2.12 PREFORMED CONTROL JOINT**

- A. Preformed control joint shall be a one-piece, flexible, PVC joint former, such as Kold-Seal Zip-Per Strip, KSF-150-5--5-, manufactured by Vinylex Corp., Knowville, Tennessee, or a one-piece steel strip with preformed groove, such as Keyed Kold Retained Kap, manufactured by Burke Concrete Accessories, Inc., San Mateo, California, or approved equal. Provide the preformed control joint material in full-length unspliced pieces.

## **2.13 PREMOLDED JOINT FILLER**

- A. Joint filler shall be preformed, nonextruded type constructed of closed-cell neoprene conforming to ASTM D 1752, Type I, as manufactured by W.R. Grace Company of Cambridge, Massachusetts; W.R. Meadows, Inc., Elgin, Illinois; or equal.

## **2.14 STEEL EXPANSION JOINT DOWELS**

- A. Steel expansion joint dowels shall conform to one of the following:
  - 1. Epoxy coated steel bar dowels with a 12-mil coating thickness. Steel bar dowels shall conform to ASTM A 36 or ASTM 615, plain rounds, Grade 40. Epoxy coating shall be in conformance with ASTM A 775; or approve equal.
  - 2. Stainless steel bar dowels conforming to ASTM A 276, Type 302.
- B. Exposed portion of expansion joint dowels shall be thoroughly greased prior to casting or adjoining wall or slab.

## **2.15 CEMENT**

- A. Cement shall conform to ASTM C150, Type II, with maximum tricalcium aluminate not to exceed 8 percent and shall be from a prequalified producer of cement (Corps of Engineers specifications). The maximum percent alkalis shall not exceed 0.6 percent.

## **2.16 AGGREGATES**

- A. Aggregates shall comply with ASTM C33 and shall contain less than 1 percent asbestos by weight or volume and be free from any substances, which will react with cement alkalis.

## **2.17 CONCRETE ADMIXTURES**

- A. Concrete shall contain an air-entraining admixture. Admixture shall conform to ASTM C260, except it shall be nontoxic after 30 days and shall contain no chlorides. Admixtures shall be Master Builders MB-AE 10, Sika AER (Sikamix 104), or approved equal.

- B. Concrete shall contain a water-reducing admixture. The admixture shall conform to ASTM C494, Type A or D except it shall contain no chlorides, shall be nontoxic after 30 days, and shall be compatible with the air-entraining admixtures. The amount of admixture added to the concrete shall be in accordance with the manufacturer's recommendations. Admixtures shall be Master Builders Pozzoloth polymer-type normal setting, Plastocrete (Sikamix 160) Normal Set, Sika Chemical Corporation, or approved equal.
- C. Do not use any admixture, which contains chlorides or other corrosive elements in any concrete.

**2.18 GROUT**

- A. Nonshrink grout shall conform to the Corps of Engineers Specification for Nonshrink Grout, CRD-C621-83, and to these specifications. Use a nongas-liberating type, cement base, premixed product requiring only the addition of water for the required consistency. Grout shall be UPCON High Flow, Master Flow 713, or approved equal. Components shall be inorganic.
- B. Ordinary type grout (dry pack) shall consist of one part portland cement to two parts sand (100 percent passing a No. 8 sieve). Add sufficient water to form a damp formable consistency.
- C. Expansive Grout. Premixed, cementations mixture with a minimum 28-day strength of 3,500 psi. Provide air-entraining content as recommended by the manufacturer.
- D. Epoxy Grout.
  - 1. Mix the two components of epoxy bonding compound in compliance with the manufacturer's instructions.
  - 2. Use sand, which is oven dry and meets the following gradation requirements for epoxy grout:

| Sieve Size | No. 8 | No. 50 | No. 100 |
|------------|-------|--------|---------|
| % Passing  | 100   | 30-15  | 55      |

**2.19 MORTAR**

- A. Mortar or grout placed on horizontal construction joints shall be a mixture of cement, sand, and water in the same proportions used in the concrete but with coarse aggregate omitted.
- B. Mortar used for repair of concrete shall be made of the same materials as used for concrete, except that the course aggregate shall be omitted and the mortar shall consist of not more than one part cement to two and one-half parts sand by damp loose volume. The quantity of mixing water shall be no more than necessary for handling and placing.

**2.20 BONDING COMPOUND**

- A. Epoxy bonding compound shall be Concessive 1001 LPL, Adhesive Engineering Company, San Carlos, California; Sikadur Hi-Mod (Sikastix 370), Sika Chemical Corporation, Lyndhurst, New Jersey; Epoxtile 2391 by W.R. Grace and Company; Euco Epoxy 463 by Euclid Chemical Company;

or approved equal.

- B. Nonepoxy bonding compound shall be Weldcrete by Larsen Products Corporation, Link by Sta-Dry Manufacturing Corp., Euco Weld by Euclid Chemical Company, or approved equal. The compound shall be rewettable for up to two weeks.

**2.21 CONCRETE MIX DESIGN**

- A. Conform to ASTM C94, except as modified by these specifications.
- B. Air content as determined by ASTM C231 shall be 4 percent to 1 percent.
- C. Maximum water-cement ratio for Class A concrete shall be equal to 0.45 by weight.
- D. Use classes of concrete as described in the following table:

| Class | Type of Work   | 28-Day<br>Compressive<br>Strength<br>(psi) | Minimum<br>Cement<br>Content<br>(lbs/c.y.) |
|-------|--|--|--|
| A     | Concrete for all structures and concrete not otherwise specified. Concrete fill at structure foundations, cradle, supports across pipe trenches. | 4,000                                      | 564  |
| B     | Pavement   | 3,000                                      | 500  |
| C     | Floor grout, miscellaneous unreinforced concrete.  | 2,000                                      | 376  |

- E. Measure slump in accordance with ASTM C143. Slump shall be as follows:

|  |               |
|--|---------------|
| Slab on grade or heavy sections wider (in plan view) than 3-feet | 3-inches max. |
| Footings, walls, suspended slabs, beams, and columns             | 4-inches max. |
| Pavement   | 2-inches max. |

Proportion and produce the concrete to have a maximum slump as shown. A tolerance of up to 1-inch above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit. Concrete of lower than usual slump may be used provided it is properly placed and consolidated.

- F. Aggregate size shall be 3/4-inch maximum for slabs and sections 8-inches thick and less. Aggregate size shall be 1-inch maximum for slabs and sections greater than 8-inches and smaller than 17-inches. Aggregate size shall be 1-1/2-inches maximum for all larger slabs and sections.

G. Combined aggregate grading shall be as shown in the following table:

|                              | Maximum Aggregate Size |        |          |
|------------------------------|------------------------|--------|----------|
|                              | 1 1/2-inch             | 1-inch | 3/4-inch |
| Aggregate Grade per ASTM C33 | 467                    | 57     | 67       |

H. Mix design for pumped concrete shall produce a plastic and workable mix. The percentage of sand in the mix shall be based on the void content of the coarse aggregate.

**2.22 CONCRETE TESTS**

A. Perform concrete quality testing on the concrete as follows:

1. Frequency of Sampling: Cast four concrete test cylinders from each 50 cubic yards of concrete, or fraction thereof, of each class of concrete placed in any one day. Sampling and curing of cylinders shall conform to ASTM C 31.
2. Strength Testing: Test cylinders in accordance with ASTM C 39. Test one cylinder at 7-days for information; test two cylinders at 28 days for acceptance; and hold one cylinder for verification. Strength acceptance will be based on the average of the strengths of the two cylinders tested at 28-days. If one cylinder of a 28-day test manifests evidence of improper sampling, molding, or testing, other than low strength, discard it and use the fourth cylinder for the test result.
3. Determine concrete slump by ASTM C 143 with each strength test sampling and as required to establish consistency.
4. Determine air content of the concrete using ASTM C 231 to verify the percentages of air in the concrete immediately prior to depositing in forms.
5. The average value of concrete strength tests shall be equal to or greater than the specified 28-day strength. Non-test shall be less than 90-percent of the specified 28-day strength.
6. If the 28-day strength tests fail to meet the specified minimum compressive strength, the concrete will be assumed to be defective and one set of three cores from each area may be taken as selected by the Construction Manager and in accordance with ASTM C42. If the average compressive strength of the set of three concrete cores fails to equal 90-percent of the specified minimum compressive strength or if any single core is less 75-percent of the minimum compressive strength, the concrete will be considered defective. The Owner may require additional coring, nondestructive load testing, or repair or removal of defective concrete. Costs of coring, testing of cores, load testing, and required repairing pertaining thereto shall be paid by the Contractor at no extra cost to the Owner.

B. To facilitate any Construction Manager-concrete sampling and testing:

1. Furnish labor to assist the Construction Manager in obtaining and handling samples at the project

- site.
2. Advise the Construction Manager in advance of concrete placing operations to allow for scheduling and completion of quality testing.
  3. Provide and maintain facilities for safe storage and proper curing of concrete test specimens on the project site, as required by ASTM C31.

### **2.23 CURING COMPOUND**

- A. Curing compound shall conform to ASTM C309, Type 1 or 1-D, Class B.
- B. Curing compound shall be compatible with required finishes and coatings.

### **2.24 RIGID INSULATION**

- A. The insulation shall be 2-inch thick, HCFC-blown, extruded polystyrene with an R-value of 5-hour foot squared degree F/BTU per inch. The insulation shall meet ASTM C578, Type IV (25 psi). Insulation shall be STYROFOAM brand Square Edge insulation as manufactured by Dow Chemical, or approved equal.
- B. The insulation shall be manufactured with a blowing agent, which provides at least 90-percent reduction in ozone depletion potential compared to standard CFC blowing agents. Other insulations are not acceptable.
- C. The insulation shall be new, free from defects, and of uniform color.
- D. The insulation shall have a limited thermal warranty stating that the R-value will not deviate more than 10-percent from its published value for a period of 15 years from the manufacturing date printed on the insulation boards.

### **2.25 ADHESIVE**

- A. Adhesive shall be as recommended by insulation manufacturer for use with polystyrene foam. Adhesive shall be formulated specifically to bond insulation to steel and concrete surfaces.

## **PART 3 -- EXECUTION**

### **3.01 FORM TOLERANCES**

- A. Failure of the forms to produce the specified concrete surface and surface tolerance shall be grounds for rejection of the concrete work. Rejected work shall be repaired or replaced at no additional cost to the Owner.
- B. The following table indicates tolerances or allowable variations from dimensions or positions of structural concrete work:

|                                  | <b>Maximum Tolerance</b>                        |
|----------------------------------|---|
| Sleeves and inserts              | +1/4" -1/4"                                     |
| Projected ends of anchors        | +1/4" -1/4"                                     |
| Anchor bolt setting              | +1/4" -1/4"                                     |
| Finished concrete, all locations | +1/4" -1/4" in 10-foot max., 1" in total length |

The planes or axes from which the above tolerances are to be measured shall be as follows:

|                            |  |
|----------------------------|--|
| Sleeves and inserts:       | Centerline of sleeve or insert.  |
| Projected ends of anchors: | Plane perpendicular to the end of the anchor as located on the drawings. |
| Anchor bolt setting:       | Centerline of anchor bolt.   |
| Finish concrete:           | The concrete surface as located on the drawings.                         |

Where equipment is to be installed, comply with manufacturer's tolerances if more restrictive than above.

### **3.02 FORM SURFACE PREPARATION**

- A. Clean form surfaces to be in contact with concrete of foreign material prior to installation.
- B. Coat form surfaces in contact with concrete with a release agent prior to form installation.

