

TECHNICAL SPECIFICATIONS

**For
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SOUTH END DRAINAGE COLLECTION SYSTEM**

CONSTRUCTION PLANS AND SPECIFICATIONS



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**SECTION 02210
GENERAL EARTHWORK**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This Section covers general requirements for earthwork construction.
- B. The work includes furnishing of all plant, equipment, labor, materials, and supplies to complete the required excavations, foundation preparation, fills, and backfills to the lines and grades shown on the Drawings and as specified herein.

1.2 REFERENCES

- A. AASHTO M145 Standard Specification for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.
- B. ASTM C117 Materials Finer than 75-sm (No. 200) Sieve in Mineral Aggregates by Washing
- C. ASTM C131 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- D. ASTM C136 Sieve Analysis of Fine and Coarse Aggregates
- E. ASTM C535 Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- F. ASTM D75 Standard Practice for Sampling Aggregates
- G. ASTM D422 Particle-Size Analysis of Soils
- H. ASTM D698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³)
- I. ASTM D1140 Amount of Material in Soils Finer than the No. 200 Sieve
- J. ASTM D1556 Density in Place by the Sand-Cone Method
- K. ASTM D1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort [56,000 ft-lb/ft³ (2,700 kN-m/m³)]
- L. ASTM D2216 Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock and Soil-Aggregate Mixtures
- M. ASTM D2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- N. ASTM D4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- O. ASTM D4718 Standard Practice for Correction of Unit Weight and Water Content of Soils Containing Oversize Particles
- P. ASTM D4253 Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
- Q. ASTM D4254 Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

- R. ASTM D6938 In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.3 DEFINITIONS

- A. Approved Low-Ground-Pressure (LGP) Tracked Equipment: Dozers or similar tracked earth-moving equipment applying a maximum track pressure of 7.0 psi.
- B. Borrow Material: Material from required excavations or from designated borrow areas on or near site.
- C. Compaction:
1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D698 or D1557.
 2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by the Manager, in accordance with ASTM D4718.
- D. Coverage: One coverage is defined as the result of successive passes by a piece of compaction equipment, which by means of sufficient overlap, will ensure that all areas of the layer of lift being compacted have been subjected to one pass of the compaction equipment.
- E. Lift: Loose (uncompacted) layer of material.
- F. MSHA: Mine Safety and Health Administration
- G. Optimum Moisture Content: Moisture content as determined by ASTM D698.
- H. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.
- I. Required Moisture Content: Moisture content required is expressed as a range of moisture (+/-) about the optimum laboratory moisture content for the specified material obtained by the test procedure specified.
- J. Suitable Material: Imported material, material from required excavations, or from on-site borrow areas which meets the specification requirements for use in constructing fills and free of unsuitable materials as defined herein. Materials will not be judged unsuitable due to moisture content.
- K. Unsuitable Materials: Materials that contain topsoil, organic muck, salt, trash, debris, waste, debris, roots, organic matter (such as strippings, roots, etc.), frozen matter, or any other materials determined by the Manager to not meet the specifications for any required fill.
- L. Well-Graded: A mixture of particle sizes that has no specific concentration, or lack thereof, of one or more sizes. A material type that, when compacted, produces a strong and relatively incompressible mass with a minimum of voids.
- M. Top Course: A well-graded mixture of gravel, sand and silt obtained from approved on-site borrow areas with a maximum particle size of 4 inches. Soil shall contain less than 30 percent by dry weight passing the No. 200 sieve (ASTM D422) and be free of unsuitable materials. The fraction of the material finer than the No. 40 sieve shall have Plastic Index of less than 4 (ASTM D4318).

1.4 SUBMITTALS

A. Earthwork Plan covering the following items:

1. Proposed source(s) of borrow material(s).
2. Proposed earthwork plan, including all stripping, excavations, stockpiling, backfilling, filling, and removal to spoil with estimated quantities, location, and flow of materials.
3. Layout of Temporary Facilities: Include drawings showing the proposed locations and arrangement of stockpile areas. For stockpiles of processed materials, detail methods of depositing materials in stockpile and reclaiming them to prevent degradation of materials after processing. Include measures to prevent contamination with foreign material and segregation.
4. Proposed layout of work activities, including a detailed schedule.
5. Proposed haul road layout diagram showing the location and details of the roadways and all appurtenant structures, including signing, lighting, flagging, barricades, and associated traffic control plan. Traffic control plan for on-site traffic shall be coordinated with Manager. Traffic control plan for public right-of ways shall be coordinated with the Utah Department of Transportation. Diagram shall show all proposed haul routes and access ramps from required excavations, borrow area, and stockpile areas to, from, and across fill areas and material crossings. Describe and show estimates of construction traffic flows on proposed haul routes and ramping schemes onto and off fill areas.
6. List of equipment and tools proposed for use in all operations of construction of each fill type, including equipment for loading, hauling, spreading, moisture conditioning, discing, scarifying, and compacting. For the compaction equipment proposed, provide sufficient data and drawings to verify the requirements specified in this section. Include the number of each type of equipment.
7. A detailed description of the sequencing and operations necessary for construction of each fill type. Clearly indicate interrelationships among other operations, including stockpiling materials.
8. Site plan or map indicating locations and sizes of temporary stockpile areas for each material type, and identifying which stockpiles are designated for imported materials and which stockpiles are designated for on-site excavated materials.
9. Description of the methods to be used to place filter and transition materials in order to avoid contamination by materials from adjacent fill or existing materials.
10. Number and length of shifts, production rates, and progress.
11. Minimum of 48-hour advance notice on the opening of all excavation areas.
12. Field records including QC documentation.

1.5 QUALITY ASSURANCE

- A. Do not place, spread, or compact fill during adverse weather conditions where such conditions will result in fill not meeting the specifications. Schedule work activities to minimize potential weather interruptions such that excavated areas will have minimum exposure to adverse weather conditions. In the event interruptions occur, no additional compensation will be provided for delay or material drying-out time. When the work is interrupted by adverse weather, fill operations shall not be resumed until field tests indicate the moisture content and density of the fill are as specified or are in condition suitable for resuming the work.
- B. Schedule work to minimize impact to ongoing Owner operations, traffic, railroad, utilities, and other Contract work being completed. Coordinate all necessary interruptions with Manager.

PART 2 PRODUCTS

2.1 EARTHWORK MATERIALS

A. General

- 1. The material gradations specified in this Section are for the materials after placement and compaction.

B. Bridging Material

- 1. Description: Soil mixture, free of deleterious materials.
- 2. Gradation (Visual): Well graded. 18-inch maximum particle size. Less than 30% passing the No. 200 sieve by dry weight. Minor variations in the material passing the No. 200 sieve may be approved by the Manager provided the material will function for its intended purpose – bridging over soft areas.

C. Structural Fill

- 1. Description: Gravel sand mixture, free of clay and unsuitable materials, meeting the requirements of AASHTO M145 A-1-a.
- 2. Plasticity Index: Non-plastic. (ASTM D4318)
- 3. Gradation (ASTM C117/C136):

Structural Fill Gradation Requirements

| U. S. Sieve | Percent Passing by Weight |
|--------------------|----------------------------------|
| 2-inch | 100 |
| No. 10 | Maximum 50 |
| No. 40 | Maximum 30 |
| No. 200 | Maximum 15 |

D. Road Base

- 1. Description: Gravel sand mixture, free of clay and unsuitable materials.
- 2. Abrasion Resistance: 50% maximum loss of weight at 500 revolutions (ASTM C131).
- 3. Sodium Sulfate Soundness: 10% maximum weighted average loss by weight, after five cycles (ASTM C88).
- 4. Plasticity Index: Non-plastic. (ASTM D4318)
- 5. Gradation (ASTM C136):

Road Base Course Gradation Requirements

| U. S. Sieve | Percent Passing by Weight |
|--------------------|----------------------------------|
| 1 1/2-inch | 100 |
| 1-inch | 90-100 |
| 3/4-inch | 70-85 |
| 1/2-inch | 65-80 |
| 3/8-inch | 55-75 |
| No. 4 | 40-65 |
| No. 16 | 25-40 |
| No. 200 | 7-11 |

- E. Top Course
 - 1. Description: Soil mixture, free of deleterious materials.
 - 2. Gradation (Visual): Well graded. 4-inch maximum particle size. Less than 30% passing the No. 200 sieve by dry weight. Minor variations in the material passing the No. 200 sieve may be approved by the Manager provided the material will function for its intended purpose – bridging over soft areas.
- F. Pipe Bedding and Pipe Zone Material

Pipe Bedding and Pipe Zone Material Gradation

| U. S. Sieve | Percent Passing by Weight |
|-------------|------------------------------|
| 1¼-inch | 100 |
| ¾-inch | 60-85 |
| 3/8-inch | 15-45 |
| No. 4 | 7-25 |
| No. 8 | 0-10 |
| No. 200 | 0-3 |

2.2 OFF-SITE BORROW MATERIAL

- A. Unless otherwise approved in writing, borrow material shall be obtained from approved borrow areas. However, Contractor's Materials Handling Plan may propose off-site sources if they meet the specified requirements at a cost benefit to Owner.

2.3 COMPACTION AND DISCING EQUIPMENT

- A. Compaction and discing equipment shall conform to the manufacturer's specifications and shall be maintained in good working condition at all times. Daily inspection records of all mobile equipment shall be maintained. The specified compaction equipment types shall be used for fills for which a minimum density is specified unless otherwise approved by the Manager.
- B. All equipment and tools used in the performance of the Work are subject to review by the Manager before work is started.
- C. Provide equipment for applying water of a type and quality adequate for the Work, free of leaks and equipped with a distributor bar or other approved device to ensure uniform application.
- D. Provide equipment for mixing, aerating, and moisture conditioning fill materials.
- E. Compaction equipment for bentonite pond liner see Section 02250 Bentonite Pond Liner.
- F. Compaction equipment for granular fill materials (includes all materials other than clay fill).
 - 1. Utilize self-propelled smooth single drum vibratory roller equivalent to a Caterpillar CS-533E in terms of drum diameter and width, total weight, and weight on the drums.
 - 2. The drum shall produce a range of frequencies of vibration and an applied force of not less than 5,000 pounds per foot of drum width.
 - 3. Operate at speeds of 4 miles per hour or less.
- G. Where special compaction is specified in this Section, use hand-held power tampers, power tampers on wheels, walk-behind rollers, heavy duty vibrating plate compactors, or

other compaction equipment suitable for the specified fill types, and capable of producing specified densities, as approved by the Manager.

- H. Discing equipment used to break up, blend, or moisture condition bentonite pond liner see Section 02250 Bentonite Pond Liner.

PART 3 EXECUTION

3.1 ACCESS AND HAUL ROADS

- A. Obtain Manager approval for all temporary facility and access/haul road layouts prior to start of construction.
- B. As a part of temporary facilities, design, construct, maintain, and provide ice and snow removal for all temporary access and haul roads as may be necessary to complete the Work. Any roads required by the Contractor shall be constructed in accordance with the approved Materials Handling Plan. Provide adequate drainage ditches, berms, and culverts to direct runoff as indicated on the Drawings..
- C. Maintain roads in good condition at all times. Provide signs, barriers, lighting, and other similar devices to assure safe operation of vehicles as required by Kennecott Utah Copper and MSHA requirements.
- D. Permit travel on construction roads by the Owner, Manager, their employees, and other contractors. When optimum use of construction plant sites requires joint use of construction roads by the Contractor and other contractors who will be working at the site, coordinate with the other contractors for joint use and maintenance of the roads. Terms and conditions of agreements for joint use and maintenance will be subject to approval by the Manager.
- E. Assume maintenance responsibility for all existing and new roads used and constructed by Contractor. Such maintenance shall include all necessary grading, surfacing repairs, and clearance of drainage courses. Unless otherwise specified, each such road shall be in a condition as it was in before Contractor use began at the completion of Work.
- F. Contractor may make use of roads under construction by other contractors with Manager's approval. Such use shall be coordinated with the other contractor so as not to delay completion of Work. Contractor is liable to the other contractor for any delays.
- G. Maintain access to the Owner's Offices and facilities at all times.
- H. Use the existing site roads, new site roads (shown on drawings) when available for site access and haul roads. Temporary turnarounds may be constructed for Contractor's operations with prior Manager approval. Only low ground pressure tracked type equipment will be allowed on subgrade for construction of all new haul/access roads. The use of any other existing roads and trails within the site and the construction of any new temporary haul/access roads shall not be permitted except as required for access to isolated construction areas. These exceptions require Manager approval.
- I. Upon completion of the work, temporary haul/access roads, and temporary turnarounds shall be removed. Any materials placed for the temporary roads and turnarounds outside of the impoundment footprint shall be removed and native materials shall be scarified and graded to blend smoothly with the surrounding land contours. The removed temporary roads and turnarounds, as well as any existing trails used by the Contractor's operations shall be prepared and seeded as detailed in Specification 02310: Seeding and Mulching. Seeding is not specified or required for areas currently not vegetated.
- J. Construction traffic is not allowed on any subgrade; transport of materials to the placement area is to occur on approved haul roads only. Only approved low ground

pressure tracked equipment shall be permitted on haul/access road subgrade without prior written approval. Haul traffic shall be discontinued on any road, if the road surface or subgrade becomes damaged; damage shall be defined as any rutting that occurs in excess of 6 inches. Provide grading, geogrid, bridging material, equipment, light loads, or whatever methods (including material, equipment, and labor) are necessary to allow haul traffic to proceed without damage to the roads. Methods used to protect roads from damage shall be provided at no additional cost to Owner. Damage to the road surface or subgrade resulting from Contractor operations shall be repaired or replaced at Manager's discretion at no additional cost to Owner.

3.2 CONTROLS

- A. Stabilize excavations or support surfaces of open cuts as required for the safety of operations. Provide sheeting, shoring, bracing, and other OSHA and MSHA approved methods to retain excavations and prevent cave-ins. Sheeting and shoring shall be designed by a registered structural engineer, licensed in the State of Utah. Shoring, sheeting, and bracing may be removed as backfilling proceeds. Perform other operations as required to render safe the condition of all excavations and open cuts.
- B. Provide OSHA and MSHA approved barriers or berms to protect vehicles and personnel on raised embankments or grades.
- C. Dewater excavations and fill placement areas in accordance with Section 02120: Construction Dewatering.
- D. Provide dust control in accordance with Section 01510: Dust Control for Contractor Operations.

3.3 DEWATERING

- A. Maintain grades to promote water drainage; provide and operate equipment to keep construction areas free of subsurface, surface, and stormwater during all excavation and backfilling; provide necessary diversion ditches or dewatering systems; dispose of water so construction and storage areas, roads, and other surfaces are not flooded; and fully meet all requirements of the Project Surface Water Pollution Prevent Plan and Section 02120: Construction Dewatering.
- B. Excavation methods without dewatering, such as by dragline, will be acceptable in areas not contiguous to structures or culverts, provided that, prior to its use in fill construction, the material excavated is dried by intermediate stockpiling and aerating to produce specified moisture content or, if no moisture content is specified, to produce a moisture content as required for the specified compaction density.
- C. Excavations for foundations of structures, culverts, and other similar excavations shall be kept dewatered until the structures, pipelines, culverts, etc. are backfilled to above the level where either groundwater or surface water will not adversely influence construction.
- D. The Contractor is responsible for monitoring water levels, determining impact on construction, and for developing and implementing construction features, methods and construction equipment that are compatible with the existing site conditions at the time of construction.

3.4 EXCAVATION

- A. Perform excavation of every type of material encountered within the limits of Project, to the lines, grades, and elevations indicated and as specified. Excavation shall conform with the notes, typical sections and the tolerances specified on the Drawings and this Specification.
- B. Do not excavate in frozen materials, except with written approval of the Manager.