### **3.03 FORM REUSE**

- A. Reuse only forms, which provide a uniform surface texture on exposed concrete surfaces. Apply light sanding or other surface treatment between uses for uniform texture. Plug unused tie rod holes with corks, shave flush, and sand the concrete surface side. Do not patch forms other than filling tie rod holes, except in the case of Class II forms, do not use metal patching discuss on Class I forms.

### **3.04 REMOVAL OF FORMS**

- A. Forms and shoring for elevation structural slabs or beams shall remain in place until the concrete has reached a compressive strength equal to the specified 28-day compressive strength as determined by test cylinders. Do not remove supports and reshore. The following table indicates the minimum allowable time after the last cast concrete is placed before forms, shoring, or wall bracing may be

removed.

|  |  |
|--|--|
| Sides of footings and encasements  | 24 hours   |
| Walls, vertical sides of beams, girders, columns, and similar members not supporting loads | 48 hours   |
| Slabs, beams, and girders  | 10 days (forms only)   |
| Shoring for slabs, beams, and girders  | Until concrete strength reaches specified 28-day strength        |
| Wall bracing   | Until to or roof slab concrete reaches specified 28-day strength |

- B. Do not remove forms from concrete, which have been placed with outside air temperature below 50-degrees F without first determining if the concrete has properly set without regard for time. Do not apply heavy loading on green concrete. Immediately after forms are removed, the surface of the concrete shall be carefully examined and any irregularities in the surface shall be repaired and finished as specified.

### 3.05 FORMED OPENINGS

- A. Openings shall be of sufficient size to permit final alignment of pipes or other items without deflection or offsets of any kind. Allow space for packing where items pass through the wall to ensure water tightness. Provide openings with continuous keyways and water stops. Provide a slight flare to facilitate grouting and the escape of entrained air during grouting. Provide formed openings with reinforcement as indicated in the typical structural details. Reinforcing shall be at least 2-inches clear from the opening surfaces and encased items.

### 3.06 EMBEDDED ITEMS

- A. Set anchor bolts and other embedded items accurately and hold securely in position until the concrete is placed and set. Check all special castings, channels, or other metal parts that are to be embedded in the concrete prior to and again after concreting. Check all nailing blocks, plugs, and strips necessary for the attachment of trim, finish, and similar work prior to concreting.

### 3.07 BEVELED EDGES (CHAMFER)

- A. Form 3/4-inch beveled edges on exposed concrete edges and corners, beam soffit corners, and where indicated on the drawings. Reentrant corners in concrete members shall not have fillets, unless otherwise shown in the drawings. The top edges of slabs, walkways, beams, and wall may be beveled with an edging trowel in lieu of using chamfer strips.

### 3.08 CONSTRUCTION JOINTS

- A. Provide construction joints in accordance with the following:

1. Slabs. Maximum spacing of 40-feet on center in each direction in plan.
2. Retaining Walls. Maximum spacing of 50-feet on center (vertical joints).
3. Box-Shaped (in plan) Structure (not culverts). Maximum total length of wall without construction joints is 80-feet.
4. Box Culverts. Maximum spacing of 50-feet for wall and slab joints transverse to the longitudinal axis of the culvert.

For purposes of maximum spacing requirements, expansion joints are considered to be construction joints.

- B. Layout of construction joints shall be shown in the drawings and according to the following guidelines:
1. Provide horizontal construction joints at top of foundation members and slabs-on-grade and at the soffit of supported slabs and beams.
  2. Space the construction joints at a maximum horizontal distance of 25-feet and a maximum vertical distance of 16-feet.
  3. Space the corner vertical construction joints between 4 and 8-feet from the corner of walls or wall intersections.
  4. Space horizontal construction joints at least 8-inches below bottom of slabs.
- C. Construction joints shall be keyed, unless otherwise detailed. Form keyways by beveled strips or boards placed at right angles to the direction of shear. Except where otherwise shown on the drawings or specified, keyways shall be at least 1 1/2-inches in depth over at least 25-percent of the area of the section.
- D. When it is necessary to make a joint because of an emergency, furnish and place reinforcing dowels across the joint. Embed dowels 48 bar diameters each side of the joint. Size and number of dowels shall match reinforcing in the member. Furnishing and placing such reinforcing steel shall be at the Contractor's expense.
- E. After the pour has been completed to the construction joint and the concrete has hardened, thoroughly clean the entire surface of the joint of surface laitance, loose or defective concrete, and foreign material, and expose clean aggregate by sandblasting the surface of construction joints before placing the new concrete. Cover horizontal construction joints with mortar, spread uniformly and work thoroughly into all irregularities of the surface. The water-cement ratio of the mortar in place shall not exceed that of the concrete to be placed, and the consistency of the mortar shall be suitable for placing and working.
- F. In case of emergency, place additional construction joints. (An interval of 45 minutes constitutes cause for an emergency construction joint.)

### **3.09 EXPANSION JOINTS**

- A. Provide expansion joints with continuous edge reservoirs, which shall be filled with a joint sealant. Leave the material used for forming the reservoirs in place until immediately before the grooves are cleaned and filled with joint sealant. After removing edge forms from the reservoir, remove grout, loose concrete, and fill; then sandblast the slots. Allow the reservoir to become thoroughly dry; then

flow out the reservoir and immediately prime and fill with the expansion joint sealant and backup materials. The primer used shall be supplied by the same manufacturer supply the joint sealant.

### **3.10 TIME BETWEEN CONCRETE POURS**

- A. At least 2-hours shall elapse after depositing concrete in the columns or walls before depositing in beams, girders, or slabs supported thereon. Place beams, girders, brackets, column capitals, and haunches monolithically as part of the floor or roof system, unless otherwise indicated on the drawings.

### **3.11 INSTALLATION OF PREMOLDED JOINT FILLER**

- A. Install in joint accurately as shown. Attach to concrete with a bonding agent recommended by the joint sealant and joint filler manufacturer for compatibility.

### **3.12 INSTALLATION OF JOINT SEALANTS**

- A. Install in joint accurately as shown. Attached to concrete with a bonding agent recommended by the joint sealant and joint filler manufacturer for compatibility.
- B. After the joints have been prepared as described above, apply the joint sealant. Apply the primer, if required, and joint sealant only with the equipment and methods recommended by the joint sealant manufacturer. Application criteria for the sealant materials, such as temperature and moisture requirements and primer cure time, shall be in accordance with the recommendations of the sealant manufacturer.
- C. Apply masking tape along the edges of the exposed surface of the exposed joints. Trowel the joints smooth with a tuck-pointing tool wiped with a solvent recommended by the sealant manufacturer.
- D. After the sealant has been applied, remove the masking tape and any sealant spillage.

### **3.13 INSTALLATION OF STEEL EXPANSION JOINT DOWELS**

- A. Install parallel to wall or slab face, perpendicular to the joint face, and in true horizontal position. Secure tightly in forms with rigid ties, Orient dowels to permit joint movement.

### **3.14 PLACING REINFORCEMENT**

- A. Place reinforcing steel in accordance with the current edition of Recommended Practice for Placing Reinforcing Bars, published by the Concrete Reinforcing Steel Institute.
- B. Place reinforcing in accordance with the following, unless otherwise indicated:
  - 1. Reinforcement indicated on the drawings is continuous through the structure to the farthest extent possible. Terminate bars 2-inches clear from faces of concrete.
  - 2. Splices may be used to provide continuity due to bar length limitations. Minimum length of bars spliced for this reason is 40-feet. Splicing of reinforcement, which is detailed to be continuous on the drawings, is not permitted.

- C. Reinforcing steel, before being positioned and just prior to placing concrete, shall be free from loose mill and rust scale and from any coatings, which may destroy or reduce the bond. Clean reinforcing steel by sandblasting or wire brushing and remove mortar, oil, or dirt to remove materials, which may reduce the bond.
- D. Do not straighten or rebend reinforcing steel in the field.
- E. Position reinforcing steel in accordance with the drawings and secure by using annealed wire ties or clips at intersections and support by concrete or metal supports, spacers, or metal hangers. Do not place metal clips or supports in contact with the forms. Bend tie wires away from the forms to provide the specified concrete coverage. Bars additional to those shown on the drawings, which may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position, shall be provided by the Contractor at his own expense.
- F. Place reinforcement a minimum of 2-inches clear of any metal pipe or fittings.
- G. Secure reinforcing dowels in place prior to placing concrete. Do not press dowels into the concrete after the concrete has been placed.
- H. Roll wire mesh used for reinforcement flat before placing concrete. Support and tie wire mesh to prevent movement during concrete placement.
- I. Position dowels for masonry walls to occur at reinforced block cells.

### **3.15 SITE MIXED CONCRETE**

- A. Conform to ACI 304.

### **3.16 READY-MIXED CONCRETE**

- A. Conform to ASTM C94.

### **3.17 PLACING CONCRETE**

- A. Conform to ACI 304.

### **3.18 PUMPING CONCRETE**

- A. Conform to ACI 304.2R-71.

### **3.19 WEATHER REQUIREMENTS**

- A. Conform to ACI 305 for placing during hot weather.
- B. Conform to ACI 306 for placing during cold weather.

### 3.20 BONDING TO OLD CONCRETE

- A. Coat the contact surfaces with epoxy bonding compound. The method of preparation and application of the bonding compound shall conform to the manufacturer's printed instructions and recommendations for specific application for this project.

### 3.21 BACKFILL AGAINST WALLS

- A. Do not place backfill against walls until the concrete has obtained a compressive strength equal to the specified 28-day compressive strength. Where backfill is to be placed on both sides of the wall, place the backfill uniformly on both sides.
- B. Do not backfill the walls of structures, which are laterally restrained or supported by, suspended slabs or slabs on grade until the slab is poured and the concrete has reached the specified compressive strength.
- C. Do not use heavy equipment to compact backfill within 5-feet of vault walls. Compact by hand or other means which will not impose significant loads on the walls.

### 3.22 CONCRETE FINISHES

- A. Complete concrete surfaces in accordance with the following schedule:

| Finish Designation | Area Applied   |
|--------------------|--|
| F-1                | Beams, columns, and exterior walls not exposed to view.  |
| F-3                | Beams, columns, and walls of structures exposed to view.<br>Underside of formed floors or slabs. |
| F-4                | Exterior and interior surfaces to be coated.   |
| S-1                | Slabs and floors to be covered with concrete or grout.   |
| S-4                | Slabs and floors of structures exposed to view.  |
| E-1                | Exposed edges. EXCEPTION: edges normally covered with earth.                                     |
| E-2                | Top of walls, beams, and similar unformed surfaces.  |

- B. Finish F-1: Repair defective concrete, fill depressions deeper than 1/2-inch, and fill tie holes.
  - 1. Finish F-3: In addition to Finish F-1, remove fins, fill depressions 1/4-inch or deeper, fill depressions and air holes with mortar. Dampen surfaces and then spread a slurry consisting of one part cement and 1 1/2 parts sand by damp loose volume, over the surface with clean burlap pads or sponge rubber floats. Remove any surplus by scraping and then rubbing with clean burlap.
  - 2. Finish F-4: Repair defective concrete, remove fins, fill depressions 1/16-inch or deeper, fill tie

- holes, remove mortar spatter, and remove bulges higher than 1/16-inch.
3. Finish S-1: Screed to grade without special finish.
  4. Finish S-4: Steel trowel finish without local depressions or high points and apply a light hair-broom finish. Do not use stiff bristle brooms or brushes. Leave hair-broom lines parallel to the direction of slab drainage.
  5. Finish E-1: Provide chamfer or beveled edges.
  6. Finish E-2: Strike smoothly and float to an F-3 or F-4 finish.

### 3.23 CURING CONCRETE

- A. Conform to ACI 308.
- B. Water cure with burlap mats unless optional curing methods are permitted.
- C. Do not use curing compound on surfaces, which are to be coated in accordance with Section 09820 and 09900.
- D. It is the responsibility of the Contractor to select the appropriate curing method in response to climatical and/or site conditions occurring at the time of concrete placement. Take appropriate measures as described in ACI 305 and 306 for protecting and curing concrete during hot and cold weather.

### 3.24 REPAIR OF DEFECTS

- A. Do not repair defects until concrete has been reviewed by the Construction Manager.
- B. Surface Defects: Repair surface defects, which are smaller than 1-foot across in any direction and are less than 1/2-inch in depth.

Repair by removing the honeycombed and other defective concrete down to sound concrete, make the edges perpendicular to the surface and at least 3/8-inch deep, thoroughly dampen the surface, work into the surface a bonding grout (one part cement to one part fine sand), fill the hole with mortar, match the finish on the adjacent concrete, and cure as specified.

- C. Severe Defects: Repair severe defects which are larger than surface defects but do not appear to affect the structural integrity of the structure.

Repair by removing the honeycombed and other defective concrete down the sound concrete, make the edges of the hole perpendicular to the surface, sandblast the surface, coat the sandblasted surface with epoxy bonding compound, place nonshrink grout, match the finish on the adjacent concrete, and cure as specified.

- D. Major Defects: If the defects are serious or affect the structural integrity of the structure or it patching does not satisfactorily restore the quality and appearance to the surface, the Construction Manager may require the concrete to be removed and replaced, complete, in accordance with the provisions of this section.

### **3.25 REPAIR OF CRACKS**

- A. Repair cracks in structures which are wider than 1/10-inch in width by cutting out a square edged and uniformly aligned joint 3/8-inch wide by 3/4-inch deep, preparing exposed surfaces of the joint, priming the joint, and applying polyurethane joint sealant.
- B. If the cracks are serious or affect the structural integrity or function of the element, the Owner's Representative may require the concrete to be removed and replaced, complete, in accordance with the provisions of this section.

### **3.26 CONCRETE SURFACES TO BE COATED**

- A. See Sections 09820 and 09900.

### **3.27 ALUMINUM SURFACES IN CONTACT WITH CONCRETE**

- A. See Section 09900

### **3.28 RIGID INSULATION**

- A. Install the insulation on the vault wall, roof slab, and access hatch with lemon-sized gobs of compatible adhesive or with non-corroding washers. Space the attachments on 22-inch centers in both directions. Fasteners on 24-inch centers in the joints are acceptable if they have 2-inch washers. Run the insulation to the line shown on the plans. Keep all joints and abutments tight. Do not apply adhesive to insulation, which will deleteriously affect it in any way.
- B. Follow manufacturer's instructions on storing and handling the insulation.
  - 1. Shield the insulation with an opaque, light-colored tarp if it will be store in direct sunlight.
  - 2. Protect insulation from open flames and from heat sources over 165-degrees F.
  - 3. Avoid contact with petroleum-based solvents or with molten asphalt or tar.

\*\*\* END OF SECTION \*\*\*

## SECTION 03210

### REINFORCEMENT STEEL

#### **PART 1 -- GENERAL**

##### **1.01 SCOPE OF WORK**

- A. The CONTRACTOR shall furnish, fabricate, and place all concrete reinforcement steel, couplers, and concrete inserts for use in reinforced concrete and masonry construction and shall perform all appurtenant work, including all the wires, clips, supports, chairs, spacers, and other accessories, all in accordance with the Contract Documents.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 01300 - Contractor Submittals
- B. Section 03300 - Cast-in-Place Concrete
- C. Section 03100 - Concrete Formwork
- D. Section 04232 - Reinforced Concrete Block Masonry
- E. Section 03400 - Precast Concrete

##### **1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS**

A. Codes:

1. The Building Code, as referenced herein, shall be the Uniform Building Code (UBC), as specified in section entitled, "Reference Standards." 01090

B. Commercial Standards

|               |   |
|---------------|---|
| ACI 315-80    | Details and Detailing of Concrete Reinforcement.  |
| ACI 318-77    | Building Code Requirements for Reinforced Concrete.<br>WRI Manual of Standard Practice for Welded Wire Fabric |
| AWS D1.4-79   | Structural Welding Code - Reinforcing Steel.  |
| ASTM A 82-79  | Specification for Steel Wire, Plain, for Concrete Reinforcement.  |
| ASTM A 185-79 | Specification for Welded Steel Wire Fabric for Concrete Reinforcement.  |
| ASTM A 615-82 | Specification for Deformed and Plain Billet-Steel Bards for Concrete Reinforcement.                           |

##### **1.04 CONTRACTOR SUBMITTALS**

- A. The CONTRACTOR shall furnish shop bending diagrams, placing lists, and drawings of all

reinforcement steel prior to fabrication in accordance with the requirements of section entitled, "Contractor Submittals." 01300

- B. Details of the concrete reinforcement steel and concrete inserts shall be submitted by the CONTRACTOR at the earliest possible date after receipt by the CONTRACTOR of the Notice to Proceed. Said details of reinforcement steel for fabrication and erection shall conform to ACI 315 and the requirements specified and shown. The shop bending diagrams shall shown the actual lengths of bars, to the nearest inch measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface. The shop drawings shall include bar placement diagrams, which clearly indicate the dimensions of each bar splice.
- C. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, the CONTRACTOR shall submit manufacturer's literature which contains instructions and recommendations for installation for each type of coupler used; certified test reports which verify the load capacity of each type and size of coupler used; and shop drawings which shown the location of each coupler with details of how they are to be installed in the formwork.
- D. If reinforced steel is spliced by welding at any location, the CONTRACTOR shall submit mill test reports, which shall contain the information necessary for the determination of the carbon equivalent as specified in AWS D1.4. The CONTRACTOR shall submit a written welding procedure for each type of weld for each size of bar which is to be spliced by welding, merely a statement that AWS procedures will be followed is not acceptable.

## **1.05 QUALITY ASSURANCE**

- A. If requested by the ENGINEER, the CONTRACTOR shall provide samples from each heat of reinforcement steel delivered in a quantity adequate for testing. The OWNER will pay costs of initial tests. The CONTRACTOR shall pay costs of additional tests due to material failing initial tests.
- B. If reinforcement steel is spliced by welding at any location, the CONTRACTOR shall submit certifications of procedure qualifications for each welding procedure used and certification of welder qualifications, for each welding procedure, and for each welder performing the work. Such qualifications shall be as specified in AWS D1.4.
- C. If requested by the ENGINEER, the CONTRACTOR shall provide samples of each type of welded splice used in the work in a quantity and of dimensions adequate for testing. At the discretion of the ENGINEER, radiographic testing of direct butt-welded splices will be performed. The CONTRACTOR shall provide assistance necessary to facilitate testing. The CONTRACTOR shall repair any weld, which fails to meet the requirements of AWS D1.4. The OWNER will pay the costs of testing; except, the CONTRACTOR shall pay the cost of all tests, which fail to meet specified requirements.

## **PART 2 -- PRODUCTS**

### **2.01 REINFORCEMENT STEEL**

- A. All reinforcement steel for all cast-in-place reinforced concrete construction shall conform to the following requirements:

1. Bar reinforcement shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel Reinforcement with supplementary requirement S-1, or as otherwise shown on the drawings.
2. Welded wire fabric reinforcement shall conform to the requirements of ASTM A 185 and the details shown; provided, that welded wire fabric with longitudinal wire of W9.5 size wire shall be either furnished in flat sheets or in rolls with a core diameter not less than 10-inches; and provided further, that welded wire fabric with longitudinal wires larger than W9.5 size shall be furnished in flat sheets only.
3. Spiral reinforcement shall be cold-drawn steel wire conforming to the requirements of ASTM A 82.

B. Accessories:

1. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement. Slab bolsters shall have gray plastic-coated legs.
2. Concrete blocks (dobies), used to support and position reinforcement steel, shall have the same or higher compressive strength as specified for the concrete in which it is located. Where the concrete blocks are used on concrete surfaces exposed to view, the color and texture of the concrete blocks shall match that required for the finished surface. Wire ties shall be embedded in concrete block bar supports.

## **2.02 MECHANICAL COUPLERS**

- A. Mechanical couplers shall be provided where shown and where approved by the ENGINEER. The couplers shall develop a tensile strength, which exceeds 125 percent of the yield strength of the reinforcement bars being spliced at each splice.
- B. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied. This shall apply to all mechanical splices, including those splices intended for future connections.
- C. The reinforcement steel and coupler used shall be compatible for obtaining the required strength of the connection.
- D. Couplers, which are located at a joint face, shall be a type, which can be set either flush or recessed from the face as shown. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement past from entering. After the concrete is placed, couplers intended for future connections shall be plugged and sealed to prevent any contact with water or other corrosive materials. Threaded couplers shall be plugged with plastic plugs, which have an O-ring seal.
- E. Hot-forged sleeve type couplers shall not be used.

## **2.03 WELDED SPLICES**

- A. Welded splices shall be provided where shown and where approved by the ENGINEER. All welded splices of reinforcement steel shall develop a tensile strength, which exceeds 125 percent of the yield strength of the reinforcement bars, which are connected.

- B. All materials required to perform the welded splices to the requirements of AWS D1.4 shall be provided.

### **PART 3 -- EXECUTION**

#### **3.01 GENERAL**

- A. All reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the requirements of the Building Code and the supplementary requirements specified herein.

#### **3.02 FURNISHINGS**

- A. All reinforcing steel shall be furnished, fabricated, and installed by the CONTRACTOR. The CONTRACTOR shall also furnish all the wires, metal supports, clips, spacers, and other appurtenances necessary to fulfill the requirements of the Contract Documents.
- B. Welded wire fabric, where required, shall be furnished as specified herein and where placed over the ground and shall be supported on wired concrete spacers or block supports spaced not more than 3-feet on centers in any direction. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.

#### **3.03 FABRICATION**

- A. General: Reinforcement steel shall be accurately formed to the dimensions and shapes shown, and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings. Stirrups and tie bars shall be bent around a pin having a diameter not less than 1-1/2 inch for No. 3 bars, 2-inch for No. 4 bars, and 2-1/2 inch for No. 5 bars. Bends for other bars shall be made around a pin having a diameter not less than 6 times the minimum thickness, except for bars larger than 1-inch, in which case the bends shall be made around a pin of 8 bar diameters. Bars shall be bent cold.
- B. The CONTRACTOR shall fabricate reinforcement bars for structures in accordance with bending diagrams, placing lists, and placing drawings. Said drawings, diagrams, and lists shall be prepared by the CONTRACTOR as specified under Section entitled "Contractor Submittals." 01300
- C. Fabricating Tolerances: Bars used for concrete reinforcement shall meet the following requirements for fabricating tolerances:
1. Sheared length:  $\pm$  1-inch
  2. Depth of truss bars: +0, - 1/2-inch
  3. Stirrups, ties, and spirals:  $\pm$  1/2-inch
  4. All other bends:  $\pm$  1-inch

#### **3.04 PLACING**

- A. **Placing:** Reinforcement steel shall be accurately positioned as shown, and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcement steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers that are strong and rigid enough to prevent any displacement of the reinforcement of the reinforcement steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used, in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous. All concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties, which are embedded in the blocks. For concrete over formwork, the CONTRACTOR shall furnish concrete, metal, plastic, or other acceptable bar chairs and spacers.
- B. The portions of all accessories in contact with the formwork shall be made of concrete, plastic, or steel coated with a 1/8-inch minimum thickness of plastic which extends at least 1/2-inch from the concrete surface. Plastic shall be gray in color.
- C. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.
- D. Bars additional to those shown which may be found necessary or desirable by the CONTRACTOR for the purpose of securing reinforcement in position shall be provided by the CONTRACTOR at its own expense.
- E. **Placing Tolerances:** Unless otherwise specified, reinforcement placing tolerances shall be within the limits specified in Section 7.5 of ACI 318 except where in conflict with the requirements of the Building Code.
- F. Bars may be moved as necessary to avoid interference with other reinforcement steel, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed the above tolerances, the resulting arrangement of bars shall be as acceptable to the ENGINEER.
- G. Welded wire fabric reinforcement placed over horizontal forms shall be supported on slab bolsters having gray, plastic-coated standard type legs as specified in Paragraph B herein. Slab bolsters shall be spaced not less than 30-inches on centers, shall extend continuously across the entire width of the reinforcement mat, and shall support the reinforcement mat in the plane shown.
- H. Welded wire fabric placed over the ground shall be supported on wired concrete blocks (dobbies) spaced not more than 3-feet on centers in any direction. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.