- C. Unless authorized in writing by the Manager, all excavations shall be in the dry in accordance with 02120: Construction Dewatering.
- D. Excavate to required lines and grades as shown on the Drawings or as directed by the Manager. Accurately grade bottom of excavations. If the nature of the soil permits, foundation meets the specified properties and the Manager gives prior approval, excavations for footings and grade beams may be made to dimensions of finished concrete and used as a concrete form.
- E. Trenches and foundation pits shall be of sufficient size to permit placement and removal of forms for the full length and width of structure footings and foundations. When concrete is to be placed in an excavated area, special care shall be taken to keep subgrades dewatered and not to disturb the bottom of the excavation prior to concrete placement. Excavation to the final grade level shall not be made until just before the concrete or aggregate is to be placed. Final excavation to subgrade shall be performed using a smooth bladed backhoe bucket. Equipment shall not be allowed to operate directly on the final subgrade. Degree of slope for open-cut earth banks shall not exceed safe angle of repose of the soil in either dry or wet condition.
- F. Where materials are removed below required elevations and beyond the required excavation limits, backfill the over-excavation and make repairs using compacted fill at Contractor's expense.
- G. Where unsuitable material is exposed at completion of excavation to the lines and grades shown on the Drawings, perform further cutting or stabilization measures as directed by the Manager until suitable bearing is reached. Remove rock encountered in proposed floor slab areas to an elevation at least 6" below bottom of intended slab. If materials are removed below required elevations through error or careless excavation, replace the over excavation with fill material placed and compacted as approved by the Manager at no additional cost to the Owner.
- H. Obtain Manager's approval before excavating under foundations, or within a 45° slope extending downward from the bottom of foundations.
- I. Store materials suitable for backfilling a sufficient distance from edges of excavation to avoid slides and cave-ins due to overloading. In no case shall material be deposited less than 4 feet from the edge of an excavation.
- J. Maintain all excavations free of leaves, brush, sticks, trash, and other debris.
- K. Verify locations of buried underground utilities and pipes and overhead utilities prior to performing any excavations with the Manager and Utility Company representatives as required. Immediately notify the Manager if underground utilities or other unexpected underground structures are encountered. Repair any utilities or pipes damaged during construction at no cost to the Owner.
- L. Carefully uncover, support and protect existing utilities. Do not cut, remove, or damage these items without the Manager's prior written approval. See Section 02220, Excavating and Backfilling for Underground Piping.
- M. Excavation of ditches and channel changes shall be accomplished by cutting accurately to the cross sections, grades, and elevations shown on the Drawings. Care shall be taken not to excavate ditches below grades shown. Ditch over-excavation shall be backfilled with embankment fill material placed in horizontal layers and compacted as specified in this Section at no additional cost to the Owner.
- N. The Owner reserves the right, during the progress of the Work, to vary the slopes, grades, or the dimensions of the excavations from those specified or shown.

3.5 EXCAVATED MATERIALS UTILIZATION

- A. Satisfactory material removed from excavations shall be used, insofar as practicable, in construction of fills within the limit of work. Process excavated material to meet moisture requirements for fills in sufficient quantities to meet the required fills.
- B. Spoil excess excavation materials within areas approved by the Manager. Satisfactory excavated materials shall not be spoiled without specific written authorization from the Manager.

3.6 STOCKPILING MATERIALS

- A. General: Contractor may temporarily stockpile excavated materials and/or processed materials for the convenience of his operations provided that stockpiles meet the following requirements and are approved by Manager and Owner.
- B. Stockpile Location and Size Limitations:
 - 1. Stockpiles shall be located in agreement with the approved Materials Handling Plan, and located so as not to interfere with the access of other contractors or borrow area users.
 - 2. Maintain stockpiles as necessary to conserve work areas. Maintain stockpile and stockpile areas such that they are clean and orderly. At the end of each work period, vertical work faces shall be knocked down and the slopes graded to ensure no sudden collapses or slope failures occur.
 - 3. Locate stockpiles with clear passages of not less than 100 feet all around each stockpile to permit access to each stockpile by others, and to positively prevent mixing of materials between stockpiles, or contamination of stockpiles with unsatisfactory material of any kind.
- C. Stockpile Foundation Preparation:
 - 1. Unless otherwise approved, foundations for each stockpile shall be stripped of all vegetation and organic materials. In the case of processed material stockpiles to be placed on clay foundations, foundation areas shall be covered with the material being stockpiled as required to prevent contamination or degradation of processed materials, compacted to form a base that will not mix with the stockpile materials, and sloped to drain.
- D. Stockpiling of Processed Materials:
 - 1. Methods used for placing processed materials in stockpiles are the Contractor's responsibility. Any method found to cause material to degrade or segregate so that it falls outside the specifications limits shall be promptly discontinued. To prevent segregation of materials, dozing or dumping of processed materials over the sides of a pile will not be permitted.
 - 2. Material stockpiled by vehicles traveling over the placed stockpile materials shall have vehicle traffic spread as evenly as practicable over the previously placed materials and not concentrated in "haul road" patterns on the stockpile.
 - 3. Do not allow equipment to contaminate the stockpiles or stockpile area with leaking oil, hydraulic fluid, or other deleterious substances.
- E. Areas around the stockpiles and areas within Contractor's assigned work area leading to the stockpiles shall be maintained in a graded and sloped to drain condition. Stabilize as necessary for trafficability at Contractor's expense.

3.7 LOADING AND HAULING

- A. Load, haul, and place material in a manner to avoid segregation and loss of material and control dust emissions. Dump material from as small a height as practicable.

3.8 FOUNDATION PREPARATION

A. General

1. Before placing fill material or concrete, verify that foundation preparation meets the specified requirements and obtain Manager approval except as otherwise specified.
2. Schedule Manager's inspection of final prepared subgrade/foundation at least 48 hours in advance of the requested inspection date. Do not place any materials on the final prepared subgrade/foundation requiring Manager approval until it is inspected and approved.
3. Grade foundation surfaces to provide relatively smooth lines and grades. Correct surface irregularities to allow for the placement of relatively smooth layers of fill.
4. Haul roads crossing foundations shall be removed prior to placement of any fill over the haul road area and the foundation surface prepared as specified.
5. Do not place fill on frozen subgrade except as otherwise specified.
6. Moisten earth-excavated surfaces upon or against which concrete is to be placed with water, and tamp or roll to form a firm foundation upon which to place concrete.

B. Debris Basin Embankment Foundation Preparation:

1. Prepare in accordance with Section 02240: Embankments, Borrow, and Backfill.

C. Temporary Access Roads Foundation Preparation:

1. Prepare by track-walking with Manager approved low-ground pressure tracked equipment. The subgrade shall not be cleared of grasses and weeds or scarified.

D. Structures and Pipe Foundation Preparation:

1. Scarify subgrade/foundation and moisture condition to within -2 percent to +3 percent of the optimum moisture content according to ASTM D698. Compact the upper 8 inches of subgrade to at least 95 percent of the ASTM D698 maximum dry density.
2. Where soft subgrade is encountered as approved by the Manger, stabilize foundation using geotextile and bridging material.

3.9 GENERAL PROCEDURES FOR FILL CONSTRUCTION

- A. Do not place fill material until the subgrade or foundation has been dewatered in accordance with Section 02120: Construction Dewatering, and the prepared subgrade or foundation have been inspected and approved by the Manager.
- B. Do not place, spread, or compact fill during adverse weather conditions where such conditions will result in fill not meeting the specifications. Schedule work activities to minimize potential weather interruptions such that excavated areas will have minimum exposure to adverse weather conditions. When the work is interrupted by adverse weather, fill operations shall not be resumed until field tests indicate the moisture content and density of the fill are as specified or are in condition suitable for resuming the work.
- C. Do not place frozen fill material, and do not place fill below water or on frozen ground except as otherwise specified.
- D. Do not allow water to pond on the top of fill lifts. Prevent runoff from contaminating fill materials.
- E. Place fill to the lines, grades and cross-sections shown on the Drawings and written field clarifications by the Manager.

- F. Control and conduct all operations including but not limited to transporting, stockpiling, excavating, producing, and placing the materials to minimize contamination, segregation, and particle breakdown.
- G. The distribution and gradation of materials throughout the fill shall be such that the material is free from lenses, pockets, streaks, or layers of material differing substantially in texture, gradation, and moisture from the surrounding material. The combined excavation and placing operations shall be such that the fill shall be mixed and blended sufficiently to provide the most homogeneous section and best practical degree of compaction and stability.
- H. Remove all organic, oversized, and other unsatisfactory materials, including concentrations of segregated coarse sizes caused by the placing operations from the fill, and dispose of in an approved manner. Minimize traffic of haul equipment on fill materials and route randomly over the fill as necessary to minimize rutting.
- I. Thoroughly moisture treat fill materials as specified to achieve compaction, and maintain at the appropriate moisture content during compaction. The moisture contained in the material during compaction shall be distributed uniformly throughout the layer of material being compacted. Apply moisture to coarse granular fills for dust control even if not required for compaction.
- J. If moisture is added on the fill, add water sufficiently in advance of compaction to permit the added water to penetrate the entire layer or the material processed to provide uniform moisture content throughout soil. If the material becomes too wet to achieve the required compaction, the material shall be removed and allowed to dry, or scarified to reduce the water content, and then recompacted before the next lift of material is placed.
- K. Unless approved by the Manager, blending of materials for purposes of modifying the material to meet the Specification requirements will not be permitted on the fill. Such blending shall be performed at the excavation site or in stockpiles away from the fill.
- L. Do not place fill adjacent to structures before the concrete has attained sufficient strength to withstand the applied construction loads. Unless otherwise approved, do not place fill material against structure walls until the concrete has attained 100% of the design compressive strength per Division 3 of these specifications.
- M. Where applicable, place fill against structures in uniform lifts on both sides of the structure such that no unbalanced loading will occur against the structure.
- N. Unless otherwise specified or specifically authorized by Manager, construct fill in continuous and approximately horizontal lifts for the full width of placement. Placement and spreading of materials shall be parallel to the crest centerline of the embankments except where insufficient space exists for such operations.
- O. Haul road fills over finished slopes shall be excavated and removed prior to completion of the Work. Rutted areas of the finished fill or cut shall be graded and compacted.
- P. Re-work materials which have not been placed in accordance with these specifications. If freezing or wetting of previously compacted and accepted fill has resulted in a decrease in compacted density of the fill, rework the fill until required densities are obtained. Reworking may include removal, rehandling, reprocessing, recompacting, or combinations of these procedures, as required by the Manager. Contractor will not be entitled additional compensation for any rework required to achieve or maintain the specified water content and dry density.
- Q. Take all necessary precautions to preserve the material outside the work lines in the soundest possible condition. Earthwork beyond the work lines performed by Contractor

for any purpose or reason, except as may be directed in writing by Manager, shall be at the expense of Contractor.

- R. Finish the surface of all excavations, fills, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown on the Drawings including specified finish tolerance. Compact surfaces reasonably smooth and free from irregularities, with uniform transitions made to adjacent areas. Grading shall direct any surface runoff away from the work area and toward approved drainage systems or impoundments.

3.10 SPECIAL COMPACTION

- A. Special compaction is required within 2 feet of walls, pipes or culverts (5 feet for walls greater than 10 feet in height), structures, and in tight, restricted, or steep areas not accessible by larger rollers, and within 2 feet of pipes. The intent of special compaction is to prevent damage to structures or pipes from compaction equipment loads.
- B. Compaction equipment used in special compaction areas shall be as specified in Part 2. No equipment may be used which by its weight or movement will damage, move or tilt out of alignment any part of the pipe or structure above, adjacent, or below the ground surface.
- C. Place specially compacted fill in maximum 6-inch thick loose lifts unless otherwise approved.

3.11 PLACING STRUCTURAL FILL

- A. Loose Lift Thickness (except as otherwise specified for special compaction):
 - 1. Under Structure Footings: Maximum 6 inches
 - 2. Structure Backfill: Maximum 12 inches.
 - 3. Under Culverts: Maximum 8-inches.
- B. Moisture Content: Plus or minus 2 percentage points of the ASTM D 698 optimum moisture content. For free draining materials, moisture condition as required to achieve required dry density.
- C. Dry Density:
 - 1. Not less than 95% of the ASTM D 698 laboratory maximum dry density except as otherwise specified for free draining materials.
 - 2. If fill consists of free draining granular materials where a moisture density relationship cannot be established in accordance with D698 as approved by the Manager, compact material by thoroughly wetting and compacting with vibratory compactors to obtain a minimum of 70% relative density as determined by ASTM D 4253 and D 4254.

3.12 PLACING PIPE BEDDING AND PIPE ZONE MATERIAL

- A. Place material adjacent to the pipe using special compaction procedures as specified in this Section.
- B. Loose Lift Thickness: Maximum 6 inches.
- C. Moisture Content: Plus or minus 2 percentage points of the ASTM D 698 optimum moisture content. For free draining materials, moisture condition as required to achieve required dry density.
- D. Dry Density:

1. Not less than 95% of the ASTM D 698 laboratory maximum dry density except as otherwise specified for free draining materials.
2. If fill consists of free draining granular materials where a moisture density relationship cannot be established in accordance with D698 as approved by the Manager, compact material by thoroughly wetting and compacting with vibratory compactors to obtain a minimum of 70% relative density as determined by ASTM D 4253 and D 4254.

3.13 PLACING ROAD BASE FILL

- A. Loose Lift Thickness: Maximum 8-inches.
- B. Moisture Content: Plus or minus 2 percentage points of the ASTM D698 optimum moisture content
- C. Dry Density: Not less than 95% of the ASTM D698 laboratory maximum dry density.

3.14 PLACING FILL, FOR ROAD EMBANKMENT FILL

- A. Loose Lift Thickness: Maximum 12-inches.
- B. Moisture Content: Plus or minus 2 percentage points of the ASTM D698 optimum moisture content.
- C. Dry Density: Not less than 95% of the ASTM D698 laboratory maximum dry density.

3.15 SPOILING EXCESS ROAD EMBANKMENT FILL

- A. Drift excess excavated material downslope to spoil materials outside the road width. Spoiled road fill may form the safety berm; however the spoiled material must be placed in a manner that will form a stable safety berm and bottom slope in accordance with MSHA requirements.
- B. Vegetation cleared from the road may be spoiled off the road edge provided no cleared vegetation debris is incorporated into spoiled materials supporting the safety berm or road slope.

3.16 PLACING TOP COURSE

- A. Lift Thickness: Maximum 6 inches
- B. Moisture Content: Plus or minus 2 percentage points of the ASTM D698 optimum moisture content.
- A. Dry Density: Not less than 95% of the ASTM D698 laboratory maximum dry density.

3.17 WORK LINES, FINISHING AND TOLERANCES

- A. General Graded Areas: Within 0.2 foot of indicated elevations, and 0.5 foot of indicated cut and fill slopes.
- B. Pipe Bedding: Within 0.1 foot of indicated pipe zone dimensions.

3.18 INSPECTION

- A. Establish the lines, grades, and structure locations before proceeding with earthwork. Any work beyond the lines and grades shown on the Drawings and any work done without authorization of the Manager shall be reworked as directed by the Manager at the Contractor's expense.

- B. All materials and each part or detail of the work are subject to inspection by the Manager. Provide access to all parts of the work and furnish the Manager with information and assistance required to make inspections.
- C. The work that involves third parties, such as utilities, shall also have access made available for periodic inspections. Schedule such inspections with the Manager a minimum of 7 working days in advance.
- D. The Manager will direct the Contractor at Contractor's expense to remove or uncover portions of the work that were not inspected and approved in accordance with these Specifications. After examination, the Contractor shall restore said portions of the work to the standards required by these Specifications at no additional cost to the Owner.
- E. If acceptance tests indicate Work does not meet specified requirements, remove Work, replace and retest until the Work is approved at no additional cost to the Owner.
- F. Maintain construction that has been approved. Any damage from equipment, weather, following construction activities, or any other cause shall be replaced by the Contractor at no additional cost to the Owner.

3.19 FIELD QUALITY CONTROL

- A. Field quality control is the responsibility of the Contractor. The Contractor shall arrange with an approved independent laboratory for the tests at the frequency noted in the specifications. The Manager or his representative will determine the test location. Corrective action required due to failing tests and the cost to retest work shall be to the Contractor's account.
- B. Manager may elect to have additional testing performed or may direct that inspection trenches or test pits be cut into the fills to determine that the specifications have been met. Such trenches or pits will be of limited depth and size, and shall be backfilled with the material excavated. When test results indicate the work is not as specified, the work will be corrected using a method approved by Manager, at no additional expense to Owner. If additional testing indicates that work meets the specified requirements, Contractor will be compensated for the excavation and backfilling.
- C. Provide Manager 48 hours advance notice when requesting a test for acceptance of work in progress or a final acceptance test. The Contractor is responsible for scheduling work activity in accordance with material QC testing and Manager's review period.