### **3.05 SPACING OF BARS**

- A. The clear distance between parallel bars (except in columns and between multiple layers of bars in beams) shall not be less than the nominal diameter of the bars nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than one inch.
- B. Where reinforcement in beams or girders is placed in 2 or more layers, the clear distance between layers shall not be less than one inch.
- C. In columns, the clear distance between longitudinal bars shall be not less than 1-1/2 times the bar

diameter, nor less than 1-1/2 times the maximum size of the coarse aggregate, nor less than 1-1/2 inches.

- D. The clear distance between bars shall also apply to the distance between a contact splice and adjacent splices or bars.

### **3.06 SPLICING**

- A. General: Reinforcement bar splices shall only be used at locations shown. When it is necessary to splice reinforcement at points other than where shown, the character of the splice shall be as acceptable to the ENGINEER.
- B. Splices of Reinforcement: The length of lap for reinforcement bars, unless otherwise shown shall be in accordance with ACI 318, Section 12.15.1 for a class C splice.
- C. Laps of welded wire fabric shall be in accordance with the ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.
- D. Splices in column spiral reinforcement, when necessary, shall be made by welding or by a lap of 1-1/2 turns.
- E. Bending or Straightening: Reinforcement shall not be straightened or rebent in a manner, which will injure the material. Bars with kinks or bends not shown shall not be used. All bars shall be bent cold, unless otherwise permitted by the ENGINEER. No bars partially embedded in concrete shall be field-bent except as shown or specifically permitted by the ENGINEER.

### **3.07 CLEANING AND PROTECTION**

- A. Reinforcement steel shall at all times be protected from conditions conducive to corrosion until concrete is placed around it.
- B. The surfaces of all reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcement shall be reinspected and, if necessary recleaned.

\*\*\* END OF SECTION \*\*\*

## SECTION 03300

### CAST-IN-PLACE CONCRETE

#### **PART 1 -- GENERAL**

##### **1.01 SCOPE OF WORK**

- A. The CONTRACTOR shall furnish all materials for concrete in accordance with the provisions of this Section and shall form, mix, place, cure, repair, finish, and do all other work as required to produce finished concrete, all in accordance with the requirements of the Contract Documents.
- B. The following types of concrete shall be covered in this Section:
1. Structural Concrete: Concrete to be used in all cases except where noted otherwise in the Contract Documents.
  2. Sitework Concrete: Concrete to be used for curbs, gutters, catch basins, sidewalks, pavements, fence and guard post embedment, underground duct bank encasement and all other concrete appurtenant to electrical facilities unless otherwise shown.
  3. Lean Concrete: Concrete to be used for thrust blocks, pipe trench cut-off blocks and cradles, where the preceding items are detailed on the Drawings as unreinforced. Concrete to be used as protective cover for dowels intended for future connection.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 01300 - Contractor Submittals  
B. Section 03100 - Concrete Formwork  
C. Section 03200 - Reinforcement Steel  
D. Section 03290 - Joints in Concrete  
E. Section 03315 - Grout  
F. Section 03480 - Precast Concrete Specialties  
G. Section 07920 - Sealants and Caulking  
H. Section 16050 - Electrical General Provisions

##### **1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS**

- A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the requirements of the Building Code and the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section; provided, that for Building Codes, the latest edition of the Code, as adopted as of the date of award by the agency having jurisdiction, shall apply to the WORK.
1. Codes and Standards: The Building Code, as referenced herein, shall be the Uniform Building Code (UBC), of the International Conference of Building Officials (ICBO). 01090
  2. Federal Specifications: UU-B-790A (Int. Amd. 1) Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellant and Fire Resistant).

3. Commercial Standards:

|               |   |
|---------------|---|
| ACI 214-77    | Recommended Practice for Evaluation of Strength Test Results of Concrete.   |
| ACI 301-79    | Specifications for Structural Concrete for Buildings.   |
| ACI 315-80    | Details and Detailing of Concrete Reinforcement.  |
| ACI 347-78    | Recommended Practice for Concrete Formwork.   |
| ASTM C156-80a | Test Method for Water Retention by Concrete Curing Materials.   |
| ASTM C31-84   | Methods of Making and Curing Concrete Test Specimens in the Field.  |
| ASTM C33-84   | Specification for Concrete Aggregates.  |
| ASTM C39-83b  | Test Method for Compressive Strength of Cylindrical Concrete Specimens.   |
| ASTM C94-83   | Specification for Ready-Mixed Concrete.   |
| ASTM C114-83b | Method for Chemical Analysis of Hydraulic Cement.   |
| ASTM C136-84a | Method for Sieve Analysis of Fine and Coarse Aggregate.   |
| ASTM C143-78  | Test Method for Slump of Portland Cement Concrete.  |
| ASTM C150-84  | Specification for Portland Cement.  |
| ASTM C157-80  | Test Method for Length Change of hardened Cement Mortar and Concrete.   |
| ASTM C192-81  | Method of Making and Curing Concrete Test Specimens in the Laboratory.  |
| ASTM C260-77  | Specification for Air-Entraining Admixtures for Concrete.   |
| ASTM C311-85  | Method for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete.                            |
| ASTM C494-82  | Specification for Chemical Admixtures for Concrete.   |
| ASTM C618-85  | Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.                          |
| ASTM D1751-83 | Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types). |
| ASTM E119-83  | Method for Fire Tests of Building Construction and Materials.   |

#### **1.04 CONTRACTOR SUBMITTALS**

- A. Mix Designs: Prior to beginning the WORK, the CONTRACTOR shall submit to the ENGINEER, for review, preliminary concrete mix designs which shall show the proportions and gradations of all materials proposed for each class and type of concrete specified herein in accordance with the Section entitled "Contractor Submittals." 01300 The mix designs shall be designed by an independent testing laboratory acceptable to the ENGINEER. All costs related to such mix design shall be borne by the CONTRACTOR.
- B. Certified Delivery Tickets: Where ready-mix concrete is used, the CONTRACTOR shall provide certified weighmaster delivery tickets at the time of delivery of each load of concrete. Each certificate shall show the public weighmaster's signature, and the total quantities, by weight of cement, sand, each class of aggregate, admixtures, and the amounts of water in the aggregate and added at the batching plant as well as the amount of water allowed to be added at the site for the specific design mix. Each certificate shall, in addition, state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to when the batch was dispatched, when it left the plant, when it arrived at the job, the time that unloading began, and the time that unloading was finished.
- C. When a water reducing admixture is to be used, the CONTRACTOR shall furnish mix designs for concrete both with and without the admixture.
- D. The CONTRACTOR shall furnish a Certificate of Compliance signed by the supplier identifying the type of fly ash and stating that the fly ash complies with ASTM C 618 and these Specifications, together with all supporting test data prior to the use of the fly ash the sample represents. The supporting data shall also contain test results confirming that the fly ash in combination with the cement and water to be used meets all strength requirements and is compatible with air-entraining agents and other admixtures.
- E. The CONTRACTOR shall submit to the ENGINEER for review the design mix for fly ash concrete together with the design mix for portland cement (non-fly ash) concrete as specified in this Section.

#### **1.05 QUALITY ASSURANCE**

- A. Tests on component materials and for compressive strength and shrinkage of concrete will be performed as specified herein. Test for determining slump will be in accordance with the requirements of ASTM C 143.
- B. The cost of all laboratory tests on cement, aggregates, and concrete, will be borne by the OWNER. However, the CONTRACTOR shall be charged for the cost of any additional tests and investigation on work performed which does not meet the specifications.
- C. Concrete for testing shall be supplied by the CONTRACTOR at no cost to the OWNER and the CONTRACTOR shall provide assistance to the ENGINEER in obtaining samples, and disposal and cleanup of excess material.
- D. Field Compression Tests:

1. Compression test specimens will be taken during construction from the first placement of each class of concrete specified herein and at intervals thereafter as selected by the ENGINEER to insure continued compliance with these specifications. Each set of test specimens will be a minimum of 4 cylinders.
2. Compression test specimens for concrete shall be made in accordance with ASTM C 31. Specimens shall be 6-inch diameter by 12-inch high cylinders.
3. Compression tests shall be performed in accordance with ASTM C 39. One test cylinder will be tested at 7 days and 2 at 28 days. The remaining cylinder will be held to verify test results, if needed.

E. Evaluation and Acceptance of Concrete:

1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 318, Chapter 4 "Concrete Quality," and as specified herein.
2. A statistical analysis of compression test results will be performed according to the requirements of ACI 214. The standard deviation of the test results shall not exceed 640 psi.
3. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for all subsequent batches of the type of concrete affected.
4. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 psi below or the average of any 3 consecutive tests being below the specified compressive strength is 1 in 100. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard of deviation.
5. All concrete which fails to meet the ACI requirements and these specifications, is subject to removal and replacement at the cost of the CONTRACTOR.

F. Shrinkage Tests:

1. Drying shrinkage tests will be made by the ENGINEER for the trial batch specified in Paragraph 2.07, herein, and during construction to insure continued compliance with these Specifications.
2. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gage length of 10 inches, fabricated, cured, dried and measured in accordance with ASTM C 157 modified as follows: Specimens shall be removed from molds at an age of  $23 \pm 1$  hours after trial batching, shall be placed immediately in water at  $70 \text{ degrees F} \pm 3 \text{ degrees F}$  for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then submerged in saturated lime water at  $73 \text{ degrees F} \pm 3 \text{ degrees F}$ . Measurement to determine expansion expressed as a percentage of original length shall be made at age 7 days. This length at age 7 days shall be the base length for drying shrinkage calculations ("0" days drying age). Specimens then shall be stored immediately in a humidity control room maintained at  $73 \text{ degrees F} \pm 3 \text{ degrees F}$  and 50 percent  $\pm 4$  percent relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as percentage of base length shall be made and reported separately for 7, 14, 21, and 28 days of drying after 7 days of moist curing.
3. The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age. The average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001-inch at each test age. If the drying shrinkage of any specimen departs from the average of that test age

by more than 0.0004 inch, the results obtained from that specimen shall be disregarded. Results of the shrinkage test shall be reported to the nearest 0.001 percent of shrinkage. Compression test specimens shall be taken in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project. Allowable shrinkage limitations shall be as specified in Paragraph 2.08, herein.

- G. **Construction Tolerances:** The CONTRACTOR shall set and maintain concrete forms and perform finishing operations so as to ensure that the completed work is within the tolerances specified herein. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the specified permissible variation from lines, grades, or dimensions shown. Where tolerances are not stated in the specifications, permissible deviations will be in accordance with ACI 347.
- H. The following construction tolerances are hereby established and apply to finished walls and slab unless otherwise shown:

| Item  | Tolerance  |
|---|--|
| Variation of the constructed linear outline from the established position in plan | In 10-feet: ¼-inch,<br>In 20-feet or more: 1/2 -inch |
| Variation from the level or from the grades shown on the drawings                 | In 10-feet: ¼-inch,<br>In 20-feet or more: ½-inch    |
| Variation from the plumb  | In 10-feet: ¼-inch<br>In 20-feet or more:1/2-inch    |
| Variation in the thickness of slabs and walls                                     | Minus ¼-inch; plus ½-inch                            |
| Variations in the locations and sizes of slab and wall openings                   | Plus or minus ¼-inch                                 |

- I. For each class of fly ash, all testing and sampling procedures shall conform with these Specifications and ASTM C 311, including the restriction that one sample weighing 4 pounds shall be taken from at least each 200 tons of fly ash supplied.
- J. Separate storage facilities shall be provided for fly ash. Fly ash shall be stored in such a manner as to permit ready access for the purpose of inspection and sampling and suitably protected against contamination or moisture. Should any fly ash show evidence of contamination or moisture or be otherwise unsuitable, the ENGINEER may reject it and require that it be removed from the site. Each class of fly ash used in concrete for this project shall be from the same source.

**PART 2 -- PRODUCTS**

**2.01 CONCRETE MATERIALS**

- A. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage. Only one brand of cement shall be used. Cement reclaimed from cleaning bags or leaking containers shall not be used. All cement shall be used in the sequence of receipt of shipments.

- B. All materials furnished for the work shall comply with the requirements of Sections 201, 203, and 204 of ACI 301, as applicable.
- C. Storage of materials shall conform to the requirements of Section 205 of ACI 301.
- D. Materials for concrete shall conform to the following requirements:
1. Cement shall be standard brand portland cement conforming to ASTM C 150 for Type V. Portland cement shall contain not more than 0.60 percent alkalis. The term "alkalis" referred to herein is defined as the sum of the percentage of sodium oxide and 0.658 times the percentage of potassium oxide ( $\text{Na}_2\text{O} + 0.658 \text{K}_2\text{O}$ ). These oxides shall be determined in accordance with ASTM C 114. A single brand of cement shall be used throughout the work, and prior to its use, the brand shall be acceptable to the ENGINEER. The cement shall be suitably protected from exposure to moisture until used. Cement that has become lumpy shall not be used. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling. Certified mill test reports for each shipment of cement to be used shall be submitted to the ENGINEER if requested regarding compliance with these Specifications.
  2. Water shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts and other impurities. The water shall be considered potable, for the purposes of this Section only, if it meets the requirements of the local governmental agencies. Agricultural water with high total dissolved solids (over 1000 mg/1 TDS) shall not be used.
  3. Aggregates shall be obtained from pits acceptable to the ENGINEER, shall be non-reactive and shall conform to ASTM C 33. Maximum size of coarse aggregate shall be as specified in Paragraph 2.05B. Lightweight sand for fine aggregate will not be permitted.
    - a. Coarse aggregates shall consist of clean, hard, durable gravel, crushed gravel, crushed rock or a combination thereof. The coarse aggregates shall be prepared and handled in two or more size groups for combined aggregates with a maximum size greater than 3/4-inch. When the aggregates are proportioned for each batch of concrete the two size groups shall be combined. See Paragraph 2.07A for the use of the size groups.
    - b. Fine aggregates shall be natural sand or a combination of natural and manufactured sand that are hard and durable.
    - c. Combined aggregates shall be well graded from coarse to fine sizes, and shall be uniformly graded between screen sizes to produce a concrete that has optimum workability and consolidation characteristics. Where a trial batch is required for a mix design, the final combined aggregate gradations will be established during the trial batch process.
    - d. When tested in accordance with "Potential Reactivity of Aggregates (Chemical Method)" (ASTM C289), the ration of silica released to reduction in alkalinity shall not exceed 1.0.
    - e. When tested in accordance with "Organic Impurities in Sands for Concrete" (ASTM C40), the fine aggregate shall produce a color in the supernatant liquid no darker than the reference standard color solution.
    - f. When tested in accordance with "Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine" (ASTM C131), the coarse aggregate shall show a loss not exceeding 42 percent after 500 revolutions, or 10.5 percent after 100 revolutions.
    - g. When tested in accordance with "Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate" (ASTM C88), the loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using sodium sulfate.
  4. Ready-mix concrete shall conform to the requirements of ASTM C94.

5. Air-entraining agent meeting the requirements of ASTM C 260 shall be used. Sufficient air-entraining agent shall be used to provide a total air content of 3 to 5 percent; provided that, when the mean daily temperature in the vicinity of the worksite falls below 40 degrees F for more than one day, the total air content provided shall be 5 to 7 percent. The OWNER reserves the right, at any time, to sample and test the air-entraining agent received on the job by the CONTRACTOR. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement.
6. Admixtures: Admixtures shall be required at the Engineer's discretion or, if not required, may be added at the Contractor's option to control the set, effect water reduction, and increase workability. In either case, the addition of an admixture shall be at the Contractor's expense. The use of an admixture shall be subject to acceptance by the ENGINEER. Concrete containing an admixture shall be first placed at a location determined by the ENGINEER. If the use of an admixture is producing an inferior end result, the CONTRACTOR shall discontinue use of the admixture. Admixtures specified herein shall conform to the requirements of ASTM C 494. The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used. Admixtures shall contain no free chloride ions, be non-toxic after 30 days, and shall be compatible with and made by the same manufacturer as the air entraining admixture.
  - a. Set controlling admixture shall be either with or without water-reducing properties. Where the air temperature at the time of placement is expected to be consistently over 80 degrees F, a set retarding admixture such as Sika Chemical Corporation's Plastiment, Master Builder's Pozzoloth 300R, or equal shall be used. Where the air temperature at the time of placement is expected to be consistently under 40 degrees F, a set accelerating admixture such as Sika Chemical Corporation's Plastocrete 161 FL, Master Builder's Pozzoloth 50C, or equal shall be used.
  - b. Low range water reducer shall conform to ASTM C 494, Type A. It shall be either a hydroxylated carboxylic acid type or a hydroxylated polymer type. The quantity of admixture used and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations.
  - c. High range water reducer shall be sulfonated polymer conforming to ASTM C 494, Type F or G.

If the high range water reducing agent is added to the concrete at the batch plant, it shall be second generation type, Daracem 100, as manufactured by W.R. Grace & Co.; Pozzoloth 430R, as manufactured by Masterbuilders; or equal. High range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified.

If the high range water reducer is added to the concrete at the job site, it shall be used in conjunction with a low range water reducer and shall be Pozzoloth 400N and Pozzoloth MBL82, as manufactured by Masterbuilders; WRDA 19 and WRDA 79, as manufactured by W.R. Grace & Co.; or equal. Concrete shall have a slump of 3 inches  $\pm$  1/2-inch prior to adding the high range water-reducing admixture at the job site. The high range water-reducing admixture shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the job site system.

Concrete shall be mixed at mixing speed for a minimum of 30 mixer revolutions after the addition of the high range water reducer.

7. Calcium Chloride: Except as otherwise provided in Paragraph 3.08B, calcium chloride will not be permitted to be used in concrete.
8. Fly ash/pozzolan shall conform to ASTM C 618, including the requirements of Table 1A, therein, and the following supplementary requirements:
  - a. Class C fly ash
    - Loss on ignition, maximum 1 percent
    - S03 content, maximum 4 percent
    - Moisture content, maximum 1 percent
    - $R = (CaO - 5\%)/(Fe_2O_3)$ , maximum 4.5
  - b. Class F fly ash
    - Loss on ignition, maximum 1 percent
    - S03 content, maximum 3 percent
    - Moisture content, maximum 1 percent
    - $R = (CaO - 5\%)/(Fe_2O_3)$ , maximum 1.5

## 2.02 CURING MATERIALS

A. Materials for curing concrete as specified herein shall conform to the following requirements:

1. Concrete curing compound shall be MB 429 as manufactured by Masterbuilders, Cleveland, OH; Hunt Process Clear ARB as manufactured by Hunt Process Co., Santa Fe Springs, CA; Select Cure CRB as manufactured by Select Products Co., Upland, CA; or equal. The curing compound shall contain a fugitive dye so that areas of application will be readily distinguishable.
2. Polyethylene sheet for use as concrete curing blanket shall be white, and shall have a nominal thickness of 6 mils. The loss of moisture when determined in accordance with the requirements of ASTM C 156 shall not exceed 0.055 gram per square centimeter of surface.
3. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, having a nominal thickness of 2 mils and permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A (Int. Amd. 1). The loss of moisture, when determined in accordance with the requirements of ASTM C-156, shall not exceed 0.055 gram per square centimeter of surface.
4. Polyethylene-coated burlap for use as concrete curing blanket shall be 4-mil thick, white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of moisture, when determined in accordance with the requirements of ASTM C 156, shall not exceed 0.055 gram per square centimeter of surface.
5. Curing mats for use in Curing Method 6 as specified in Paragraph 3.09G herein, shall be heavy shag rugs or carpets or cotton mats quilted at 4 inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.
6. Evaporation retardant shall be used after initial screeding and floating when temperature, wind, and humidity condition may cause drying shrinkage cracks in slab and shall be a material such as Confilm as manufactured by Masterbuilders, Cleveland, OH; or equal.

## 2.03 NON-WATERSTOP JOINT MATERIALS

A. Materials for non-water stop joints in concrete shall conform to the following requirements:

1. Preformed joint filler shall be a non-extruding, resilient, bituminous type conforming to the requirements of ASTM D 1751.
2. Elastomeric joint sealer shall conform to the requirements of Section entitled "Sealants and Caulking." 07920
3. Mastic joint sealer shall be a material that does not contain evaporating solvents; that will tenaciously adhere to concrete surfaces; that will remain permanently resilient and pliable; that will not be affected by continuous presence of water and will not in any way contaminate potable water; and that will effectively seal the joints against moisture infiltration even when the joints are subject to movement due to expansion and contraction. The sealer shall be composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance containing no volatile oils or lubricants and shall be capable of meeting the test requirements set forth hereinafter, if testing is required by the ENGINEER.

#### **2.04 MISCELLANEOUS MATERIALS**

- A. Floor sealer/hardener shall be a colorless, aqueous solution of zinc and/or magnesium fluosilicate or of sodium silicate, and shall be as manufactured by Master Builders Company, W.R. Grace Co., or equal. The solution shall be delivered ready for use in the manufacturer's original sealed containers. Each gallon of the fluosilicate solution shall contain not less than 2 pounds of crystals.
- B. Damp-proofing agent shall be an asphalt emulsion, such as Sonneborn Hydrocide 660, Flintkote C-13-E Foundation Coating, or equal.
- C. Epoxy adhesives shall be the following products for the applications specified:
  1. For bonding freshly-mixed, plastic concrete to hardened concrete, Sikadur Hi-Mod Epoxy Adhesive, as manufactured by Sika Chemical Corporation; Concrecive 1001-LPL, as manufactured by Adhesive Engineering Company; or equal.
  2. For bonding hardened concrete or masonry to steel, Colma-Dur Gel, Sikadur Hi-Mod Gel, or equal.

#### **2.05 CONCRETE DESIGN REQUIREMENTS**

- A. General: Concrete shall be composed of cement, admixtures, aggregates and water. These materials shall be of the qualities specified. The exact proportions in which these materials are to be used for different parts of the work will be determined during the trial batch. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface. Mix designs with more than 41 percent of sand of the total weight of fine and coarse aggregate shall not be used. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items. The proportions shall be changed whenever necessary or desirable to meet the required results at no additional cost to the OWNER. All changes shall be subject to review by the ENGINEER.
- B. Water-Cement Ratio and Compressive Strength: The minimum compressive strength and cement content of concrete shall be not less than that specified in the following tabulation.

| Type of Work  | Min. 28-day Compressive Strength (psi) | Max. Size Aggregate (in.) | Min. Cement per Cu.Yd. (sacks) | Max. W/C Ratio (hy.wt.) |
|---|--|---------------------------|--------------------------------|-------------------------|
| Structural Concrete: Walls, slabs on grade and footing and all other concrete items not specified elsewhere   | 4,000                                  | 1-1/2                     | 6.0                            | 0.50                    |
| Structural Concrete: Roof, floor slabs, columns, sections 10-in. and less in thickness, and sections which require special placement due to shape or density of reinforcing or embedded items | 4,000                                  | 1                         | 6.0                            | 0.50                    |
| Sitework Concrete   | 3,000                                  | 1                         | 5.0                            | 0.50                    |
| Lean Concrete   | 2,000                                  | 1                         | 4.0                            | 0.60                    |

\*Note: One sack of cement equals 94 lbs.