**Table 3-1
Field Quality Control Testing**

| Material | Placement Area | Test Type | ASTM Test Method | Frequency of Testing (one test per no. of cubic yards indicated) |
|-----------------|--|-----------------------------|-------------------------|--|
| Structural Fill | All Areas | Field Moisture /Density | ASTM D 6938 | 100 cy ¹ |
| | | Gradation | ASTM C 117 C 136 | 1,000 cy ² |
| | | Laboratory Moisture/Density | ASTM D 698 ⁴ | 5,000 cy ² |
| | | Liquid and Plastic Limits | ASTM D 4318 | 5,000 cy ² |
| Road Base | Maintenance Roads, Haul Road on South | Field Moisture /Density | ASTM D6938 | 100 cy ¹ |
| | | Gradation | ASTM C117 C136 | 1,000 cy ² |

| Material | Placement Area | Test Type | ASTM Test Method | Frequency of Testing (one test per no. of cubic yards indicated) |
|-------------------|------------------------|-----------------------------|-------------------------|--|
| | Impoundment | Laboratory Moisture/Density | ASTM D698 ⁴ | 5,000 cy ² |
| | | Liquid and Plastic Limits | ASTM D4318 | 5,000 cy ² |
| Pipe Bedding | Bedding and Pipe Zone | Field Moisture /Density | ASTM D 6938 | 100 cy ¹ |
| | | Gradation | ASTM C 117 C 136 | 1,000 cy ² |
| | | Laboratory Moisture/Density | ASTM D 698 ⁴ | 5,000 cy ² |
| | | Liquid and Plastic Limits | ASTM D 4318 | 5,000 cy ² |
| Bridging Material | Subgrade Stabilization | Gradation | Visual | Continuous |

Notes:

- ¹ Minimum one per day (on days of placement), one per lift, one per structure or one per area of placement, whichever results in the greatest number of tests.
- ² Minimum 1 per material type or change. If any of the analyses or visual inspection by the Manager indicates the material may not meet specifications or is not represented by material testing, additional testing shall be performed by the Contractor to treat the changed material as a new material type. No fill material will be permitted in the work that has not, in the Manager's opinion, been represented by material QC testing. For subsequent tests to prove conformance with the Technical Specifications, additional soil samples shall be collected from in-place areas as directed and as deemed appropriate by the Manager. Such additional testing shall be carried out in accordance with the requirements and the standard test methods for testing specified at no additional cost to the Owner.
- ³ The percent compaction requirements for materials where a moisture density relationship can be established will be evaluated as follows: The in-place density as compacted by the Contractor will be determined by the field density test using the nuclear method (ASTM D6938) or sand-cone method (ASTM D1556). The maximum dry density of the fill at the location of the in-place density test will be estimated using a one-point moisture density test and full-curve moisture density tests (family of curves) of representative fill materials. Both the one-point and the full-curve laboratory moisture-density tests shall be performed according to ASTM D698. The one-point test results will be compared to the representative moisture density curves to estimate the maximum dry density of the compacted fill at the location of the in-place density test. Comparison of the one-point laboratory moisture density test to the family of curves will be in accordance with AASHTO T272, except that ASTM D698 will be used as the laboratory moisture density test. The percent compaction in-place will be calculated as the ratio (in percent) of the in-place dry density to the estimated maximum dry density of the compacted fill at the location of the in-place density test.
- ⁴ If granular fill consists of free draining granular materials where a moisture density relationship cannot be established in accordance with ASTM D698 as approved by the Engineer, test in accordance with ASTM D4253 and D4254.

END OF SECTION

SECTION 02220
EXCAVATING AND BACKFILLING FOR UNDERGROUND PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This Section covers the requirements for excavating and backfilling for the relocation or replacement of all underground utilities and for the installation of below grade utility piping systems.
- B. Conform to Section 02210: General Earthwork requirements except as otherwise specified in this Section.

1.2 SUBMITTALS

- A. Utility Excavation and Backfill Plan 30 days prior to commencing with work, which shall cover Contractor's plan for proposed trenching alignments with trenching, piping/conduit materials, backfill materials and utility installation details.
- B. Records of all survey measurements, including field notes, of uncovered and relocated utilities.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Bedding and Pipe Zone Material: As specified in Section 02210: General Earthwork.
- B. Trench Backfill: Fill above the pipe zone material described above shall be excavated material from the trench construction.

PART 3 EXECUTION

3.1 PREPARATION

- A. Locate utilities by review of Drawings, blue stake, detection devices, permits, or any other methods necessary to determine location of utilities prior to commencement of work.
- B. Locate, uncover, support, and protect all existing identified lines and services prior to commencement of Work.

3.2 TRENCHING

- A. Excavate trenches at required elevations and dimensions shown on the Drawings. Relocated utilities shall match existing grades and shall be placed at lines shown on the Drawings. Width of trench below the top of the pipe shall be kept at a minimum, allowing adequate space for laying conduit or pipe, constructing underground structures, inspection, backfilling and compaction.
- B. Excavate all materials encountered, except for existing services and permanent structures. Remove rock, boulders, portions of abandoned structures, and other hard obstructions to a depth at least 4 inches below pipe barrel and an additional 2 inches below bells and couplings. Surfaces shall be level, or sloped if required, clean, and clear of mud or frozen material. Maintain surfaces in good condition until pipe is laid and structures are built.

- C. Existing Underground Lines and Services: Contractor shall carefully locate, uncover, support, and protect existing lines and services. Do not cut, remove, relocate, or damage these items without Manager's prior written approval; Contractor shall otherwise repair or replace them to equal or better than original condition. Repair or replacement shall be at Contractor's expense. All third-party utility interferences, disconnecting, removal, and relocations shall be scheduled with the utility a minimum of 7 working days in advance. All materials, placement, inspections, and approvals shall be in accordance with the utility's standards and requirements.
- D. Excavating Under and Adjacent to Foundations: Contractor shall not excavate under footings or other foundations or structures, or within a 45 degree slope extending downward from the bottom edge of footings or foundations. Stability of such foundations must be ensured. Contractor shall provide an analysis prepared by a licensed Engineer in the State of Utah under the employ of Contractor to support any request for exception from this requirement. Any damage to structures due to excavations shall be promptly repaired or replaced, as directed by the Engineer, at no additional cost to the Owner.
- E. Excavating Through Paving: Where trench excavation must pass through existing paved areas, Contractor shall remove paving along neat saw cut straight lines.
- F. Material Storage and Disposal: Contractor shall select excavated materials which can be reused later; classify and stockpile each type separately; and dispose of unsuitable and excess material and debris in designated spoil areas in conformance with Section 02210: General Earthwork.

3.3 SUBGRADE COMPACTION

- A. Subgrade conditions at the bottom of excavations are subject to Engineer's approval in accordance with Section 02210: General Earthwork. Where a soft trench bottom is encountered that does not permit compaction of bedding, the trench bottom shall be over-excavated and backfilled with bridging material as specified in Section 02220: General Earthwork. Over excavation required from encountering unsuitable subgrade, as determined by the Engineer, shall be reimbursable via time and material documentation. Where materials are over excavated below required elevations, place and compact pipe bedding material as specified to correct elevations at no additional cost to Owner.

3.4 PLACING PIPE ZONE MATERIAL

- A. Provide pipe zone material not less than 6 inches below pipe invert and top and both sides. Grade bedding surface to the tolerances specified herein. For pipe having belled, flanged, or mechanical joints, shape bedding at joints as required to accommodate the joints and ensure uniform bearing of the pipe.
- B. Place the pipe zone material in horizontal lifts and compact the lifts as specified herein, using appropriate equipment to ensure that the specified compaction is obtained beneath the haunches of the pipe. Bedding and pipe zone materials shall be brought up using a maximum difference of 6 inches between each side of the pipe and with care to avoid displacing the pipe.
- C. Place pipe zone material adjacent to the pipe using special compaction procedures as specified in Section 02220: General Earthwork.
- D. Lift Thickness: See Section 02210 General Earthwork
- E. Moisture Content: See Section 02210 General Earthwork

F. Dry Density: See Section 02210 General Earthwork

3.5 PIPE LAYING

A. General:

1. All work shall be performed in accordance with the pipe manufacturer's recommendations.
2. Pipe laying shall follow excavation as closely as possible. Pipe to be located below grade shall be laid in trenches maintained free of water. Dewater in accordance with Section 02120: Construction Dewatering.
3. Contractor shall carefully inspect pipe and fittings before installation. Items which are defective shall be rejected and removed from the site at no cost to Owner.
4. Contractor shall lay pipe in such a manner that bottom of pipe is uniformly supported in firm, compacted bedding material. The pipe barrel shall be in contact with the trench bottom for its full length. Contractor shall fill areas excavated to lower than planned elevations, and where rock is encountered, with compacted bedding material.

B. Placing Bedding: Provide bedding not less than 6 inches below pipe invert. Grade bedding surface accurately. For pipe having belled, flanged or mechanical joints, shape bedding at joints as required to accommodate the joints and ensure uniform bearing of the pipe. Place the bedding and pipe zone material in horizontal lifts and compact the lifts in accordance with this Section and as specified in Section 02210: General Earthwork, using appropriate equipment to ensure that the specified compaction is obtained beneath the haunches of the pipe. Bedding and pipe zone materials shall be brought up at the same rate on both sides of the pipe and with care to avoid displacing the pipe.

C. Cleaning and Protecting: Contractor shall clean piping interior of dirt and other foreign matter. For bell and spigot pipe, keep a swab in the line and pull it past each joint after its completion. Protect open ends of pipe with temporary stoppers or covers.

D. Manager must approve installation and testing of all underground piping systems prior to backfilling.

3.6 BACKFILLING AND COMPACTING

A. Backfill excavations only after installations have been completed, tested, inspected, and approved by Manager. Before proceeding, excavations shall be free of forms, debris, temporary blocking such as bricks and stones, and other foreign materials. Concrete structures or thrust blocks shall have attained sufficient strength to withstand pressure of earth and compacting operation.

B. Compact backfill to the requirements specified in Section 02210: General Earthwork. Contractor shall furnish power-operated or power-driven hand-operated equipment wherever possible to compact backfill. Compacting of backfill materials by ponding, flooding, or jetting will not be permitted. Material placed over layers not satisfactorily compacted shall be removed and the unsatisfactory areas re-compacted at no cost to Owner.

C. Perform necessary grading to achieve final elevations as designated on the Drawings. Surfaces shall be compacted, reasonably smooth and free from irregularities, with uniform transitions made to adjacent areas. Provide a minimum 1.4"/ft slope away from building walls, unless Drawings indicate otherwise.

- D. Replace pavement, base course, and compacted subgrade disturbed by trenching operations with materials equal in quality and thickness to the adjacent compacted subgrade, base course, and pavement.
- E. To prevent excessive live loads on the pipe, sufficient compacted backfill (but not less than three feet or to the depth indicated on the Drawings) shall be in place over the pipe before heavy construction equipment travels over the pipe.

3.7 FIELD QUALITY CONTROL

- A. Conduct field quality control in accordance with Section 02210: General Earthwork.

END OF SECTION

**SECTION 02225
HIGH DENSITY POLYETHYLENE PIPE (HDPE)**

PART 1 GENERAL

1.1 SCOPE

- A. This section covers furnishing and installation of the high density polyethylene (HDPE) pipeline as shown on the drawings and specified herein.

1.2 RELATED WORK

Related work specified in other sections includes:

- A. Section 02220 – Pipe Excavation and Backfill

1.3 REFERENCES

- A. The published specifications and instructions of the manufacturer selected shall become part of this specification.
- B. The latest edition of the following publications form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
 - 1. American Society for Testing Materials (ASTM)
 - 2. ASTM D 4976 Standard Specifications for Polyethylene Plastics, Molding & Extrusion Materials
 - 3. .ASTM D 2321 Underground Installation of Flexible Thermoplastic Sewer Pipe.
 - 4. ASTM D 2837 Standard Method for Obtaining Design Basis for Thermoplastic Pipe
 - 5. ASTM D 3350 Standard Specification for Polyethylene Plastic Pipe and Fittings.

1.4 SUBMITTALS

The following shall be submitted:

- A. Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed.
- B. A plan for pipe joining and installation. The plan must be reviewed and approved by the Engineer prior to pipe installation.

1.5 STORAGE AND HANDLING

- A. Pipe shall be stored on clean level ground to prevent undue scratching or gouging.
- B. Sections of pipe with deep cuts or gouges shall be removed and ends of pipes rejoined.
- C. Handling of the joined pipe shall be in such a manner that the pipe is not damaged by dragging over sharp or cutting objects.
- D. Lifting of joined pipe sections shall preclude concentration of bending stresses at joints and shall be done in a manner which evenly distributes lifting stresses along the full length of the pipe.

- E. Pipe shall be stored in a shaded area or covered to avoid temperature extremes which may cause the pipe to bow or warp

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

- A. The high density polyethylene pipe shall have a minimum dimension ratio (DR) of 17 unless otherwise shown on drawings.
- B. The piping material and fittings shall be Type III, Class C, Category 5, Grade P34 as tabulated in ASTM D 1248, and shall have a PE 3408 designation.
- C. The manufacturer shall comply with NSF Standard 14 by certifying in writing to the design engineer and making the pipe with the NSF logo in the printline. The manufacturer shall also comply with NSF Standard 61 for the water service connections. The manufacturer shall comply with AWWA Standard C901 by certifying to the design engineer and marking the pipe with the appropriate AWWA standard in the printline.
- D. Fittings shall be pressure rated to match the system piping to which they are joined. At the point of fusion, the outside diameter and minimum wall thickness of the fitting shall meet the outside diameter and minimum wall thickness specifications of AWWA C901.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

- A. High density polyethylene pipe shall be installed according to the requirements of ASTM D 2321, and the manufacturer's requirements.
- B. Sections of pipe shall be joined into continuous lengths by the butt fusion method and shall be performed in strict conformance with the pipe manufacturer's recommendations using approved equipment. Sections of pipe shall be as long as practical to minimize the number of joints. Internal beads at the joints caused by the butt fusion welding method are required to be removed.

3.2 PRESSURE AND LEAK TEST

- A. The system design testing pressures is 100 psi.
- B. Testing prior to pipe installation outside of the trench
 - 1. The Contractor shall test all piping either in sections or as a unit. The test shall be made by placing temporary bulkheads as needed in the pipe and filling the line slowly with water. Care shall be taken to see that all air vents are open during the filling. After the piping or section thereof has been filled, subject the pipe to a hydrostatic test pressure that is 1.5 times the system design pressure for a maximum of three hours. During this time, add water periodically to maintain the test pressure; this compensates for the initial stretching of the pipe. The line-pressure tightness is determined by visual observation; therefore, it is not necessary to measure the make-up water. Examine every fused joint; any leakage must be repaired and then retested.

2. The Contractor shall be responsible to ensure that appropriate safety precautions are observed during the hydrostatic testing above ground.
- C. Testing in the trench:
1. Fill the pipeline with water after it has been laid; bleed off any trapped air. Subject the lowest element in the system to a test pressure that is 1.5 times the design pressure, and check for any leakage. When, in the opinion of the engineer, local conditions require that the trenches be backfilled immediately after the pipe has been laid, apply the pressure test after backfilling has been completed but not sooner than a time which will allow sufficient curing of any concrete that may have been used.
 2. The test procedures consist of two steps: the initial expansion and the test phase. When test pressure is applied to a water-filled pipe, the pipe expands. During the initial expansion of the pipe under test, sufficient make-up water must be added to the system at hourly intervals for three hours to maintain the test pressure. After about four hours, initial expansion should be complete and the actual test can start.
 3. When the test is to begin, the pipe is full of water and is subjected to a constant test pressure of 1.5 times the design pressure. The test phase should not exceed three hours, after which time any water deficiency must be replaced and measured. Add and measure the amount of make-up water required to return the test pressure and compare this to the maximum allowance in Table 1 below.

**TABLE 1
ALLOWANCE FOR EXPANSION UNDER TEST PRESSURE**

| Pipe Size | Nominal US Gallon/100 ft of Pipe | | |
|-----------|----------------------------------|--------|--------|
| | 1-Hour | 2-Hour | 3-Hour |
| 2 | 0.08 | 0.12 | 0.15 |
| 3 | 0.10 | 0.15 | 0.25 |
| 4 | 0.13 | 0.25 | 0.40 |
| 5 | 0.21 | 0.41 | 0.63 |
| 6 | 0.30 | 0.60 | 0.90 |
| 8 | 0.50 | 1.00 | 1.50 |
| 10 | 0.75 | 1.30 | 2.10 |
| 12 | 1.10 | 2.30 | 3.40 |
| 14 | 1.40 | 2.80 | 4.20 |
| 16 | 1.70 | 3.30 | 5.00 |
| 18 | 2.20 | 4.30 | 6.50 |
| 20 | 2.80 | 5.50 | 8.00 |
| 22 | 3.50 | 7.00 | 10.50 |
| 24 | 4.50 | 8.90 | 13.30 |
| 28 | 5.50 | 11.10 | 16.80 |
| 30 | 6.20 | 12.60 | 19.10 |
| 32 | 7.00 | 14.30 | 21.50 |
| 36 | 9.00 | 18.00 | 27.00 |
| 42 | 12.00 | 24.00 | 36.00 |
| 48 | 15.00 | 27.00 | 43.00 |
| 54 | 18.00 | 30.00 | 50.00 |

- D. An alternate leakage test consists of maintaining the test pressure over a period of four hours, and then dropping the pressure by 10 psi. If the pressure then remains within 5% of the target value for one hour, this indicates there is no leakage in the system.
- E. Under no circumstances shall the total time under test exceed eight hours at 1.5 times the system pressure rating. If the test is not complete within this time limit (due to leakage, equipment failure, etc.), the test section shall be permitted to "relax" for eight-hours prior to the next test sequence.

END OF SECTION

**SECTION 02230
TRENCH DAMS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This section covers the requirements for the furnishing and installation of trench dams.
- B. Conform to Section 02220: Excavating and Backfilling for Underground Piping except as otherwise specified in this Section.

1.2 DEFINITIONS

- A. Trench Dam: Placement of low permeability material in pipe embedment zone to prohibit groundwater flow along trench.

1.3 SUBMITTALS

- A. List of materials and equipment proposed for installing trench dams.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Clay or other impervious material approved by the Engineer must be free of roots, stumps, wood, debris, frozen, or other objectionable materials.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Trench dams shall be installed on all drainage lines where grades exceed 10%.
- B. Horizontal Spacing for trench dams shall be as follows:

| SLOPE | MAX SPACING |
|------------|-------------|
| 10% - 15% | 100 FT |
| 15% - 20% | 80 FT |
| 20% - 35% | 65 FT |
| 35% - 50% | 50 FT |
| 50% - Over | 30 FT |

- C. Key trench dams a minimum of two feet beyond undisturbed material on sides and bottom of trench. Top of trench dam shall extend to a minimum of 1 foot below the finished ground surface.
- D. Thickness of trench dam shall be a minimum of 18 inches.

- E. Clay trench dams shall be installed in 6 inch lifts, compacted to 95% Modified Proctor Density.
- F. Bearing area of trench dam shall be resting on undisturbed soil free of roots, stumps, wood, debris, or other objectionable materials.
- G. No fittings shall be located within five feet of trench dams.
- H. Cap all drainage line trenches where the grade exceeds 10% with a trench dam at the highest end of the run.

3.2 FIELD QUALITY CONTROL

- A. Conduct field quality control in accordance with Section 02210: General Earthwork.

END OF SECTION

**SECTION 02280
GEOTEXTILE**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This section covers the requirements for selection and installation of geotextiles for separation of materials between the subgrade/fill and riprap in accordance with Section 02260.

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM)

- 1. ASTM D4354 Standard Practice for Sampling of Geosynthetic for Testing.
- 2. ASTM D4355 Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
- 3. ASTM D4491 Standard Test Method for Water Permeability of Geotextiles by Permittivity
- 4. ASTM D4533 Standard Test Method for Index Trapezoidal Tearing Strength of Geotextiles
- 5. ASTM D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
- 6. ASTM D4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile
- 7. ASTM D4759 Practice for Determining the Specification Conformance of Geosynthetics.
- 8. ASTM D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
- 9. ASTM D5261 Standard Test Method for Measuring Mass per Unit Area of Geotextiles
- 10. ASTM D6241 Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

1.3 DEFINITIONS

- A. Minimum Average Roll Value (MARV): Property values as determined of any individual roll tested from the manufacturing lot or lots of a particular shipment. Values for strength properties shall be for the weakest principal direction.

1.4 SUBMITTALS

- A. Product data, samples of geotextile, and manufacturer's recommended installation procedures. Each sample shall be tagged, dated, and include the project and product specification on the tag.
- B. Certificate of compliance signed by an authorized representative of the geotextile manufacturer certifying that the geotextile meets the specified requirements. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. Provide written certification that the minimum average roll values given in the Manufacturer's specification are guaranteed by the Manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Geotextile labeling, shipment, and storage shall follow ASTM D 4873. Product labels shall clearly show the manufacturer or supplier name, style, and roll number. Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate.
- B. Supply geotextiles in rolls wrapped in relatively impermeable and opaque covers to protect geotextile during shipping and storage.
- C. Storage and Protection:
 - 1. During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, mud, dirt, dust, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, temperatures in excess of 160°F (71°C), and any environmental condition that may damage the property values of the geotextile.
 - 2. Preserve integrity and readability of roll labels.
- D. Handling
 - 1. Use forklifts equipped with slings and spreader bars or other equipment suitable for unloading rolls without damage.
 - 2. Inspect and reject rolls that are damaged or do not meet labeling requirements.

1.6 QUALITY ASSURANCE

- A. Manufacturer's Quality Control (MQC) Sampling, Testing, and Acceptance
 - 1. Geotextiles are subject to sampling and testing to verify conformance with this specification. Sampling shall be in accordance with the most current modification of ASTM Standard D 4354, using the section titled, "Procedure for Sampling for Purchaser's Specification Conformance Testing." In the absence of purchaser's testing, verification may be based on manufacturer's certifications as a result of testing by the manufacturer of quality assurance samples obtained using the procedure for Sampling for Manufacturer's Quality Assurance (MQA) Testing. A lot size shall be considered to be the shipment quantity of the given product or a truckload of the given product, whichever is smaller.
 - 2. Testing shall be performed in accordance with the method referenced in this specification for the indicated application. Geotextile product acceptance shall be based on ASTM D4759. Product acceptance is determined by comparing the average test results of all specimens within a given sample to the specification MARV. Refer to ASTM D4759 for more details regarding geotextile acceptance procedures.
- B. Certification
 - 1. The Contractor shall submit a certificate stating the name of the manufacturer, product name, style number, chemical composition of the filaments or yarns, and other pertinent information to fully describe the geotextile.
 - 2. The manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request.
 - 3. The manufacturer's certificate shall state that the finished geotextile meets MARV requirements of the specification as evaluated under the manufacturer's quality control program. A person having legal authority to bind the manufacturer shall attest to the certificate.

4. Either mislabeling or misrepresentation of materials shall be reason to reject those geotextile products.

PART 2 PRODUCTS

2.1 GENERAL

- A. Supply geotextile rolls in the maximum available width.
- B. The finished manufactured geotextile shall have good appearance qualities. It shall be free from such defects that would affect the specific properties of the geotextile, or its proper functioning.
- C. Manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.
- D. Geotextiles shall be able to withstand direct exposure to ultraviolet radiation from Sun for up to 30 days without any noticeable effect on index or performance properties.

2.2 NON WOVEN GEOTEXTILE

- A. Ultraviolet stabilized continuous filament, needle-punched, non-woven geotextile material composed of polypropylene, or polyester filaments manufactured from prime quality virgin polymer meeting the properties in Table 1 for riprap underlayment, unless other geotextile installations and requirements are noted on the drawings..

**Table 1
8 ounce Non-Woven Geotextile Requirements
(Riprap Underlayment)**

| Property | Test Procedure | Minimum Average Roll Value |
|---------------------------|----------------|----------------------------|
| Weight | ASTM D5261 | 8 oz/yd ² |
| Grab Strength | ASTM D4632 | 200 lbs |
| Grab Elongation | ASTM D4632 | 50 % |
| Tear Strength | ASTM D4533 | 80 lbs |
| CBR Puncture Resistance | ASTM D6241 | 500 lbs |
| A.O.S. E.O.S | ASTM D4751 | 0.18 mm (80) US Sieve |
| Water Flow Rate | ASTM D4491 | 95 gpm/ft ² |
| U.V. Resistance (500 hrs) | ASTM D4355 | 70 % |

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install at locations shown on the Drawings, and where directed by Manager or specified for stabilization.
- B. Handle and install in a manner to ensure geotextiles are not damaged.
- C. Do not drive vehicles or operate equipment directly on installed fabric.
- A. Under riprap, prepare the subgrade surface for geotextile placement by smoothing and trimming as necessary to create a smooth, firm surface for the geotextile.

- B. Unroll geotextile onto prepared subgrade in a smooth and wrinkle-free condition. Do not drag the geotextile across the subgrade.
- C. Remove any remaining wrinkles and folds in the geotextile by stretching and securing as required.
- D. Use sand bags, or other suitable means to prevent exposed geotextile from being uplifted by wind, water, or other natural force until overlying materials are placed.
- E. On slopes, anchor securely and deploy down the slope in a controlled manner to continually keep in tension.
- F. Adjacent geotextile panels shall be sewn, heat bonded, or overlapped a minimum of 18 inches. All seams shall be oriented parallel to (in the direction of) the slope. Seams constructed perpendicular or transverse to the direction of the slope will not be accepted.
- G. Where overlapped, shingle uphill edges over downgrade panels.
- H. Prevent damage to underlying layers during placement of geotextile.
- I. Place cover as soon as possible. The geotextile shall not be exposed to precipitation prior to being installed and shall not be exposed to direct sunlight for more than 14 days after installation. Geotextile exposure periods may exceed 14 days when approved by the Engineer based on evaluation of geotextile resistance to UV degradation and on local environmental conditions.
- J. Place overlying materials in a manner that does not dislodge seams or create wrinkles in the geotextile and such that no excess tensile stresses occur in geotextile.

3.2 FIELD QUALITY CONTROL

- A. Notify the Engineer at least 48 hours before placing geotextile for any purpose.
- B. Should the geotextile be damaged to the extent that it is no longer usable as determined by the Engineer, replace the portion of geotextile as directed by the Engineer at no additional cost to the Owner.
- C. Remove damaged areas of a size exceeding 10 percent of the roll width and replace across the entire roll width with new material. Damaged areas of a size less than 10 percent of the roll width may be patched. All patches must extend a minimum of 18 inches beyond the damaged area in all directions. The patch shall be sewn by hand or machine or heat bonded so as not to accidentally shift out of position during placement of overlying materials.

END OF SECTION

**SECTION 03110
CAST-IN-PLACE CONCRETE**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This Specification Section covers the supply and installation of cast-in-place concrete, formwork, curing and associated work.

1.2 GENERAL REQUIREMENTS AND PROCEDURES

- A. To be complete, this Section requires the use of American Concrete Institute Standard ACI 301, "Specifications for Structural Concrete for Buildings." This Section supplements and modifies ACI 301 and shall take precedence where conflicts exist.
- B. Work shall be performed in accordance with this Section, with other Sections referenced in this Specification and in the Contract, with the Drawings referenced in the Contract, and with other requirements set forth in the Contract itself.
- C. Work may be performed coincidentally with work by others.
- D. Except as noted, concrete work shall conform to recommended practice contained in related references given in Section 1.5 of ACI 301.

1.3 REFERENCES

- A. ACI 301- Specification for Structural Concrete for Buildings
- B. ACI 318 – Building Code Requirements for Reinforced Concrete
- C. ACI 305R – Hot Weather Concreting
- D. ACI 306 – Cold Weather Concreting
- E. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary
- F. ASTM C33 – Concrete Aggregates
- G. ASTM C39 - Test Methods for Compressive Strength of Concrete Cylinder Specimens
- H. ASTM C94 – Ready-Mixed Concrete
- I. ASTM C109 – Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 Inch Cube Specimens)
- J. ASTM C25 – Definition of Terms Relating to Concrete and Concrete Aggregate
- K. ASTM C150 – Portland Cement
- L. ASTM C171 – Sheet Materials for Curing Concrete
- M. ASTM C260 – Air Entraining Admixtures for Concrete
- N. ASTM C309 – Liquid Membrane – Forming Components for Curing Concrete
- O. ASTM C494 – Chemical Admixtures for Concrete
- P. American Plywood Association (APA) U.S. Product Standard PS-1 for Construction and Industrial Plywood.

1.4 SUBMITTALS

CONTRACTOR shall submit the following for OWNER'S REPRESENTATIVE's review:

- A. Quality Control Plan
- B. Information for all CONTRACTOR-furnished products organized as follows:
 - 1. Name of specific product including manufacturer and model or product identification.
 - 2. Mix design for concrete to be placed. Mix design must be approved by OWNER'S REPRESENTATIVE 4 days prior to first concrete placement.
 - 3. Whether or not product exactly meets Drawing and Specification requirements and list of differences if it does not.
 - 4. Published information and certifications pertaining to product including, but not limited to, catalog cuts, manufacturer's certifications and tests, shipping instructions, shipping labels, preparation instructions, and installation instructions.
- C. Copies of certified laboratory test results with supporting test data for mix design, aggregate, admixture, bonding adhesive, grout, non-shrink mortar, and curing compound.
- D. Mill test reports for cement.
- E. Concrete delivery tickets.
- F. Field records including:
 - 1. All QC documentation.
 - 2. Field Survey records.
- G. As-built drawing that accurately depicts each concrete structure as constructed including the structure's location and orientation, dimensions, elevations, and location/position of embedded piping or conduits which are concealed from view and anchor bolts or plates.
- H. CONTRACTOR shall submit a Concrete Placement Plan which describes equipment, manpower, concrete supervisor qualifications and description of proposed concrete operations.

1.5 QUALITY ASSURANCE

- A. CONTRACTOR shall provide and maintain a Quality Control Program
- B. CONTRACTOR shall test all materials as required by Specifications and standards referenced.
- C. CONTRACTOR shall have at least 10 years of documented experience in the installation of concrete of the type and complexity required by this Specification.

PART 2 PRODUCTS

2.1 GENERAL

- A. Where applicable, reference is made to material requirements given in ACI 301, Section 4.2.
- B. CONTRACTOR shall use manufactured materials in accordance with manufacturer's recommendations. If such recommendations differ from requirements specified, call to OWNER'S REPRESENTATIVE's attention before proceeding. The more stringent requirements will apply.

2.2 BASIC MATERIALS

- A. Portland Cement: (See ACI 301, Section 4.2.) For all concrete, use ASTM C150 Type II. When such properties as high early strength and air-entrainment are required, use admixtures. For exposed concrete, use same brand of cement throughout.
- B. Admixtures: (See ACI 301, Section 4.2.) Following are the only admixture materials which will be permitted in concrete.
1. Air-Entraining Admixture: ASTM C260, neutralized Vinsol resin, containing no chlorides, compatible with water reducing admixture, such as W.R. Grace, Daravair; Master Builders, MB-VR; Sika, AER; or OWNER'S REPRESENTATIVE-approved equal.
 2. Water Reducing Admixture: ASTM C494, Type A, such as W.R. Grace WRDA; Master Builders Pozzoloth N; Sika Plastocrete-161, or OWNER'S REPRESENTATIVE-approved equal. When required by climatic and other job conditions at time of placement, use (1) Type D water reducing and retarding admixtures, such as W.R. Grace, Daratard; Master Builder, Pozzoloth Retarder; or Sika, Plastocrete-161R; or (2) Type E water reducing and accelerating admixtures, such as W.R. Grace Darex Set Accelerator used with WRDA; Master Builder Pozzoloth HE; or Sika Plastovrete-161HE. Do not use Sika Plastocrete-161He in slabs cast on steel form deck or in concrete in contact with magnesium or aluminum. When requested by OWNER'S REPRESENTATIVE, CONTRACTOR shall obtain services of a full-time qualified concrete technician employed by the admixture manufacturer to assist in proportioning concrete mixes and to advise on subsequent adjustment of mixes to suit job conditions. OWNER'S REPRESENTATIVE will consider approving the use of substitute products provided they are of similar type, have been proven in field service for at least 10 years, and are capable of producing concrete meeting specified quality requirements with regard to slump, compressive strength, entrained air content, controlled rate of hardening, improved workability, and improved surface texture.
Pumping Aid: Where included in design mix to assist in pumping concrete, use a water soluble lubricant that decreases friction in the pipeline and increases flow without interfering with the hydration of cement or the compressive strength of the concrete, such as W.R. Grade Darex Pumping Aid or OWNER'S REPRESENTATIVE-approved equal.
- C. Water: As per ACI 301, Section 4.2.
- D. Fine Aggregate: Standard fine aggregate, natural san, ASTM C33.
- E. Course Aggregate: Aggregate for Standard weight concrete shall consist of grave, crushed gravel or crushed stone conforming to ASTM C33.

2.3 FORM MATERIALS AND RELATED ITEMS

- A. See ACI 301, Section 2.
- B. Forms: Use wood, steel or other approved material based on safety, and quality of finished work. Plywood for forms and form liners used on exposed concrete work shall conform to U.S. Product Standard PS-1, High Density Overlay, stamped with APA grade trademark, such as Simposn Form Guard 5 ply EXT-DFPA-Plyform, 5/8 inch thick. Earth cuts shall not be used as forms unless approved by OWNER'S REPRESENTATIVE. Shop drawings are not required for formwork.
- C. Form Ties: For exposed work, use type so arranged that when forms are removed, no metal will be closer than $\frac{3}{4}$ inch from any surface.

- D. Compressible Form Material: A material which is sufficiently rigid to support concrete in smooth plane when placed, and capable of being compressed under force of building expansion, such as Dow Chemical Co., Styrofoam SM or OWNER'S REPRESENTATIVE-approved equal.