- C. Adjustments to Mix Design: The mixes used shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability, and surface finish and the CONTRACTOR shall be entitled to no additional compensation because of such changes.
- D. At the Contractor's option, fly ash/pozzolan may be used as a partial cement replacement in concrete as follows:
1. Fly ash shall replace not more than 15 percent by weight of the portland cement in the design mix. The design mix shall contain a minimum of 6 sacks of cement per cubic yard before the replacement is made.
  2. Fly ash for hydraulic/liquid containing structures shall be Class C fly ash. Fly ash concrete for all other structures shall be Class C or F fly ash.

## 2.06 CONSISTENCY

- A. The quantity of water entering into a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete which can be worked properly into place without segregation, and which can be compacted by the vibratory methods herein specified to give the desired density, impermeability and smoothness of surface. The quantity of water shall be changed as necessary, with variations in the nature of moisture content of the aggregates, to maintain uniform production of a desired consistency. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143. The slumps shall be as follows:

| Part of Work                        | Slump (in.)                   |
|-------------------------------------|-------------------------------|
| Footings and slabs                  | 3-inches +1/2-inches, -1-inch |
| Other work                          | 3 inches ±1 inch              |
| With high range water reducer added | 8-inches max.                 |

## **2.07 TRIAL BATCH AND LABORATORY TESTS**

- A. Before placing any concrete, a testing laboratory designated by the ENGINEER shall prepare a trial batch of each class of concrete having a 28-day strength of 4,000 psi or higher, based on the preliminary concrete mixes submitted by the CONTRACTOR. During the trial batch the aggregate proportions may be adjusted by the testing laboratory using the two coarse aggregate size ranges to obtain the properties in Paragraph 2.05A. If one size range produces an acceptable mix, a second size range need not be used. Such adjustments shall be considered refinements to the mix design and shall not be the basis for extra compensation to the CONTRACTOR. All concrete shall conform to the requirements of this Section, whether the aggregate proportions are from the Contractor's preliminary mix design, or whether the proportions have been adjusted during the trial batch process. The trial batch shall be prepared using the aggregates, cement and admixture proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain 3 drying shrinkage, and 6 compression test specimens from each batch. The cost of not more than 3 laboratory trial batch tests for each specified concrete strength will be borne by the OWNER but the CONTRACTOR shall furnish and deliver the materials in steel drums at no cost. Any additional trial batch testing required shall be performed at the expense of the CONTRACTOR.
- B. The determination of compressive strength will be made by testing 6-inch diameter by 12-inch high cylinders; made, cured and tested in accordance with ASTM C 192 and ASTM C 39. Three compression test cylinders will be tested at 7-days and 3 at 28-days. The average compressive strength for the 3 cylinders tested at 28-days for any given trial batch shall not be less than 125-percent of the specified compressive strength.
- C. A sieve analysis of the combined aggregate for each trial batch shall be performed according to the requirements of ASTM C 136. Values shall be given for percent passing each sieve.

## **2.08 SHRINKAGE LIMITATION**

- A. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age (as specified in Paragraph 2.07), shall be 0.036 percent or 0.043 percent, respectively. The CONTRACTOR shall only use a mix design for construction that has first met the trial batch shrinkage requirements.
- B. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirements by more than 25 percent.
- C. If the required shrinkage limitation is not met during construction, the CONTRACTOR shall take any or all of the following actions, at no additional cost to the OWNER, for securing the specified shrinkage requirements. These actions may include changing the source or aggregates, cement and/or admixtures; reducing water content, washing of aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

## **2.09 MEASUREMENT OF CEMENT AND AGGREGATE**

- A. The amount of cement and of each separate size of aggregate entering into each batch of concrete

shall be determined by direct weighing equipment furnished by the CONTRACTOR and acceptable to the ENGINEER; provided that, where batches are so proportioned as to contain an integral number of conventional sacks of cement, and the cement is delivered at the mixer in the original unbroken sacks, the weight of the cement contained in each sack may be taken without weighing as 94 pounds.

## **2.10 MEASUREMENT OF WATER**

- A. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the ENGINEER and capable of measuring the water in variable amounts within a tolerance of one percent. The water feed control mechanism shall be capable of being locked in position so as to deliver constantly any specified amount of water to each batch of concrete, and the meter shall include a set-back register with a readily visible vertical face and double hands indicating in cubic feet and decimals thereof. A positive quick-acting valve shall be used for a cut-off in the water line to the mixer. The operating mechanism must be such that leakage will not occur when the valves are closed.

## **2.11 READY-MIXED CONCRETE**

- A. At the Contractor's option, ready-mixed concrete may be used meeting the requirements as to materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C 94, including the supplementary requirements specified in Paragraphs 2.12B through 2.11F, herein.
- B. Ready-mixed concrete shall be delivered to the site of the work, and discharge shall be completed within 75 minutes after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever is first. In hot weather, or under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85 degrees F or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 60 minutes.
- C. Truck mixers shall be equipped with electrically actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.
- D. Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.
- E. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the specified slump is 3 inches or less, or if they differ by more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus,

condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

- F. Each batch of ready-mixed concrete delivered at the job site shall be accompanied by a certified weighmaster delivery ticket furnished to the ENGINEER in accordance with Paragraph 1.04B, herein.
- G. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the ENGINEER.

### **PART 3 -- EXECUTION**

#### **3.01 PROPORTIONING AND MIXING**

- A. Proportioning: Proportioning of the concrete mix shall conform to the requirements of Chapter 3 (Proportioning" of ACI 301; provided, that the maximum slump for any concrete shall not exceed 4 inches except when the use of high range water reducer is permitted which increases the maximum slump to 8 inches.
- B. Mixing: Mixing of concrete shall conform to the requirements of Chapter 7 of said ACI 301 Specifications.
- C. Slump: Maximum slumps shall be as specified in Paragraph 2.06A, herein.
- D. Retempering: Retempering of concrete or mortar which has partially hardened will not be permitted.

#### **3.02 PREPARATION OF SURFACES FOR CONCRETING**

- A. General: Earth surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud and debris at the time of placing concrete.
- B. Joints in Concrete: Concrete surfaces upon or against which concrete is to be placed, where the placement of the old concrete has been stopped or interrupted so that, as determined by the ENGINEER, the new concrete cannot be incorporated integrally with that previously placed, are defined as construction joints. The surfaces of horizontal joints shall be given a compacted roughened surface for good bond. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of all laitance, loose or defective concrete, and foreign material. Such cleaning shall be accomplished by sandblasting followed by thorough washing. All pools of water shall be removed from the surface of construction joints before the new concrete is placed.
- C. After the surfaces have been prepared all approximately horizontal construction joints shall be covered with a layer of mortar approximately one-inch thick. The mortar shall have the same proportions of cement and sand as the regular concrete mixture. The water-cement ration of the

mortar in place shall not exceed that of the concrete to be placed upon it, and the consistency of the mortar shall be suitable for placing and working in the manner hereinafter specified. The mortar shall be spread uniformly and shall be worked thoroughly into all irregularities of the surface. Wire brooms shall be used where possible to scrub the mortar into the surface. Concrete shall be placed immediately upon the fresh mortar. When casting deep walls (more than 6-feet high) over slabs or footings, in lieu of the one-inch thick mortar, a 6-inch lift of a rich pea gravel mix with the same water-cement ration as the wall concrete shall be placed and spread uniformly. Wall concrete shall follow immediately and shall be placed upon the fresh pea gravel mix.

- D. Placing Interruptions: When placing of concrete is to be interrupted long enough for the concrete to take a set, the working face shall be given a shape by the use of forms or other means, that will secure proper union with subsequent work; provided that construction joints shall be made only where acceptable to the ENGINEER.
- E. Embedded Items: No concrete shall be placed until all formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been completed and accepted by the ENGINEER at least 4 hours before placement of concrete. All surfaces of forms and embedded items that have become encrusted with dried grout from concrete previously placed shall be cleaned of all such grout before the surrounding or adjacent concrete is placed.
- F. All inserts or other embedded items shall conform to the requirements herein.
- G. All reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms where shown or by shop drawings and shall be acceptable to the ENGINEER before any concrete is placed. Accuracy of placement is the responsibility of the CONTRACTOR.
- H. Casting New Concrete Against Old: Where concrete is to be cast against old concrete (any concrete which is greater than 60 days of age), the surface of the old concrete shall be thoroughly cleaned and roughened by sand-blasting (exposing aggregate) prior to the application of an epoxy bonding agent.
- I. No concrete shall be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes, or other means, and carried out of the forms, clear of the work. No concrete shall be deposited underwater nor shall the CONTRACTOR allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, will be subject to the review of the ENGINEER.
- J. Corrosion Protection: Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2-inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.
- K. Openings for pipes, inserts for pipe hangers and brackets, and the setting of anchors shall, where practicable, be provided for during the placing of concrete.

- L. Anchor bolts shall be accurately set, and shall be maintained in position by templates while being embedded in concrete.
- M. Cleaning: The surfaces of all metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

### **3.03 HANDLING, TRANSPORTING, AND PLACING**

- A. General: Placing of concrete shall conform to the applicable requirements of Chapter 8 of ACI 301 and the requirements of this Section.
- B. Non-Conforming Work or Materials: Concrete which upon or before placing is found not to conform to the requirements specified herein shall be rejected and immediately removed from the work. Concrete which is not placed in accordance with these Specifications, or which is of inferior quality, shall be removed and replaced by and at the expense of the CONTRACTOR.
- C. Unauthorized Placement: No concrete shall be placed except in the presence of duly authorized representative of the ENGINEER. The CONTRACTOR shall notify the ENGINEER in writing of at least 24 hours in advance of placement of any concrete.
- D. Placement in Wall Forms: Concrete shall not be dropped through reinforcement steel or into any deep form, whether reinforcement is present or not, causing separation of the coarse aggregate from the mortar on account of repeatedly hitting rods or the sides of the form as it falls, nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete. In such cases, some means such as the use of hoppers and, if necessary, vertical ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without separation. In no case shall the free fall of concrete exceed 4 feet below the ends of ducts, chutes, or buggies. Concrete shall be uniformly distributed during the process of depositing and in no case after depositing shall any portion be displaced in the forms more than 6 feet in horizontal direction. Concrete in forms shall be deposited in uniform horizontal layers not deeper than 2 feet; and care shall be taken to avoid inclined layers or inclined construction joints except where such are required for sloping members. Each layer shall be placed while the previous layer is still soft. The rate of placing concrete in forms shall not exceed 5 feet of vertical rise per hour.
- E. Casting New Concrete Against Old: An epoxy adhesive bonding agent shall be applied to the old surfaces according to the manufacturer's written recommendations. This provision shall not apply to joints where water stop is installed, see Section entitled, "Water stop Joints in concrete." 03290
- F. Conveyor Belts and Chutes: All ends of chutes, hopper gates, and all other points of concrete discharge throughout the Contractor's conveying, hoisting and placing system shall be so designed and arranged that concrete passing from them will not fall separated into whatever receptacle immediately receives it. Conveyor belts, if used, shall be of a type acceptable to the ENGINEER. Chutes longer than 50 feet will not be permitted. Minimum slopes of chutes shall be such that concrete of the specified consistency will readily flow in them. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted. All conveyor belts and chutes shall be covered. Sufficient illumination shall be provided

in the interior of all forms so that the concrete at the places of deposit is visible from the deck or runway.