2.4 CURING MATERIALS

- A. See ACI 301, Section 12.1.
- B. Curing Compound: Liquid membrane-forming type (sodium silicate type not approved) meeting all requirements of ASTM C309, Type 1D clear or translucent, having a fugitive dye to facilitate visual check of coverage. Use of Type 2 or 3 white or light gray pigmented type is required during hot weather. Instructions on containers of compound delivered to the job shall clearly state the maximum coverage rate which meets ASTM C309 moisture retention requirement.
- C. Waterproof Sheet Materials: Any of the types listed in and meeting requirements of ASTM C171: waterproof paper, 4 mil polyethylene film, white burlap polyethylene sheet.
- D. Sealing materials for laps in waterproof covering: pressure sensitive tape, nonstaining mastic, or other effective adhesive recommended by covering manufacturer.
- E. Finishing Aid: Sprayable material designed to form a monomolecular film on fresh plastic concrete, and to retard moisture evaporation prior to finishing, such as Master Builders Confilm or OWNER'S REPRESENTATIVE-approved equal.

2.5 JOINT DEVICES AND FILLER MATERIALS

- A. Expansion Joint Material: ASTM D1752; closed polyvinyl chloride or molded vinyl foam, resiliency recovery of 95 percent if not compressed to more than 50 percent of original thickness, such as W.R. Meadows "Ceramar" or OWNER'S REPRESENTATIVE-approved equal.
- B. Water Stops: Polyvinyl chloride, such as Western Textile Products "Greenstreak" or OWNER'S REPRESENTATIVE-approved equal. Stops are to be centered with center bulb at the constructed joint and placed parallel to the wall.
- C. Elastomeric Sealant: ASTM C920 Type 2, Grade WS, Class 25; on-part urethane sealant-gun grade, such as Sonnebon "Sonolastic WP-1" or OWNER'S REPRESENTATIVE-approved equal.

2.6 MISCELLANEOUS

- A. Nonshrink Grout for Structural Application: Ready-to-use non-metallic type grout conforming to the requirements of ASTM C1107. Master Builders Masterflow 928 Grout for flowable and fluid applications, Master Flow 713 for dry pack application of OWNER'S REPRESENTATIVE-approved equal. CONTRACTOR shall demonstrate that he can properly prepare and place grout by first mixing the grout following manufacturer's instructions and using no more than the recommended maximum water. CONTRACTOR shall then handle or pump the grout using the equipment he intends to use to place the material. After such handling, he shall cast 7 each 2 inch cubes and deliver to OWNER'S REPRESENTATIVE. OWNER'S REPRESENTATIVE will test three of the cubes for compressive strength at one day (24 hours) after casting, two cubes at 7 days, and two cubes at 28 days. OWNER'S REPRESENTATIVE may, at his option, delete the 7- and 28-day tests. OWNER'S REPRESENTATIVE's testing laboratory will perform the tests. Tests shall be in accordance with ASTM C109 except for the use of cover plates in accordance with ASTM C942. CONTRACTOR shall submit his mix design (percent water to grout mix by weight, mixing methods, and mixing time per unit weight dry grout). CONTRACTOR shall have satisfactorily demonstrated his ability to prepare the grout if at

least two of the cubes have compressive strengths at least 90 percent of the published one-day strength for that product. Thereafter, CONTRACTOR shall use the demonstrated mix design and shall accurately measure and record the amount of water used to prepare each batch. If he wishes to change mix design or placement procedures, CONTRACTOR shall repeat demonstration.

- B. Nonshrink Mortar for Patching Purposes: Read-to-use non-metallic aggregate type, similar to nonshrink grout, but graded finer to facilitate featheredging of patches, such as Master Builders Embecco Pre-Mixed Mortar or OWNER'S REPRESENTATIVE-approved equal. Nonshrink mortar shall be prepared and applied in accordance with manufacturer's recommendations.
- C. Bonding Adhesive: Two component epoxy resin system, such as Sika Sikadur Hi Mod or OWNER'S REPRESENTATIVE-approved equal. Bonding adhesive shall be prepared and applied in accordance with manufacturer's recommendations.
- D. Anchor Bolts: In accordance with manufacturer's recommendations.
- E. Vapor Barrier: Unless otherwise shown on Drawing, 6-mil-thick clear polyethylene film type recommended for below-grade application.

2.7 CONCRETE MATERIALS AND ADMIXTURES

- A. As per ACI 301, Section 4, except as noted. Concrete shall have both structural strength and durability of exposure to the elements of soil and weather.
- B. Mix Requirements: Conform to following:
 - 1. Normal weight concrete.
 - 2. 4000 psi minimum compressive strength at 28 days.
 - 3. Portland cement ASTM C150 Type II.
 - 4. Maximum ¾ inch coarse aggregate.
 - 5. Maximum slump = 3 inches.
 - 6. Air content range 4% minimum to 6% maximum by volume.
 - 7. Maximum water content ratio by weight = 0.45.
 - 8. For Pumped Concrete: Where concrete is to be pumped, the slumps indicated above are to be measured at the point of deposit, the outlet end of pump hose. Additional slump required for pumping shall be attained with the use of water reducing admixture.
- C. Air Entrainment: All concrete will have air entrainment because of its reduced permeability.
- D. Use of Admixtures: Only the admixtures specified in Article 2.2.B will be permitted in concrete. Mix designs shall take into account all admixtures required or proposed for use. When more than one type is used, they shall be of same manufacturer wherever possible, to assure compatibility.
 - 1. Use air-entraining admixture, not air-entraining cement, to obtain and control required air content.
 - 2. Water reducing admixture may be used in all concrete. Use proper type when conditions require that rate of early strength development be controlled. Concrete for mass concrete foundations shall contain a retarding-type water-reducing agent in amount recommended by manufacturer, based on the temperature encountered at time of placing concrete.
 - 3. Do not use calcium chloride in concrete.
- E. Average Strength: In meeting the strength requirements specified, the selected mixture proportion shall produce an average compressive strength exceeding the specified

strength by the amount indicated below. Where concrete production facility has test records, a standard deviation shall be established. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths within 1000 psi of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the sample of concrete and tested at 28 days or at other tests age designated for determination of the specified strength.

- F. Where a concrete production facility does not have test records meeting the above requirements but does have a record based on 15 to 29 consecutive tests, a standard deviation may be established as the product of the calculated standard deviation and a modification factor from the following table:

| <u>No. of Tests^a</u> | <u>Modification Factor for Standard Deviation</u> |
|---------------------------------|---|
| Less than 15 | See Note |
| 15 | 1.16 |
| 20 | 1.08 |
| 25 | 1.03 |
| 30 or more | 1.00 |

^a Interpolate for intermediate number of tests.

Note: When a concrete production facility will less than 15 tests shall not be used.

2.8 PRODUCTION OF CONCRETE

- A. As per ACI 301, Chapter 7, except as noted.
- B. Ready-Mixed Concrete shall be used for all work, except that when small quantities (not over ½ cu yd) are needed for isolated items, concrete may be batch mixed at site, subject to prior approval by OWNER'S REPRESENTATIVE.
- C. Furnish a batch ticket (delivery ticket) with each load of concrete. Concrete delivered without a batch ticket containing complete information as specified shall be rejected. Collect and complete the batch ticket at the placement site and deliver all batch tickets to the Manager on a daily basis. The Manager shall have access to the batch tickets at any time during the placement. The following information shall be provided on each batch ticket:
1. Supplier's name and date
 2. Truck number
 3. Project number and location
 4. Concrete class designation and item number
 5. Cubic yards batched
 6. Time batched
 7. Mix design number
 8. Type, brand, and amount of each admixture
 9. Type, brand, and amount of cement and pozzolan
 10. Mass (weights) of fine and coarse aggregates
 11. Moisture of fine and coarse aggregate
 12. Gallons of batch water (including ice)
 13. Allowable water add at site.
- D. Add the following information to the batch ticket at the placement site:
1. Gallons of water added by truck operator plus quantity of concrete in the truck each time water is added
 2. Number of revolutions of drum at mixing speed (for truck mixed concrete)
 3. Discharge time

- 4. Location of batch in placement
 - 5. Water cement ratio
- E. Mixing Time: Concrete which has attained its initial set or has contained water for longer than listed below, shall not be deposited in the work.

Concrete Temperature
At Time of Placement

Under 80°F
80°F - 85°F
86°F - 90°F
Over 90°F

Maximum Time
Before Placement

1 ½ hour
1 ¼ hour
1 hour
1 hour, with OWNER'S REPRESENTATIVE's approval dependent on slump and use. Shall not use as structural concrete.

- F. The above mixing times may be extended with concrete set retarding admixtures to suit field conditions, submit mix designs in accordance with ACI-318, Chapter 5, trial mixture or average strength to OWNER'S REPRESENTATIVE for review.

PART 3 EXECUTION

3.1 FORMWORK

- A. Excavation, backfill, and other earthwork required to construct concrete structures shall be performed by CONTRACTOR in accordance with Section 02210.
- B. Formed surfaces shall be constructed as per ACI 301, Section 2, except as noted.
- C. Form Design and Construction: CONTRACTOR shall make forms accurately conforming to required line, grade and shape, and sufficiently tied and braced to maintain proper position and dimensions during concrete placing. Arrange forms and supports so they may be readily removed without damaging new concrete.
- D. Form Removal: CONTRACTOR shall adjust the following guideline for cold or hot weather conditions and if accelerating or retarding admixtures are used.
 - 1. Load supporting forms and shoring shall not be removed in less than 7 days and after cylinders have been broken and results indicate 75 percent of the required 28 day compressive strength has been attained. Superimposed construction loads must be restricted to one-half the design live load until full 28 day strengths are achieved.
 - 2. Nonload support forms may be removed as soon as practical without damaging the concrete by removal of its support, or by the stripping operation. For footings, grade beams, piers, floor slabs and similar work; minimum 72 hours.
 - 3. In all cases when forms are removed prior to total curing time specified, exposed surfaces must be cured and protected from damage.
- E. CONTRACTOR shall provide ¾ inch chamfer at all exposed concrete edges.

3.2 PLACING

- A. CONTRACTOR shall place concrete per ACI 301, Section 5, except as noted.
- B. Preparation Before Placing:
 - 1. Cleaning: CONTRACTOR shall remove loose mill scale and rust, dirt and other coatings that would reduce or destroy bond from reinforcing steel. Thoroughly clean forms of hardened concrete, wood chips, shavings and other debris.

2. No concrete shall be placed in or under water. Reinforcing steel shall always be placed in the dry. Tremies shall be used to restrict the free fall of concrete to a maximum of three feet. Concrete shall not be placed on frozen ground.
3. If CONTRACTOR elects to do so, he may place a thin layer (approximately 3 inches in thickness) of lean concrete below the bottom of the structural foundation slabs to serve as a working platform and an aid to supporting the bar steel, etc. This concrete should be a uniform reasonably well graded mix, screeded to a reasonably level surface. This is not a requirement and if CONTRACTOR chooses to do so, this working slab shall be below and not a part of the structural foundation slab thickness as shown on the Drawings and shall be at CONTRACTOR's expense.
4. Concrete placement between defined construction joints shall be continuous monolithic concrete placement.
5. Before any concrete is placed, all ice, snow, and frost shall be completely removed by CONTRACTOR and the temperature of all surfaces to be in contact with the new concrete shall be raised to as close as may be practical to the temperatures of the new concrete that is to be placed thereon.
6. Arrangements for covering, insulating, or housing newly-placed concrete shall be made by CONTRACTOR in advance of placement and shall be adequate to maintain, in all parts of the concrete, the temperature and moisture conditions recommended herein for winter curing temperatures and methods. No concrete shall be placed on or against a frozen subgrade or one that contains frozen materials.
7. Notification: CONTRACTOR shall give twenty-four hours advance notice of the intent to place concrete to OWNER'S REPRESENTATIVE indicating that all formwork, embedments, and reinforcing steel have been inspected and accepted by CONTRACTOR's QC.
8. Pre-wet forms, concrete and foundations immediately prior to placing concrete against them.
9. CONTRACTOR shall place concrete in approximately final location and shall not move concrete laterally using vibrating equipment.
10. Pre-wet earth subgrade before placing concrete upon it. Subgrade shall be moist with no standing water.

C. Bonding: For joint surface preparation, see Article 3.3C.

3.3 JOINT AND EMBEDDED ITEMS

- A. CONTRACTOR shall install joints and embedded items per ACI 301, except as noted.
- B. Bonding: Where fresh concrete is placed on or against hardened concrete, obtain bond as specified in ACI 301, Section 5.3.
- C. Anchor Bolts and Embedded Items:
 1. Anchor bolts and other items to be embedded in concrete shall be plumb and securely held in place using structurally stable templates while the concrete is being placed. CONTRACTOR shall support these items adequately so that any movement of persons or equipment on adjacent bar steel will not create movement of the embeded item.
 2. Anchor bolts which are installed in pipe sleeves shall be accurately set both for alignment elevations and plumbness. Anchor bolt thread, nuts, and sleeves shall be protected from injury at all times and precaution shall be taken to keep the bolt sleeve open and free of concrete until the equipment to be set is in place. Anchor bolts in sleeves shall have the top 2 inches of the sleeve interior protected with approved material which is moisture resistant and will prohibit entry of water, snow, or ice. Application shall be easily removed and shall be placed immediately after bolts are concreted in place.

3. Unless otherwise shown or specified, all holding nuts shall be hexagonal. All anchor bolts shall be checked by CONTRACTOR for alignment, elevation, and plumbness prior to a concrete placement, during concrete placement, and immediately after the concrete has been placed. If an error is found, it shall be corrected and the corrected bolt shall be inspected by OWNER'S REPRESENTATIVE for acceptability.
 4. Tolerance for anchor bolt group settings shall be $\pm 1/8$ inch from baseline. $+ 1/16$ inch tolerance will be allowed within the group. All anchor bolts shall be rigidly held in proper position including plumbness and to elevation by means of heavy wood templates, or other approved material. Bottoms of bolts shall be securely wired to reinforcing steel to assure their retaining accurate position and plumbness. Templates and bolts shall be set in place before the concrete is placed. Welding of bolts to reinforcing steel will not be permitted. Reinforcing steel shall be set to avoid interference with anchor bolts. If an interference is found, it shall be corrected and the corrected installation reviewed by OWNER'S REPRESENTATIVE for acceptability.
- D. Control joints shall be provided accurately and neatly in floor slabs by one of the following methods:
1. Sawn: After 4 hours and generally before 12 hours after finishing concrete, when it is firm enough to resist raveling, tearing, or dislodging of aggregates, make cut approximately $1 \frac{1}{4}$ inches deep or $\frac{1}{4}$ slab thickness, using power saw, and blowing joints clean.
 2. Grooved: Using an appropriate jointing tool, carefully form a narrow groove approximately 1 inch deep. Do not use this method where heavy traffic is expected.
 3. Protect edges of control joints from physical damage; keep cuts clean and free of oil, grease or other contaminants until joint sealant is installed.
- E. Waterstops: Waterstops shall be installed to form a continuous watertight barrier. The joining of discontinuous ends shall be in strict accordance with the Manufacturer's printed instructions.

3.4 PATCHING OF SURFACE DEFECTS

- A. CONTRACTOR shall perform patching per ACI 301 Section 5, except as noted.
- B. Concealed concrete surfaces not exposed to view upon completion, may be patched with nonshrink mortar specified herein.
- C. Holes left after removal of form ties shall be cleaned and filled with non-shrink mortar. Holes left by removal of tie rods shall be reamed and filled with non-shrink mortar.

3.5 FINISHING OF FORMED SURFACES

- A. CONTRACTOR shall finish concrete per ACI 301, Chapter 10, and as specified below.
- B. Selection of Finishes:
 1. Smooth Form Finish: Use for structure foundations and walls, and all exposed surfaces.

3.6 SLABS (FINISHING OF RELATED UNFORMED SURFACES)

- A. CONTRACTOR shall finish concrete slabs per ACI 301, Section 5, except as noted.
- B. Finishes and Tolerances:

1. Broom Finish: Use with Class B tolerance, except as noted below.
2. Finishing of various areas shall be as follows:
 - a. Top surfaces of exposed foundations and exterior slabs shall receive a tight wood floated finish followed with a light broomed finish.
 - b. Top surface of foundations, grade beams, and walls below grade and not exposed to view shall receive a wood floated finish.
 - c. Float Finish: Slabs that are to receive a steel trowel finish shall be given a float finish. Screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. After the concrete has stiffened to permit the operation and the water sheen has disappeared, it shall be wood floated.
 - d. Trowel Finish: Slabs on interior of structures, excluding exterior slab surfaces, shall be given a trowel finish immediately following floating. Surfaces shall be trowelled to produce smooth, dense slabs free from blemishes including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. A final hard steel trowelling shall be done by hand. Do not broom finish interior of structures.

3.7 CURING AND PROTECTION

- A. CONTRACTOR shall cure and protect concrete per ACI 301, Section 5, except as noted.
- B. General: Requirements for curing and protection specified in ACI 301 shall be strictly observed, with particular emphasis on the following:
 1. Initial curing may be accomplished by any of the methods given in ACI 301, except as noted, using materials specified herein. Use specified curing, sealing and hardening compound for final curing of slabs and foundations.
 2. Maintain initial curing for approximately 12 hours after finishing. Increase this period to 24 hours when air temperature is 75°F and above.
 3. Total curing period shall consist of 7 cumulative days, (3 days for high-early strength concrete) not necessarily consecutive, during which air in contact with concrete is above 50°F.
 4. For formed surfaces, keep wood forms in contact with concrete wet, as well as steel forms heated by the sun. After form removal maintain curing for remaining time of required curing period.
- C. Weather Requirements:
 1. Cold Weather: CONTRACTOR shall follow the recommendations in ACI 306R. Do not add any chemicals, anti-freeze or other foreign materials to concrete to prevent freezing. When placing concrete at or below 40°F, or when temperature is forecasted to fall below 40°F, both the mixing water and aggregates shall be heated to provide mixed concrete which shall be at a minimum temperature of 55°F when placed. Heat and protect placed concrete by tarpaulins, housing, or other approved coverings. Covering shall contain the heat around all concrete surfaces, including top of slabs. Maintain temperature at minimum of 50°F, for five days after placing and protect from freezing for an additional two days. At the end of this period, protection shall be removed in such a manner that the drop in temperature of any portion of the concrete shall be gradual and will not result in thermal cracking. Keep exposed surfaces wet during heating period. Concrete damaged by freezing shall be removed and replaced.
 2. Hot Weather: Follow the recommendations in ACI 305R. The maximum temperature of any concrete mix shall not exceed 90°F at the time the concrete is placed. The temperature of aggregate and mixing water shall be reduced by the use of chilled water or ice as required.

3. Warm, Dry, or Windy Weather: Use finishing aid specified to reduce moisture evaporation from freshly placed concrete when it is exposed to rapid drying conditions: direct sunlight, low humidity, heated interior, high wind, etc. prepare dilute solution and spray apply on plastic concrete immediately after screeding, at rate of 40 to 75 gallons solution/5000 sq ft. If drying conditions are particularly severe, make additional applications as required following various finishing steps.
- D. Use of Curing Methods: CONTRACTOR shall maintain curing protection in good condition during required period. Repair, reapply or replace when necessary.
1. Water: When excessive amounts of water are used for curing, provide means for removal so that harmful effects to other construction and to earth surfaces will be minimized.
 2. Waterproof Sheet Materials: These will be permitted for initial curing only. Use largest practicable size sheets. Lap joints not less than 4 inches and seal carefully. Anchor covering securely in place.
 3. Curing Compound (Also see par. 2.4B herein): Apply uniformly at a coverage rate not less than that stated by manufacturer which meets ASTM C309 moisture retention requirement.
 4. Reflective Materials: During hot sunny weather (generally 75°F and above) use of white or light colored curing materials is recommended to help keep down concrete surface temperature.

3.8 EVALUATION OF CONCRETE STRENGTH

- A. As per ACI 301, as applicable.

3.9 ACCEPTANCE OF STRUCTURE

- A. As per ACI 301, as applicable.

3.10 INCIDENTAL WORK

- A. CONTRACTOR shall perform the following incidental work:

B. Grouting:

1. Mixes: Grout mix shall consist of nonshrink grout material (specified under Miscellaneous Items) and water only. Use correct amount of water in accordance with manufacturer's recommendations.
2. Mixing for not less than 3 minutes shall be done in a mortar mixer as close as possible to locations of use. Do not mix more grout than can be placed in ½ hour period, and once mixed do not add water to retemper.
3. Forms shall be of adequate materials and strength, sufficiently tight to prevent leakage, and securely anchored to withstand applied pressure. Provide access space necessary for grout placement.
4. Preparation: Contact surfaces of concrete shall be cleaned of laitance, dirt, oil, grease and loose material, then roughened and saturated with water, and excess water removed. Metal members and anchor bolts shall be cleaned of dirt, oil, grease and loose material, and aligned, leveled and maintained in correct final position during grouting.
5. Placement: Grout shall be placed quickly and continuously, avoiding segregation, bleeding or breaking down of initial set. Grout may be poured, or placed by plunger, pump or pressure, as most practicable. Make sure spaces are completely filled and there are no voids.
6. Finishing: After initial set (within 12 to 24 hours), remove forms, cut off exposed edges vertically, and finish neatly. Cure grout with wet burlap for first 48 hours. Leveling devices shall remain undisturbed 48 hours after placing grout; if later removed, voids shall be pointed flush.

7. Test grout in accordance with ASTM C109. Eleven cubes will be prepared for each days grouting operation. Three cubes tested at 3 days, 3 at 7 days, 3 at 28 days and 2 held in reserve.
- C. Surface Protection: All concrete surfaces shall be protected from injury by construction activities, until acceptance of the work by OWNER'S REPRESENTATIVE. All concrete work shall be protected from dirt and oil at all times.

3.11 FIELD QUALITY CONTROL

- A. CONTRACTOR shall make submittals, perform all required inspections and field tests, and collect samples for OWNER'S REPRESENTATIVE-performed laboratory tests in accordance with the OWNER'S REPRESENTATIVE-approved Quality Control Plan and the requirements of this Section and other Contract documents. If any deficiencies are noted during any tests and inspections, such deficiencies shall be corrected by CONTRACTOR at no expense to OWNER and the tests shall be reconducted. OWNER'S REPRESENTATIVE will provide acceptance upon successful completion of field testing.
- B. Tests shall be in accordance with ACI 301.
- C. Testing requirements shall be as listed in ACI 301, modified and supplemented as follows:
1. Sampling, making specimens, capping, handling, curing and testing will conform strictly to referenced ASTM standards, and each procedure will be performed by authorized laboratory personnel only. Tests for slump, air content and compressive strength are required, but not for flexure unless specifically ordered.
 2. Five cylinders will be prepared for each 50 cubic yards of concrete or part thereof used in one day's placing of concrete. One cylinder will be tested at 7 days, 3 at 28 days, and 1 held in reserve.
 3. Laboratory will report test results to OWNER'S REPRESENTATIVE with copy to CONTRACTOR.
 4. In addition to the items to be reported as outlined in ASTM C39, the unit weight, air content, slump, temperature and pour location of test cylinders will be noted.
- D. CONTRACTOR shall coordinate with the OWNER'S REPRESENTATIVE's laboratory to assure proper performance of all required testing services. Promptly deliver concrete material samples, furnish mill test reports of cement and reinforcing steel, furnish assistance in obtaining samples and handling specimens, and provide necessary facilities at site for storage and curing. Test concrete aggregates in accordance with ASTM C33 for each 1000 cubic yards of coarse and fine aggregate.
- E. CONTRACTOR shall maintain an orderly and current file of all submittals, approvals, inspection reports, field test reports, and OWNER'S REPRESENTATIVE-furnished laboratory test results for each individual structure requiring more than one cubic feet of concrete.
- F. All tests shall be documented and provided to OWNER'S REPRESENTATIVE within 2 days of receipt of test results.

END OF SECTION

**SECTION 03210
CONCRETE REINFORCEMENT**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Reinforcing steel and accessories for cast-in-place concrete, and epoxy dowels.

1.2 REFERENCES

A. American Society of Testing and Materials International (ASTM)

1. ASTM A185 – Standard Specification for Steel Welded Wire Reinforcement, Plain for Concrete
2. ASTM A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
3. ASTM A706 – Standard Specification for Low-Alloy Steel Deformed Bars and Plain Bars for Concrete Reinforcement
4. ASTM A767 – Standard Specification for Zinc-Coated (Galvanized) Bars for Concrete Reinforcement
5. ASTM A775 – Standard Specification for Epoxy-Coated Reinforcing Steel Bars
6. ASTM A780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

B. American Concrete Institute (ACI)

1. ACI 117 – Specification for Tolerances for Concrete Construction and Materials
2. ACI 301 – Specifications for Structural Concrete
3. ACI 318 – Building Code Requirements for Structural Concrete
4. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures
5. ACI SP-66 – ACI Detailing Manual

C. Concrete Reinforcing Steel Institute (CRSI)

1. CRSI Manual of Standard Practice.
2. CRSI 63 Recommended Practice for Placing Reinforcing Bars.
3. CRSI 65 Recommended Practice for Placing Bar Supports, Specifications, and Nomenclature.

D. American Welding Society (AWS)

1. AWS D1.4 – Structural Welding Code for Reinforcing Steel

1.3 SUBMITTALS

A. Quality Control Plan.

B. Shop and Reinforcement Placement Drawings:

1. Drawings showing complete information necessary for fabrication and placing
2. Prepare shop drawings in accordance with ACI SP-66.
3. Concrete cover for reinforcement shall conform to ACI 301, unless Drawings indicate otherwise.
4. Indicate bar sizes; spacings; locations and quantities of reinforcing steel; bending and cutting schedules; and supporting and spacing devices.

5. Show locations of splices. Proposed reinforcing splices not indicated on the Drawings will require written approval by the Manager.
 6. Drawings submitted for review must bear evidence that they have been checked. Incomplete or unchecked drawings will not be reviewed. Changes made to previously submitted drawings must be encircled and identified as revisions and resubmitted as shown above for review.
 7. Review of drawings by Manager will be for adherence to overall basic design. Correctness of dimensions, proper design of details, quantities and field fit shall be the responsibility of Contractor.
- C. Mill Test Reports:
1. Submit mill test reports and other acceptable evidence that materials furnished comply with specified requirements.
 2. Smooth dowel coating.
- D. Epoxy adhesive manufacturers installation instruction for epoxy dowels.

1.4 QUALITY ASSURANCE AND QUALITY CONTROL

- A. Perform concrete reinforced work in accordance with the CRSI Manual of Standard Practice and Document 63 and 65.
- B. All reinforcing steel furnished shall be identified with Manufacturer's mark and grade symbol.
- C. Manufacturer and Contractor shall provide and maintain a quality control program.
- D. Contractor shall have at least ten years of documented experience in the installation of concrete reinforcement of the type and complexity required by this Specification.
- E. Manufacturer and Contractor shall test all materials as required by Specifications and standards referenced
- F. All welding and welding procedures shall be in accordance with AWS D1.4.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Submit a schedule which establishes reinforcing steel delivery dates.
- B. Provide receiving inspection per Article 3.3
- C. Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid rusting.
- D. Handle and store in a manner to prevent damage to bars or coatings.
- E. All systems for handling epoxy-coated bars shall have padded contact areas. The bars or bundles shall not be dropped or dragged. Coated bars shall be stored on padded wooden or steel cribbing. Sufficient spacers and padding shall be used to prevent damage to the bars and coatings.
- F. Protect from contaminants such as grease, oil, and dirt.
- G. Provide identification after bundles are broken and tags removed.

1.6 SPECIAL STORAGE, HANDLING, AND SHIPPING OF EPOXY-COATED REINFORCING

- A. Bars shall be handled and stored in a manner to prevent damage to bars or coating.

- B. All systems for handling epoxy-coated bars shall have padded contact areas. The bars or bundles shall not be dropped or dragged. Coated bars shall be stored on padded wooden or steel cribbing. Sufficient spacers and padding shall be used to prevent damage to the bars and coating.
- C. Bars shall be shipped using sufficient dunnage to adequately protect the bars and their external coating. Chains or steel bands shall not be used without sufficient padding to prevent damage to the coating.
- D. Bars shall be loaded for shipping in accordance with ASTM A775, and in compliance with all transport regulations.

PART 2 PRODUCTS

2.1 REINFORCEMENT

- A. Reinforcing Bars:
 - 1. ASTM A 615, 60 ksi minimum yield strength and 40 ksi for ties and stirrups; deformed billet steel bars; welding for fabrication or installation not permitted. Use for all concrete work unless indicated otherwise on Drawings.
 - 2. ASTM A 706, 40 ksi minimum yield strength, weldable low-alloy-steel reinforcing bars, deformed.
 - 3. Epoxy Coatings: Where shown or specified, provide epoxy coated bars in accordance with ASTM A775.
- B. Welded Wire Fabric: ASTM A185 Plain Type; in flat sheets; galvanized in accordance with ASTM A767 Class I finish.
- C. Smooth Steel Dowels
 - 1. Dowels: ASTM A615, Grade 60 round smooth steel bars.
 - 2. Bond Breaking Compound: Use a bond-breaking compound approved by the Manager.

2.2 ACCESSORY MATERIALS

- A. Accessories shall be sized and shaped for strength and support of reinforcement during concrete placing. Accessories installed on top of vapor barrier shall be designed to not puncture vapor barrier during concrete placement.
- B. For Epoxy-Coated Reinforcement: Accessories supporting epoxy-coated reinforcement shall have an exterior coating of epoxy, vinyl, or other non-abrasive material. The coating shall extend the full length of the accessory or for 2 inches on either side of the point of contact with the epoxy-coated reinforcement, whichever distance is less. Reinforcing bars used as support bars shall be epoxy coated.
- C. Adjacent to Exposed Surfaces: Where concrete surfaces are exposed to weather or water in the finished structure, the portions of accessories in contact with formwork shall be plastic or epoxy-coated.
- D. Tie Wire: Minimum 16 gage annealed type.
- E. Chairs, Bolsters, Bar Supports, and Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions, in accordance with CRSI Manual of Standard Practice. Use of concrete block, rocks, or other items for reinforcement support will not be allowed. Bar supports shall comply with requirements of ACI 301.

- F. Dowel Epoxy Adhesive: Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System (HIT HY-150), or approved equal.

2.3 FABRICATION

- A. Fabricate concrete reinforcing in accordance with Manager approved shop drawings and ACI 318 and ACI SP-66.
- B. Reinforcing splices must be reviewed and approved in writing by the Manager.
- C. Welding reinforcing bars is not permitted unless shown otherwise on the Drawings. Reinforcing bars to be welded shall conform to ASTM A 706.
- D. Cut and bend bars at the mill or shop prior to shipment. Heating of reinforcement for bending or straightening will not be permitted.
- E. For epoxy-coated or galvanized reinforcement, clean and repair damaged coatings. For epoxy-coated items, repair in accordance with ASTM A 775. For galvanized items, repair in accordance with ASTM A780.
- F. Bundling and tagging shall be per CRSI Manual of Standard Practice. Secure like pieces in bundles and tag them for identification.
- G. All cuts and bends shall be made to conform to CRSI Manual of Standard Practice, ACI 117 or ACI SP-66.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Before placing concrete, clean reinforcement of loose rust, loose mill scale, dirt, grease, and other substances, which would impair bond with concrete. Remove rust by vigorous rubbing with burlap cloth or wire brushing.
- B. Accommodate formed openings.
- C. Place, support, and secure reinforcement against displacement. Do not deviate from required position.
- D. Place reinforcement in accordance with the Manager Approved Contractor's reinforcing steel placement submittals and CRSI 65.
- E. Splice reinforcing bars by lapping and securely wiring together. Splices are subject to written approval by the Manager and shall conform, to the requirements of ACI 318. Do not use mechanical splices. Do not weld or tack weld reinforcing bars.
- F. On ground concrete bricks may be used to support bars. Over formwork, use metal, plastic, or other approved bar chairs and spacers.
- G. Place and secure embedded metalwork and conduit so as to not interfere with reinforcement installation.
- H. Field bending of reinforcement is not allowed unless approved by the Manager in writing.
- I. Locate splices where shown on the Manager-approved shop drawings and conform to requirements in ACI 318, Class B.

- J. Place reinforcement with clear distance of 1-inch, minimum, between reinforcement and anchor bolts, form ties, or other embedded metalwork unless otherwise shown on Drawings.
- K. Tolerances:
1. Maintain concrete cover over reinforcement within 1/2 inch of specified cover where specified cover is greater than 2-1/2 inches.
 2. Maintain concrete cover over reinforcement within 1/4 inch of specified cover where specified cover is 2-1/2 inches or less.
 3. Maintain spacing of reinforcing bars within 1 inch of required spacing.
 4. Tolerances provided in ACI 117.
- L. Placing Welded Wire Fabric:
1. In lieu of high chairs or other supports, welded wire fabric may be laid on freshly placed and screed concrete. Screed the concrete to within 1 1/2 inches of top of slab, set the mesh reinforcing on fresh concrete and place the remaining concrete as soon as possible, without disturbing the position of the mesh and avoiding cold joints.
 2. Setting of welded wire fabric on forms or on grade and subsequent lifting or "hooking it up" through the plastic concrete is not permitted. "Walking-in" the wire mesh is not permitted.
- M. Repair of coating damage caused during shipping of field handling and placing shall conform to the following:
1. Damage need not be repaired in cases where the damaged area is 1/4 by 1/4 inch or smaller and the sum of all damaged area in each 1-foot length of bar does not exceed 0.5% of the bar surface area in each 1-ft length of bar. All damaged areas larger than 1/4 inch square shall be repaired. The total bar surface area covered by patching material shall not exceed 2%.
 2. Areas requiring repairs shall be cleaned to remove dirt and damaged coating using surface grinders or other suitable means. Remove all dust, dirt, oil, grease, or other detrimental contaminants which impair adhesion of the repair material.
 3. Repair material for damaged epoxy coating shall be in accordance with the epoxy-coating applicator's recommendations for field repair of damaged coating.
 4. Repair material for damaged galvanized coating shall be accomplished using Manager-approved zinc-rich paint applied in accordance with ASTM A780 and the paint manufacturer's instructions.
 5. All coating repair work shall be at no additional cost to Owner.