- G. Placement in Slabs: Concrete placed in sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the pour. As the work progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.
- H. Temperature of Concrete: The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 40 degrees F in moderate weather, and not less than 50 degrees F in weather during which the mean daily temperature drops below 40 degrees F. Concrete ingredients shall not be heated to a temperature higher than necessary to keep the temperature of the mixed concrete, as placed, from falling below the specified minimum temperature. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, the CONTRACTOR shall employ effective means, such as precooling of aggregates and mixing water using ice or placing at night, as necessary to maintain the temperature of the concrete, as it is placed, below 90 degrees F. The CONTRACTOR shall be entitled to no additional compensation on account of the foregoing requirements.
- I. Cold Weather Placement: Earth foundations shall be free from frost or ice when concrete is placed upon or against them. Fly ash concrete shall not be placed when the air temperature falls below 50 degrees F.

### **3.04 PUMPING OF CONCRETE**

- A. General: If the pumped concrete does not produce satisfactory end results, the CONTRACTOR shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.
- B. Pumping Equipment: The pumping equipment must have 2 cylinders and be designed to operate with one cylinder only in case the other one is not functioning. In lieu of this requirement, the CONTRACTOR may have a standby pump on the site during pumping.
- C. The minimum diameter of the hose (conduits) shall be 4-inches.
- D. Pumping equipment and hoses (conduits) that are not functioning properly, shall be replaced.
- E. Aluminum conduits for conveying the concrete will not be permitted.
- F. Proportioning: Minimum compressive strength, cement content, and maximum size of aggregates shall be as specified in Paragraph 2.05, herein.
- G. Gradation of coarse aggregates shall conform to ASTM C 33 and shall be as close to the middle range as possible.
- H. Gradation of fine aggregate shall conform to ASTM C 33, with 15 to 30 percent passing the number 50 screen and 5 to 10 percent passing the number 100 screen. The fineness modulus of sand used shall not be over 3.00.

- I. Water and slump requirements shall conform to Paragraphs 2.01D.2 and 2.05B for water and 2.06A for slump.
- J. Cement and admixtures shall conform to Paragraph 2.01D, herein.
- K. Field Control: Concrete samples for slump per ASTM C 143 and test cylinders per ASTM C 31 and C 39 will be taken at the placement (discharge) end of the line.

### **3.05 ORDER OF PLACING CONCRETE**

- A. The order of placing concrete in all parts of the work shall be acceptable to the ENGINEER. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 7 days before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until the 2 adjacent wall panels have cured at least 14 days.
- B. The surface of the concrete shall be level whenever a run of concrete is stopped. To insure a level, straight joint on the exposed surface of walls, a wood strip at least 3/4 of an inch thick shall be tacked to the forms on these surfaces. The concrete shall be carried about 1/2 of an inch above the underside of the strip. About one hour after the concrete is placed the strip shall be removed and any irregularities in the edge formed by the strip shall be leveled with a trowel and all laitance shall be removed.

### **3.06 TAMPING AND VIBRATING**

- A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted, throughout the entire depth of the layer which is being consolidated, into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete during placement. Vibrators shall be high-speed power vibrators (8000 to 10,000 rpm) of an immersion type in sufficient number and with (at least one) standby units as required.
- B. Care shall be used in placing concrete around water stops. The concrete shall be carefully worked by rodding and vibrating to make sure that all air and rock pockets have been eliminated. Where flat-strip type water stops are placed horizontally, the concrete shall be worked under the water stops by hand, making sure that all air and rock pockets have been eliminated. Concrete surrounding the water stops shall be given additional vibration, over and above that used for adjacent concrete placement to assure complete embedment of the water stops in the concrete.
- C. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against all surfaces. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly as specified. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the results herein specified within 15 minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall be kept from contact with the surfaces of the forms. Care shall be taken not to

vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

### 3.07 FINISHING CONCRETE SURFACES

- A. **General:** Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions shown are defined as tolerances and are specified in Paragraphs 1.05G and 1.05H, herein. These tolerances are to be distinguished from irregularities in finish as described herein. Aluminum finishing tools shall not be used.
- B. **Formed Surfaces:** No treatment is required after form removal except for curing, repair of defective concrete, and treatment of surface defects. Where architectural finish is required, it shall be as specified in Section 3.08 herein, and as shown on the exterior elevations.
- C. **Unformed Surfaces:** After proper and adequate vibration and tamping all unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. The classes of finish specified for unformed concrete surfaces are designated and defined as follows:
1. **Finish U1** - Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8-inch. No further special finish is required.
  2. **Finish U2** - After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 1/4-inch. Joints and edges shall be tooled where shown or as determined by the ENGINEER.
  3. **Finish U3** - After the floated surface (as specified for Finish U2) has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of all irregularities.
  4. **Finish U4** - Steel trowel finish (as specified for Finish U3) without local depressions or high points. In addition, the surface shall be given a light hairbroom finish with brooming perpendicular to drainage unless otherwise shown. The resulting surface shall be rough enough to provide a nonskid finish.
- D. Unformed surfaces shall be finished according to the following schedule:

| <b>Unformed Surface Finish Schedule</b>                                  |               |
|--|---------------|
| <b>Area</b>  | <b>Finish</b> |
| Grade slabs and foundations to be covered with concrete or fill material | U1            |
| Floors to be covered with grouted tile or topping grout                  | U2            |
| Slabs that are water bearing with slopes 10 percent                      | U3            |

|  |    |
|--|----|
| and less   |    |
| Sloping slabs that are water bearing with slopes greater than 10 percent | U4 |
| Slabs not water bearing  | U4 |
| Slabs to be covered with built-up roofing                                | U2 |
| Interior slabs and floors to receive architectural finish                | U2 |

E. Floor Sealer Hardener (Surface Applied):

1. Floors to receive hardener shall be cured, cleaned, and dry with all work above the completed. Apply zinc and/or magnesium fluosilicate evenly using 3 coats, allowing 24 hours between coats.
2. The first coat shall be 1/3 strength, second coat 1/2 strength, and third coat 2/3 strength. Each coat shall be applied so as to remain wet on the concrete surface for 15 minutes. If sodium silicate is used, it shall be applied evenly, using 3 coats, allowing 24 hours between coats, and the material shall be applied full strength at the rate of one gallon per 300 square feet. Approved proprietary hardeners shall be applied in conformance with the manufacturer's instruction. After the final coat is completed and dry, surplus hardener shall be removed from the surface by scrubbing and mopping with water.
3. Floor hardener shall be applied where shown.

**3.08 ARCHITECTURAL FINISH**

- A. Smooth Concrete Finish: Immediately after the forms have been stripped, the concrete surface shall be inspected and any poor joints, voids, rock pockets, or other defective areas shall be repaired and all form-tie fastener holes filled as required in Paragraphs 3.12 and 3.13, herein.
- B. After the concrete has cured at least 14 days, the surface shall be wetted, and a grout shall be applied with a brush. The grout shall be made by mixing one part portland cement and one part of fine sand that will pass a No. 16 sieve with sufficient water to give it the consistency of thick paint. The cement used in said grout shall be 1/2 gray and 1/2 white portland cement, as determined by the ENGINEER. White portland cement shall be Atlas white, or equal, furnished by the CONTRACTOR. Calcium chloride in the amount of 5 percent by volume of the cement shall be used in the brush coat. The freshly applied grout shall be vigorously rubbed into the concrete surface with a wood float filling all small air holes. After all the surface grout has been removed with a steel trowel, the surface shall be allowed to dry and, when dry, shall be vigorously rubbed with burlap to remove completely all surface grout so that there is no visible paint-like film of grout on the concrete. The entire cleaning operation for any area shall be completed the day it is started, and no grout shall be left on the surface overnight.
- C. Surface Overnight: Cleaning operations for any given day shall be terminated at panel joints. It is essential that the various operations be carefully timed to secure the desired effect, which is a light-colored concrete surface of uniform color and texture without any appearance of a paint or grout film.
- D. In the event that improper manipulation results in an inferior finish, the CONTRACTOR shall rub such inferior areas with carborundum bricks.

- E. Before beginning any of the final treatment on exposed surfaces, the CONTRACTOR shall treat in a satisfactory manner a trial area of at least 200 square feet in some inconspicuous place selected by the ENGINEER and shall preserve said trial area undisturbed until the completion of the job.
- F. All architecturally treated concrete surfaces shall conform to the accepted sample in texture, color, and quality. It shall be the Contractor's responsibility to maintain and protect the concrete finish.

**3.09 CURING AND DAMPPROOFING**

- A. General: All concrete shall be cured for not less than 14 days after placing, in accordance with the methods specified herein for the different parts of the work, and described in detail in the following paragraphs:

| Surface to be Cured or Damp-proofed  | Method |
|--|--------|
| Unstripped forms   | 1      |
| Wall sections with forms removed   | 6      |
| Construction joints between footings and walls, and between floor slab and columns | 2      |
| Encasement concrete and thrust blocks  | 3      |
| All concrete surfaces not specifically provided for elsewhere in this paragraph    | 4      |
| Floor slabs on grade in hydraulic structures                                       | 5      |
| Roof and slabs not on grade  | 6      |
| Exterior buried surfaces of roof slabs   | 7      |

- B. Method 1: Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removed. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed within 14 days of placing the concrete, curing shall be continued in accordance with Method 6, Paragraph 3.09G, herein.
- C. Method 2: The surface shall be covered with burlap mats, which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.
- D. Method 3: The surface shall be covered with moist earth not less than 4 hours, nor more than 24 hours, after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 days after placement of concrete.
- E. Method 4: The surface shall be sprayed with a liquid curing compound.
  - 1. It shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film, which will seal thoroughly.
  - 2. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the curing period. Should the seal be damaged or broken before the expiration of the curing period, the break shall be repaired immediately by the application of additional curing

compound over the damaged portion.

3. Wherever curing compound may have been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, said compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.
  4. Where curing compound is specified, it shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces, and within 2 hours after removal of forms from contact with formed surfaces. Repairs required to be made to formed surfaces shall be made within the said 2-hour period; provided, however, that any such repairs which cannot be made within the said 2-hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound, following which repairs shall be made as specified herein.
- F. Method 5: Immediately after the concrete has been screeded, it shall be treated with a liquid evaporation retardant. The retardant shall be used again after each work operation as necessary to prevent drying shrinkage cracks.
1. Immediately after each square foot of the concrete has been finished, it shall be given a coat of curing compound in accordance with Method 4, Paragraph 3.09E, herein. Not less than one hour nor more than 4 hours after the coat of curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs. The curing blankets shall be polyethylene sheet, polyethylene-coated waterproof paper sheeting or polyethylene-coated burlap. The blankets shall be laid with the edges butted together and with the joints between strips sealed with 2-inch wide strips of sealing tape or with edges lapped not less than 3 inches and fastened together with a waterproof cement to form a continuous watertight joint.
  2. The curing blankets shall be left in place during the 14-day curing period. A portion of the curing blankets may be temporarily removed for a maximum of 4 hours to allow placing of adjacent concrete work. The exposed slab shall be wetted with water delivered through a fog nozzle prior to placing the removed curing blankets back to the slab as specified in Section 3.09.F.1. Should the curing blankets become torn or otherwise ineffective, the CONTRACTOR shall replace damaged sections. During the first 3 days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials shall be permitted on the curing blankets. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket. The CONTRACTOR shall add water under the curing blanket as often as necessary to maintain damp concrete surfaces at all times.
- G. Method 6: Concrete slabs shall be treated with an evaporation retardant as specified in Method 5. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 14 consecutive days beginning immediately after the concrete has been placed or forms removed. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period. The curing medium shall be weighted or otherwise held in place to prevent being dislodged by wind or any other causes. Until the concrete surface is covered with the curing medium the entire surface shall be kept damp by applying water-using nozzles that atomize the flow so that the surface is not marred or washed. The curing blankets and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours. Immediately after the application of water has terminated at the end of the curing period, the curing medium shall

be removed and curing compound immediately applied in accordance with Method 4, Paragraph 3.09E, herein. The CONTRACTOR shall dispose of excess water from the curing operation to avoid damage to the work.