3.2 EPOXY DOWEL INSTALLATION

- A. Install epoxy dowels only where shown on the Drawings or otherwise approved by the Manager.
- B. Install epoxy dowels in strict accordance with the manufacturers written instructions, including hole drilling and hole size, hole cleaning and preparation, epoxy injection, dowel placement, and cure times.

3.3 FIELD QUALITY CONTROL AND INSPECTION

- A. If any deficiencies are revealed during the performance of the Work, correct such deficiencies shall be corrected by Contractor at no expense to Owner.

- B. Provide receiving inspection to verify that all materials are of the types and quantity required for the Work, are not damaged or exhibit other unsatisfactory characteristics (to include but not limited to: proper packing for storage, dirt, moisture).
- C. Perform inspections as required to ensure that reinforcing materials, fabrication, and placement are in accordance with this section. Specifically, Contractor shall check reinforcement pieces prior to placement to ensure materials are as specified, fabrication is in accordance with Manager-approved shop drawings, pieces have proper tag numbers, and coatings are in acceptable condition. After placement, Contractor shall inspect reinforcement to ensure that it has been installed in accordance with the placement drawings, all required accessories are in place, reinforcing has been properly tied, and coatings are in acceptable condition.
- D. Maintain an orderly and current file by structure of approved submittals and inspection reports verifying compliance with the section.
- E. Notify the Manager at least 24-hours in advance of a requested concrete reinforcement inspection. Provide sufficient time in the schedule for the Manager to inspect the reinforcing steel prior to placement of concrete. Concrete placed without inspection and approval by the Manager may be subject to rejection and removal at no additional cost to the Owner.
- F. The Manager's inspection of steel reinforcing prior to concrete placement will not relieve the Contractor from responsibility to conform to the Drawings and Specifications.

END OF SECTION

**SECTION 03310
PRECAST STRUCTURAL CONCRETE**

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes precast structural concrete.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design precast structural concrete, including comprehensive engineering analysis by a qualified professional engineer licensed in the state of Utah, using performance requirements and design criteria indicated.
- B. Structural Performance: Precast structural concrete units and connections shall withstand design loads indicated within limits and under conditions indicated.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each precast concrete mixture.
- C. Shop Drawings: Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement. Detail fabrication and installation of precast structural concrete units.
- D. Delegated-Design Submittal: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Qualification Data: For fabricator.
- F. Welding certificates.
- G. Material certificates.
- H. Material test reports.
- I. Source quality-control reports.
- J. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
 - 1. Participates in PCI's Plant Certification program and is designated a PCI-certified plant as follows:
 - a. Group C.
- B. Design Standards: Comply with ACI 318 and design recommendations in PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast structural concrete units indicated.

- C. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code - Steel."
 - 2. AWS D1.4, "Structural Welding Code - Reinforcing Steel."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Support units during shipment on nonstaining shock-absorbing material in same position as during storage.
- B. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.
- C. Lift and support units only at designated points shown on Shop Drawings.

1.6 COORDINATION

- A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 PRODUCTS

2.1 REINFORCING MATERIALS

- A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 60 percent.
- B. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- C. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- D. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

2.2 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I/II, gray, unless otherwise indicated.
- B. Supplementary Cementitious Materials:
- C. Retain mineral or cementitious admixtures in four subparagraphs below. Because fly ash, gray silica fume, and ground slag affect color uniformity, they are not recommended by PCI where appearance is important.
 - 1. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
 - 2. Metakaolin Admixture: ASTM C 618, Class N.
 - 3. Silica Fume Admixture: ASTM C 1240, with optional chemical and physical requirement.

- 4. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
 - D. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C 33, with coarse aggregates complying with Class 5S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.
 - E. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
 - F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.
- 2.3 STEEL CONNECTION MATERIALS
- A. Carbon-Steel Shapes and Plates: ASTM A 36.
 - B. Carbon-Steel-Headed Studs: ASTM A 108, AISI 1018 through AISI 1020, cold finished, AWS D1.1, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 116.
 - C. Carbon-Steel Plate: ASTM A 283.
 - D. Carbon-Steel Structural Tubing: ASTM A 500, Grade B.
 - E. Wrought Carbon-Steel Bars: ASTM A 675, Grade 65 (Grade 450).
 - F. Deformed-Steel Wire or Bar Anchors: ASTM A 496 or ASTM A 706.
- A. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A; carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A 563; and flat, unhardened steel washers, ASTM F 844.
 - G. High-Strength Bolts and Nuts: ASTM A 325 or ASTM A 490, Type 1, heavy hex steel structural bolts; heavy hex carbon-steel nuts, ASTM A 563; and hardened carbon-steel washers, ASTM F 436.
 - 1. Do not zinc coat ASTM A 490 bolts.
 - H. Zinc-Coated Finish: For exterior steel items, and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123 or ASTM A 153.
 - 1. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035B or SSPC-Paint 20.
- 2.4 BEARING PADS
- A. Provide bearing pads for precast structural concrete units as recommended by precast fabricator for application.
- 2.5 GROUT MATERIALS
- A. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time.

2.6 CONCRETE MIXTURES

- A. Prepare design mixtures for each type of precast concrete required.
 - 1. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
 - 2. Limit use of fly ash to 25 percent replacement of portland cement by weight and granulated blast-furnace slag to 40 percent of portland cement by weight; metakaolin and silica fume to 10 percent of portland cement by weight.
- B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.
- C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 or PCI MNL 116 when tested according to ASTM C 1218.
- D. Normal-Weight Concrete Mixtures: Proportion by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
 - 1. Compressive Strength (28 Days): 5000 psi minimum.
 - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
- E. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 116.
- F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 116.
- G. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.
- H. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.7 FABRICATION

- A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.
 - 1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."
- B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.
- C. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.
- D. Cast-in openings larger than 10 inches in any dimension. Do not drill or cut openings or prestressing strand without Managers' approval.

- E. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.
- F. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses.
- G. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
- H. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units.
- I. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air on surfaces. Use equipment and procedures complying with PCI MNL 116.
- J. Comply with PCI MNL 116 procedures for cold-weather concrete placement.
- K. Comply with PCI MNL 116 procedures for hot-weather concrete placement.
- L. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that will not show in finished structure.
- M. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.
- N. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet Engineer's approval.

2.8 FABRICATION TOLERANCES

- A. Fabricate precast structural concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL 116 product dimension tolerances.

2.9 COMMERCIAL FINISHES

- A. Standard Grade: Normal plant-run finish produced in molds that impart a smooth finish to concrete. Surface holes smaller than 1/2 inch caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are permitted. Fill air holes greater than 1/4 inch in width that occur more than once per 2 sq. in. Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Limit joint offsets to 1/8 inch.
- B. Screed or float finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a uniform finish. Hand screed at projections. Normal color variations, minor indentations, minor chips, and spalls are permitted. Major imperfections, honeycombing, or defects are not permitted.

2.10 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect precast structural concrete according to PCI MNL 116 requirements.

- B. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Engineer's approval. Engineer reserves the right to reject precast units that do not match approved samples, sample panels, and mockups.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.
- B. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, supports, and bracing as required to maintain position, stability, and alignment of units until permanent connection.
 - 1. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
 - 2. Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
- C. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.
- D. Field cutting of precast units is not permitted without approval of the Engineer.
- E. Welding: Comply with applicable AWS D1.1/D1.1M and AWS D1.4 for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.
- F. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.
- G. Grouting: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled.

3.2 ERECTION TOLERANCES

- A. Erect precast structural concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

3.3 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 - 1. Erection of precast structural concrete members.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Field welds will be visually inspected and nondestructive tested according to ASTM E 165 or ASTM E 709. High-strength bolted connections will be subject to inspections.
- D. Testing agency will report test results promptly and in writing to Contractor and Engineer.

- E. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.
- F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- G. Prepare test and inspection reports.

3.4 REPAIRS

- A. Repair precast structural concrete units if permitted by Engineer.
 - 1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units has not been impaired.
- B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet.
- C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780.
- D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
- E. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by Engineer.

3.5 CLEANING

- A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.
- B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
 - 1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.
 - 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION

**SECTION 05110
MISCELLANEOUS METALS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This Specification Section covers the furnishing and installing of miscellaneous metal items. Items shown on the Drawings but not specifically noted in this Specification shall be of quality and workmanship conforming to similar items described in this Section. Required items of work include but are not necessarily limited to:
1. Structural frames and members not part of structural steel.
 2. Steel grating: flooring, covers, treads.
 3. Miscellaneous plate and angle assemblies: closures, expansion joints, corner guards.
 4. Access Hatches
 5. Castings and other metal parts associated with pits and drainage: manhole frames and covers, cast gratings, and ladder rungs.
 6. Miscellaneous parts for assembling and attaching items specified herein: fasteners, sleeves, anchors, inserts, hardware and accessories.
 7. Miscellaneous parts for attaching work of other trades which are not covered in other Specifications: fasteners, sleeves, anchors, inserts and anchor bolts.

1.2 SUBMITTALS

- A. Shop fabrication and erection drawings showing complete information necessary for fabrication and erection. Clearly distinguish between shop and field bolts and welds. Show all holes for attaching or accommodating other work as shown. State on lists of materials the computed weights of steel and the size, type and number of fasteners required for each field connection on lists of materials the computed weights of steel and the size, type and number of fasteners required for each field connection.
1. Drawings submitted for review must bear evidence that they have been checked. Incomplete or unchecked Drawings will not be reviewed. Changes, other than Manager required changes made to previously submitted Drawings must be encircled and identified as revisions and resubmitted as shown above for review.
 2. Review of Drawings will be for adherence to overall basic design. Correctness of dimensions, proper design of details, quantities, and field fit shall be the responsibility of the Contractor.
- B. Product Data Sheets for Manufacturer's standard products providing adequate information to determine suitability of product.
- C. Shop Fabrication Quality Control.
- D. Certificates of compliance for all miscellaneous metals stating that the item(s) furnished meet the requirements of this Specification and the standards referenced.
- E. Qualified Welding Procedures and performance qualification records.
- F. Installation Quality Plan.
- G. Field Q.C. Test reports showing the results of all required field quality tests performed and all tests performed to prove compliance with this Specification.

- H. As-built drawings showing as-built layout, anchorage, connections, relationship to other parts of work.
- I. Shop and field painting procedures.

1.3 DELIVERY AND HANDLING

- A. Contractor shall:
 - 1. Deliver or cause to be delivered miscellaneous metal items in the order required for erection continuity according to a mutually established schedule of delivery dates. Furnish parts which require embedment, together with applicable instructions, in ample time for setting in the work.
 - 2. Provide receiving inspection per Article 3.8.A.
 - 3. Repair damage to this and other work resulting from handling miscellaneous metal items or from failure to maintain adequate precautions. Handle so that metal items and coatings will not be damaged, and surfaces will be free of mud, dirt and other foreign substances.
 - 4. Keep stored materials clear of ground by means on timbers and blocking, and properly drained.

1.4 QUALITY ASSURANCE

- A. Fabricator shall be a company specializing in the fabrication of miscellaneous metal with a minimum of ten years documented experience.
- B. Fabricator and Contractor shall provide and maintain a quality control program.
- C. Contractor shall test all materials as required by Specifications and standards referenced.
- D. Contractor shall have at least ten years of documented experience in the installation of miscellaneous metals of the type and complexity required by this Specification.
- E. Codes and Regulations:
 - 1. Except as otherwise specified herein or shown on the Drawings, all work shall conform to the requirements of AISC "Code of Standard Practice for Steel Buildings and Bridges" and AISC "Steel Construction Manual".
 - 2. Contractor shall comply with all national, state and local laws, codes, ordinances and regulations, including the IBC and ASCE 7
 - 3. All welding and welding procedures shall be in accordance with AWS D1.1.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Furnish all new materials.
- B. Structural Steel Shapes and Plates: ASTM A36.
- C. Checkered Plate: ASTM A283, Grade B low carbon steel floor plate; shop painted in accordance with this Specification.
- D. Steel Bar Grating: Standard welded rectangular type, conforming to ANSI/NAAMM Metal Bar Grating Manual guidelines. Grating at all interior areas to be plain 1 ½ inch deep x 3/16 inch wide bearing bars with all cross bars spaced 4 inches o.c. Grating at all exterior areas to be 1 ½ inch deep x 3/16 serrated bearing bars with all cross bars spaced 4 inches o.c. All grating shall be coated after fabrication with Dipping Gloss Black

as supplied by Valley Paint Mfg., Woods Cross, Utah or Manager approved equal. Supply completed with all associated studs, nuts, and saddle clips.

- E. Iron Castings: ASTM A48, not less than Class 30 with 30,000 psi tensile strength. Castings shall be tough and free from cracks, flaws, blow holes and other defects. Coat surfaces with high grade asphalt protective material.
- F. Ductile Iron Steps: Neenah No. R-1982-J ductile iron steps.
- G. Manhole Covers and Frames: Material shall be ductile iron, Grade 65-45-12 with tensile strength of 65,000 psi, conforming to ASTM A536. Castings shall have one shop coat of asphalt paint.
- H. Welding Electrodes: AWS A5.1 or A5.2, E70XX series.
- I. Hardware for hinged covers and other operating parts: heavy duty industrial type appropriate for the application; galvanized.
- J. Galvanizing: Unless otherwise noted, the following shall be galvanized: embedded items, hardware and fasteners. Bolts, including nuts and washers, shall be zinc coated conforming to ASTM A153, Class C. Other items shall conform to ASTM A123, A153, or A525 as applicable, 1.25 oz/sq.ft. class.
- K. Cold Galvanizing Compound: Ready-mixed zinc-rich coating containing 95% metallic zinc by weight: Galvicon of Galivon Corp; ZRC of The Sealube Co; Galvonox Type 1 of Subox Coatings Div, BASF Wyandotte Corp; or Manager approved equal. Use only for field touch-up of damaged areas of galvanized surfaces.
- L. Pipe Bollards: Fabricate pipe bollards from Schedule 40 steel pipe; shop painted in accordance with this Specification.

2.2 FABRICATION

- A. General: Fabricate miscellaneous metal work in accord with Drawings and Specifications as detailed on approved shop drawings. Conform to applicable requirements of the AISC "Specification for Structural Steel Building," and "Code of Standard Practice for Steel Buildings and Bridges."
- B. Special Requirements:
 - 1. Fabricate frames from rolled sections as required by Drawings, with mitered corners continuously welded and ground smooth. Make each member of one piece; short sections butt-welded together are not permitted. Select frame sections for trueness of web and flange, and straighten as required so that finished frames are uniform, square and true. Provide suitable anchors for attachment to other materials.
 - 2. Steel Bar Grating Items: Fabricate into convenient size panels, according to requirements specified herein under Materials. Make openings where shown on Drawings, band openings and exposed ends with steel bars, and reinforce as required for adequate support. Provide patterned steel nosing on bar grating treads.
 - 3. Ductile Iron Steps: Furnish and install ductile iron steps as specified where shown on the Drawings.
 - 4. Manhole Covers and Frames: Furnish and install the manhole covers and frames as specified where shown on the Drawings.
- C. Design: Components not completely detailed and members not sized on Drawings shall be proportioned to provide ample strength and stiffness under expected loads. Joints

exposed to weather shall be formed to exclude water or to drain. Design in accordance with IBC and AISC requirements.