H. Method 7:

1. Method 6 shall be used for curing.
2. Immediately after completion of curing the surface shall be sprayed with a damp proofing agent consisting of an asphalt emulsion. Application shall be in 2 coats. The first coat shall be diluted to 1/2 strength by the addition of water and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon of dilute solution. The second coat shall consist of an application of the specified material, undiluted, and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon. Damp proofing material shall conform to the requirements of Paragraph 2.04B, herein.
3. As soon as the asphalt emulsion, applied as specified herein, has taken an initial set, the entire area thus coated shall be coated with whitewash. Any formula for mixing the whitewash may be used which produces a uniformly coated white surface and which so remains until placing of the backfill. Should the whitewash fail to remain on the surface until the backfill is placed, the CONTRACTOR shall apply additional whitewash.

### **3.10 PROTECTION**

- A. The CONTRACTOR shall protect all concrete against injury until final acceptance by the OWNER. Fresh concrete shall be protected from damage due to rain, hail, sleet, or snow. The CONTRACTOR shall provide such protection while the concrete is still plastic and whenever such precipitation is imminent or occurring. Immediately following the first frost in the fall, the CONTRACTOR shall be prepared to protect all concrete against freezing. After the first frost, and until the mean daily temperature in the vicinity of the worksite falls below 40 degrees F for more than one day, the concrete shall be maintained at a temperature not lower than 50 degrees F for at least 72 hours after it is placed.

### **3.11 CURING IN COLD WEATHER**

- A. Water curing of concrete may be reduced to 6 days during periods when the mean daily temperature in the vicinity of the worksite is less than 40 degrees F; provided that, during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing shall be temporarily discontinued.
- B. Concrete cured by an application of curing compound will require no additional protection from freezing if the protection at 50 degrees F for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces; otherwise, the concrete shall be protected against freezing temperatures for 72-hours immediately following 72-hours protection at 50-degrees F. Concrete cured by water curing shall be protected against freezing temperatures for 3-days immediately following the 72-hours of protection at 50-degrees F.
- C. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40-degrees F in 24-hours. In the spring, when the mean daily temperature rises above 40 degrees F for more than 3 successive days,

the specified 72-hour protection at a temperature not lower than 50-degrees F may be discontinued for as long as the mean daily temperature remains above 40-degrees F; provided that the concrete shall be protected against freezing temperatures for not less than 48-hours after placement.

- D. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. Use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound; provided, that the use of curing compound for such surfaces is otherwise permitted by these Specifications.

### **3.12 TREATMENT OF SURFACE DEFECTS**

- A. As soon as forms are removed, all exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the ENGINEER. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall have them repaired as specified herein. Concrete containing extensive voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced. All repairs and replacements herein specified shall be promptly executed by the CONTRACTOR at its own expense.
- B. Defective surfaces to be repaired as specified in Paragraph 3.12A, shall be cut back from true line a minimum depth of 1/2-inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of all laitance or soft material, and not less than 1/32-inch depth of the surface film from all hard portions, by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces under repair will remain moist, but not so wet as to overcome the suction upon which a good bond depends. The material used for repair proposed shall consist of a mixture of one sack of cement to 3 cubic feet of sand. For exposed walls, the cement shall contain such a proportion of Atlas white portland cement as is required to make the color of the patch match the color of the surrounding concrete.
- C. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. These holes then shall be repaired in an approved manner with dry-packed cement grout. Holes left by form-tying devices having a rectangular cross-section, and other imperfections having a depth greater than their least surface dimension, shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.
- D. All repairs shall be built up and shaped in such a manner that the completed work will conform to the requirements of Paragraph 3.08 or 3.09, as applicable, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of said repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.
- E. Prior to filling any structure with water, all cracks that may have developed shall be "vee'd" as shown and filled with sealant conforming to the requirements of Section entitled "Joints in Concrete." 03290 This repair method shall be done on the water-bearing face of members. Prior to backfilling,

faces of members in contact with fill, which are not covered with a waterproofing membrane, shall also have cracks repaired as specified herein.

### **3.13 PATCHING HOLES IN CONCRETE**

#### **A. Patching Small Holes**

1. Holes that are less than 12-inches in their least dimension and extend completely through concrete members, shall be filled as specified herein.
2. Small holes in members which are water-bearing or in contact with soil or other fill material, shall be filled with non-shrink grout. Where a face of the member is exposed to view, the non-shrink grout shall be held back 2-inches from the finished surface. The remaining 2-inches shall then be patched according to Paragraph 3.12B herein.
3. Small holes through all other concrete members shall be filled with non-shrink grout, with exposed faces treated as above, or completely filled according to Paragraph 3.12B.

#### **B. Patching Large Holes**

1. Holes which are larger than 12-inches in their least dimension, shall have a keyway chipped into the edge of the opening all around, unless a formed keyway exists. The holes shall then be filled with concrete as specified herein.
2. Holes which are larger than 24-inches in their least dimension and which do not have reinforcing steel extending from the existing concrete, shall have reinforcing steel set in grout in drilled holes. The reinforcing added shall match the reinforcing in the existing wall unless shown.
3. Large holes in members which are water bearing or in contact with soil or other fill, shall have a bentonite type water stop material placed around the perimeter of the hole as specified in the Section entitled "Joints in Concrete," 03290 unless there is an existing water stop in place.

### **3.14 CARE AND REPAIR OF CONCRETE**

- A. The CONTRACTOR shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the OWNER. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at the Contractor's expense.

\*\*\* END OF SECTION \*\*\*

## SECTION 03401

### PRECAST CONCRETE VAULTS

#### **PART 1 -- GENERAL**

##### **1.01 THE REQUIREMENT**

- A. General. The Contractor shall furnish and install prefabricated vaults of types shown on the drawings, for accommodating the meter and drainage facilities shown. The prefabricated vaults shall be the product of Quikset Utility Vaults, Inc., Santa Ana, California. Installation of the vaults shall include the necessary excavation, foundation preparation, vault erection, exterior piping installation and backfill.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Earthwork. 02200

#### **PART 2 -- PRODUCTS**

##### **2.01 MATERIALS**

- A. General: Each vault consists essentially of a basic vault with the particular type of extensions and vault cover. The basic components and assembly thereof shall be as shown on the drawings.
- B. Floor Slab: The floor slab of each vault shall be capable of resisting uplift resulting from a water table standing at the surface of the ground adjacent to the vault.
- C. Roofs or Covers shall be constructed to withstand H-20 loading.
- D. Piping Knockouts shall be provided to facilitate piping installation as shown on the drawings.
- E. Grout used in the joints shall be composed of two parts of sand and one part of cement with sufficient water added to make the grout flow along the joint of its own weight.
- F. Preformed Joint Sealant shall be Quik-Seal or approved equivalent.

#### **PART 3 -- EXECUTION**

##### **3.01 INSTALLATION**

- A. Field Preparation: Prior to setting the floor section of each vault, the Contractor shall properly prepare the foundation thereof. A sand bed 6 inches minimum thickness shall be provided and shall be compacted and shaped to the proper elevation to receive the vault base section in proper relation to the elevation of the piping entering the walls of the vault.

- B. Base Section: Setting of the base section on the prepared compacted sand shall be performed in a manner which will provide uniform bearing pressure over the base area. The base section as installed shall be level and shall prevent flow of grout along the groove once the groove is properly filled.
- C. Joints: All joints shall be water tight and shall be made with the use of cement sand grout or with a preformed joint sealant.
- D. Placing Grout: Prior to placing grout, the joint to be filled shall be thoroughly cleaned and then soaked but shall be free of standing water at the time of grout placement. The insertion of the tongue of the subsequent section shall be performed in a manner which will completely seal the joint. Excess grout flowing out of the joint on the inside of the vault shall be cleaned off for appearance.
- E. Joint Sealant shall be installed as recommended by manufacturer.

\*\*\* END OF SECTION \*\*\*

## SECTION 03480

### PRECAST CONCRETE SPECIALTIES

#### **PART 1 -- GENERAL**

##### **1.01 SCOPE OF WORK**

- A. The Contractor shall construct all manholes, catch basins, neutralization pits, cleanouts, and other appurtenances complete and in accordance with the Contract Documents.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 02200 – Earthwork
- B. Section 02617 – Reinforced Concrete Pipe
- C. Section 02625 - Ductile Iron Pipe
- D. Section 03305 – Minor Concrete

##### **1.03 REFERENCED SPECIFICATIONS, CODES AND STANDARDS**

- A. Without limiting the generality or other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publication are in conflict with the requirements specified here, the more stringent requirement shall apply.
  - 1. Commercial Standards:
    - ASTM A478 – Specification for Precast Reinforced Concrete Manhole Sections

##### **1.04 CONTRACTOR SUBMITTALS**

- A. The Contractor shall submit drawings of precast concrete manhole sections showing details of reinforcement and joints in accordance with Section 01300 – Contractor Submittals.

#### **PART 2 -- PRODUCTS**

##### **2.01 PRECAST CONCRETE MANHOLE SECTIONS**

- A. Precast concrete sections, 600-mm and larger, in diameter, used as manhole sections shall conform to ASTM C478, Class IV, Wall C. Sections shall have rebate joints. Top sections shall be of the shape as indicated in the Contract Documents. Design and manufacture shall be based on H-20 loading. Precast manhole shall be equal in all respects to those manufactured by Associated Concrete Products, or centrifugally spun manhole units as manufactured by Ameron, or approved equal.

##### **2.02 JOINT SEALANT**

- A. The joint sealant compound shall be Quik-seal, a pre-formed, cold-applied, ready-to-use plastic joint sealing compound as supplied by Quickset Utility Vaults, Santa Ana, California, Ram-Nek by K.T. Snyder Company, or approved equal.

### **2.03 NON-SHRINK GROUT**

- A. Grout, where required, shall be of the non-shrink type. The Contractor shall use non-shrink grout, which produces a void filling action that counteracts shrinkage occurring in both the plastic and hardening states. Grout shall be proportional with and in accordance with the manufacturer's instruction for the use intended.

### **2.04 MANHOLE STEPS**

- A. Manhole steps shall be ½-inch steel reinforced, plastic steps as manufactured by M.A. Industries, Inc.

## **PART 3 -- EXECUTION**

### **3.01 INSTALLATION**

- A. Precast concrete manhole sections shall be set so as to be vertical with sections and ladder rungs in true alignment. The joint of previously set section shall be covered with mortar and joint sealant before the new section is placed. Before the mortar is set, joints shall be pointed and exterior joints thoroughly tooled so as to be slightly concave with a hard polished surface free of cracks. Interior joints shall be tooled flush in a similar manner.
- B. Connections to manhole structure shall be made by casting sections of pipe into the base, by using non-shrink grout as indicated in the Contract Documents, and/or using an approved resilient connector.

### **3.02 CONCRETE CATCH BASINS**

- A. Concrete catch basins shall be of the type and sizes at the locations as indicated in the Contract Documents.

\*\*\* END OF SECTION \*\*\*