- D. Assembly and Connections: Insofar as practicable, assemble work in the shop, ready for field installation. Connect by welding or bolting in manner to develop strength of members involved. Wherever possible, bolts shall be concealed.
1. Bolting: Bolts shall be of proper length to permit full thread in the nut. Use a lock washer under the nut for connecting items subject to moving foot traffic or vibration.
 2. Welding shall be performed preferably in flat position, by shielded or submerged electric arc methods only, using proper electrodes for conditions of use, in accord with AWS D1.1, "Structural Welding Code." Make welds smooth and regular, solid and homogenous throughout, and free from pits, slag, scale and other defects. Where exposed to weather, welds shall be continuous, unless otherwise noted.
- E. Workmanship:
1. Make all work square, plumb, straight and true, accurately fitted, with tight joints and intersections, and neat in appearance. Members shall have sharply defined profiles and be free from twists, bends and defects impairing strength and durability. Items not presenting a finished and workmanlike appearance will be rejected.
 2. Cut members accurately; standard gas cutting machine may be used in the shop if ends and edges can be finished so that appearance is acceptable. Use extra care in making miters. Provide all required holes for this and other work, by drilling or punching, and wherever necessary, countersinking.
 3. Provide all required supporting members, bracing, brackets and reinforcement, as well as straps, lugs, clips, anchors and other connections to facilitate installation and anchorage.
 4. Clip off projecting edges and corners. Finish and dress surfaces, edges and welds smoothly and neatly by grinding, chipping and wire brushing. Reduce sharp edges by grinding.

2.3 FINISHES

- A. Comply with NAAMM Metal Finishes Manual: for recommendations relative to application and designations of finishes.
- B. Finish metal fabrications after assembly.
- C. Galvanizing: For those items indicated for galvanizing, apply zinc-coating by the hot-dip process compliance with the following requirements:
1. ASTM A153 for galvanizing iron and steel hardware.
 2. ASTM A123 for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.0299 inch thick and heavier.
- D. Shop Finish Painting:
1. Prepare carbon steel surfaces to comply with minimum requirements of SSPC SP-10 for surface preparation.
 2. Apply three coat finish paint system to all uncoated surfaces of metal fabrications (except those with galvanized finish, those to receive Dipping Gloss Black, or those to be embedded in concrete) unless otherwise indicated. Apply finish paint system in accordance with paint Manufacturer's written instructions.

2.4 SOURCE QUALITY CONTROL

- A. Contractor shall perform the following inspection and tests:
1. Structural steel shall be identified by heat or melt numbers.
 2. Visual inspection shall be performed at place of fabrication and in the field. Additionally, Contractor shall provide information and access required for inspections by Manager. Promptly remove material rejected by the Manager, either at shop or construction site, and replace it with acceptable material. Rejection of material may be made at any time, even at construction site after it has been erected, if it fails to conform to specified requirements.
 3. Visual weld inspection shall be performed in accordance with the inspection matrix and conforming to AWS D1.1, Drawings and Specifications. Welds found not in accordance with AWS standards shall be removed and replaced.

PART 3 EXECUTION

3.1 PREPARATION

- A. Contractor shall coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Contractor shall coordinate delivery of such items to project site.
- B. Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from water and concrete entry.

3.2 INSTALLATION

- A. **Fastening to In-Place Construction:** Contractor shall provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as shown on Drawings or as required to adequately support and secure the metal fabrication in place.
- B. **Cutting, Fitting, and Placement:** Contractor shall perform cutting, drilling, and fitting required for installation of miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Contractor shall provide temporary bracing or anchors in formwork for items that are to be built into concrete or similar construction.
- D. Contractor shall fit exposed connections accurately together. Weld connections that cannot be shop welded because of shipping size limitations. However, do not weld connections which are to be left as exposed joints. Do not weld, cut, or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.
- E. **Field Welding:** Contractor shall comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shown after finishing and contour of welded surface matches those adjacent.
- F. Contractor shall coordinate miscellaneous metal installation with other work in a manner which will facilitate and expedite project completion. Erect work to proper lines and levels, plumb and true, and in correct relation to other work.
- G. Contractor shall secure work in a rigid and substantial manner with appropriate fasteners, concealed wherever practicable. Do not enlarge holes without the Manager's prior approval.
- H. Contractor shall obtain the Manager's prior approval before any gas cutting is done in the field. Do not cut any structural steel members.
- I. Contractor shall provide guys, bracing and falsework for temporary support where necessary. Remove them after permanent work is self-supporting.

3.3 SETTING LOOSE PLATES

- A. Contractor shall clean concrete and masonry bearing surfaces of any bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates of any grease, oil, paint or other material that will reduce bonding.
- B. Contractor shall set loose leveling and bearing plates on wedges, or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the bearing plate before grouting.
1. Use read-to-use nonmetallic nonshrink grout. Refer to Section 03110 for grout material and application requirements.
 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 INSTALLATION OF METAL BAR GRATINGS

- A. Contractor shall install gratings to comply with recommendations of NAAMM grating standard referenced that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
- B. Contractor shall secure removable units to supporting members with type and size of clips and fasteners indicated, or if not indicated as recommended by grating manufacturer for type of installation conditions shown.
- C. Contractor shall secure nonremovable units to supporting members by welding where both materials are the same; otherwise, fasten by bolting as indicated above. All grating shall be bolted to the supporting members with a minimum of six Nelson studs and saddle anchors per each 45 sq.ft. of grating panel area to prevent shifting of the grating, except where grating is indicated to be welded. A minimum of four 1" x 1/4" fillet welds per panel shall be used to anchor grating panels that are indicated on the Drawings to be welded to their supports.
- D. Contractor shall attach toe plates to gratings by welding.

3.5 CLEANING AND TOUCHUP

- A. Touch-Up Painting: Contractor shall immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting .
- B. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint.

3.6 FIELD QUALITY CONTROL

- A. Contractor shall perform the following tests and inspections. If any deficiencies are revealed during any tests and inspections, such deficiencies shall be corrected by Contractor at no expense to Owner and the tests shall be reconducted.
- B. Provide receiving inspection to verify that all miscellaneous metal items are of the types and quantity required for the Work, are not damaged or exhibit other unsatisfactory characteristics.
- C. Contractor shall perform inspections as required to ensure that miscellaneous metals, fabrication, and installation are in accordance with the requirements of this Specification. Specifically, Contractor shall check miscellaneous metal pieces prior to installation to ensure materials are as specified, fabrication is in accordance with Manager-approved shop drawings, pieces have proper tag numbers, and coatings are in acceptable condition. After erection, Contractor shall inspect miscellaneous metals to ensure that they have been installed in accordance with the shop drawings, all required accessories are in place, assembly has been properly completed, and coatings are in acceptable condition.
- D. Inspect all completed work for squareness, plumbness, accuracy of fit, and appearance and report results to Manager.
- E. Contractor shall maintain an orderly and current file by structure of approval submittals and inspection reports verifying compliance with this Section.

3.7 FIELD DATA SHEET

- A. Require with bid Manufacturers documented evidence of number of years experience manufacturing product (refer to Article 1.4).
- B. Require with bid Contractors documented evidence of number of years experience installing product (refer to Article 1.4).

END OF SECTION

APPENDIX A
QUALITY CONTROL INSPECTION
FORMS EXAMPLES

PROJECT:

| |
|--|
| |
| |
| |
| |

PROJECT LOCATION:

CLIENT:

DENSITY GAUGE:

Include Gauge make, model and serial number

JOB NO:

DATE:

TECHNICIAN:

PAGE:

STD. COUNT:

| |
|----|
| |
| |
| |
| of |
| / |

Include density and moisture count

WATER CONTENT AND DENSITY OF IN-PLACE SOIL BY NUCLEAR METHOD (ASTM D2922, D3017)

| Curves: | Lab # or curve | Max Dry Density | Optimum moisture | Proctor | Proctor method | Material description |
|---------|----------------|-----------------|------------------|---------|----------------|----------------------|
| | | | | | | |
| | | | | | | |
| | | | | | | |

| Test Number | Elevation or Depth * | Probe Depth | Location | Moisture Content (%) | Wet Density (pcf) | Dry Density (pcf) | Lab # or curve | Percent compaction | Percent compaction Required |
|-------------|----------------------|-------------|----------|----------------------|-------------------|-------------------|----------------|--------------------|-----------------------------|
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

* BTS = Below Top of Slab

* BTTB = Below Top of Sub Base

* FBC = Final Base Course

* TOSB = Top of Sub Base

* TOF = Top of Fill

* BTW = Below Top of Wall

* BTOF = Below Top of Fill

* TOA = Top of Asphalt

* TOW = Top of Wall



Client: Kennecott Utah Copper
4700 Daybreak Parkway
South Jordan, UT 84095-

Report Date: January 29, 2014

Project #: 13-819-03203

Report #: 6064

Tested By: Larry Pennington

Date Tested: 1/28/2014

General Location of Testing: Structural Backfill for Footings

Attn: Reed Robison
Project Name: KUC MM & C Building
6190 Yard
Bingham, UT

FIELD DENSITY TEST USING NUCLEAR DENSITY GAUGE (ASTM D6938-05)

Moisture Density Curves Used

| AMEC Lab # | Maximum Density | Optimum Moisture | Test Type / Method | Description | Id # | Supplied By |
|------------|-----------------|------------------|--------------------|-------------|------|---------------|
| | 134.7 | 7.4 | | | 1 | Staker Import |

Nuclear Density Gauge

Make: Troxler
Model #: 3440
Serial #: 30261

| Test # | Location | Elevation | Test Mode | Probe Depth (in) | % Moisture Required | | | Wet Density (pcf) | Dry Density (pcf) | Maximum Density (pcf) | % Compaction Required | |
|--------|--|-----------|-----------|------------------|---------------------|-----|-----|-------------------|-------------------|-----------------------|-----------------------|--------|
| | | | | | Actual | (-) | (+) | | | | Com- paction | Min |
| 01 | 20' East of West End, Centerline of Trench | 4' BTOA | D | 6 | 6.8 | | | 136.9 | 128.2 | 134.7 | 95 | 95 100 |
| 02 | 20' West of East End, Centerline of Trench | 4' BTOA | D | 6 | 5.6 | | | 136.6 | 129.3 | 134.7 | 96 | 95 100 |
| 03 | 20' East of West End, Centerline of Trench | 6' BTOA | D | 6 | 6.4 | | | 137.8 | 129.5 | 134.7 | 96 | 95 100 |
| 04 | 20' West of East End, Centerline of Trench | 6' BTOA | D | 6 | 6.4 | | | 138.5 | 130.3 | 134.7 | 97 | 95 100 |

Reviewed By: _____

MF

Distribution: Client File: Supplier: Email: Other: Addressee (2)

BTSB=Below Top of Subbase, **BTO**F= Below Top of Fill, **FSG** = Finished Subgrade, **FBC** = Finished Base Course, **BOP** = Bottom of Pipe, **BOB** = Bottom of Base, **BOF** = Bottom of Footing, **OGP** = Original Ground Prep
Test Mode = D for Direct Transmission and **B** for Backscatter Modes



Client: Kennecott Utah Copper
4700 Daybreak Parkway
South Jordan, UT 84095-

Report Date: April 21, 2014

Attn: Nick Anderson
Project Name: KUC East Waste Rock Expansion
Bingham Canyon
Bingham, UT

Project #: 14-819-03236
Work Order #: 7
Lab #: 8291
Sampled By: Nick Anderson
Date Sampled: 4/15/2014
Visual Description of Material: Brown Clay with Gravel
Sample Source: Clay Stockpile, Northwest Corner, 10' Deep

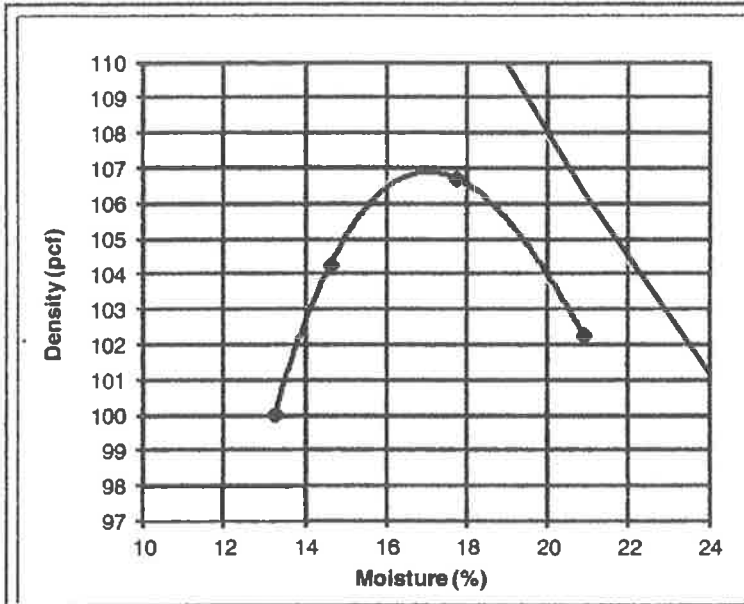
SOILS / AGGREGATES

Type of Specification: East Waste Rock - Low Permeability Clay

Sieve Analysis (ASTM C117-04/C136-06)

200 Wash Procedure: A **Specifications**

| | Sieve Size | Passing | Min | Max |
|------------------------|-------------------|----------------|------------|------------|
| Coarse Portion: | 3in. | 100% | | |
| | 2in. | 99% | 100 | 100 * |
| | 1 1/2in. | 96% | | |
| | 1in. | 90% | | |
| | 3/4in. | 87% | | |
| | 1/2in. | 83% | | |
| | 3/8in. | 82% | | |
| | #4 | 82% | 75 | 100 |
| Fine Portion: | #10 | 78% | | |
| | #20 | 77% | | |
| | #40 | 76% | | |
| | #100 | 74% | | |
| | #200 | 69% | 55 | 100 |



Correction Soil Containing Oversize Particles (ASTM D4718-87)

Moisture Density Relationship: (ASTM D698-07) **Method:** C
Preparation Method: Dry **Rammer Type:** Mechanical
Specific Gravity: 2.651 **Coarse Specific Gravity:** 2.478
Maximum Density: 106.9
Optimum Moisture: 17.0

Plasticity Index (ASTM D4318-10)

| | | | |
|--------------------------|----|----|------|
| Liquid Limit: | 57 | 25 | 55 * |
| Plastic Limit: | 18 | | |
| Plasticity Index: | 39 | 15 | 60 |

Preparation Method: Dry **Liquid Limit Method:** B
PI Air Dried.

* Material did not fall within specified tolerances.

Soil Classification (ASTM D2487-10) CH

Reviewed By: *Nick Anderson*
MF

Distribution: Client File: Supplier: Email: Other: Addressee (2)

FIELD CONCRETE PLACEMENT RECORD (T141)

PROJECT DATA:

Project Number: _____ Lab Specimen No.: _____

Project Name: _____

Client: _____

Test Type: Concrete: _____ Grout: _____ Mortar: _____ Masonry Prisms: _____ Other: _____

Cast Date: _____ Contractor: _____

MIX & FIELD DATA:

Type of Placement: _____

General Placement Location: _____

Specimen Location: _____

Specimen Strength: _____ @ 28 days Set #: _____ Technician: _____

Mix ID No.: _____ Plant #: _____ Supplier: _____

Truck: _____ of _____ Truck #: _____ Ticket #: _____

Batch Size: _____ yds³ Water Added: _____ Admixtures: _____

Batch Time: _____ Sample Time: _____ Discharge Time: _____

| | ACTUAL | SPECS | AID #: _____ |
|-----------------------|--------|-------|---|
| Slump (in/mm) | | | Notes: _____ _____ _____ _____ |
| Entrained Air (%) | | | |
| Unit Weight (pcf) | | | |
| Concrete Temp (°F/°C) | | | |
| Ambient Temp (°F/°C) | | | |

Weather: _____

Specimen Storage Location: _____

Cure Box Temp's: HI: _____ Low: _____ Picked Up By: _____ Date: _____

SPECIMEN DATA:

| Size (in/mm) | No. of Cylinders/Frequency (# to be broken @ what date) *(On Field Cures put # to be broken, age, @ what date) | | | | | | | Diameter (in/mm) | Area (in/mm) |
|-----------------|---|---|---|----|----|------------------------|------------------------|---------------------|-----------------|
| | Age | 3 | 7 | 14 | 28 | ____ day Field Cure | ____ day Field Cure | | |
| | Cyls | | | | | | | | |
| | Date | | | | | | | | |

Input Date: _____ Input By: _____

Report of Compression Test Results

Client: Kennecott Utah Copper
4700 Daybreak Parkway
South Jordan, UT 84095-

Report Date: March 05, 2014
Project #: 13-819-03203

Attn: Reed Robison

Project Name: KUC MM & C Building
Address: 6190 Yard
Bingham, UT
Architect:
Engineer:

Project Manager:
Specimen Type: Concrete ASTM C39-10

Mix and Field Data

CastDate: 2/4/2014

Contractor: Jacobsen

Type of Placement: Footing

Inspector: Lisa Huish

Location: Footing Bases

Strength: Required (f'c) : 3000 psi @ 28 Days

Mix #: 3325605

Supplier: Jack B Parson

Load: 2 of 3

Truck #: 1862

Ticket #: 61987418

Plant #: 619

Batch Size (cy): 9

Water Added (gal):

Admixture: CALC

| | <u>Actual</u> | <u>Specs</u> |
|---|---------------|--------------|
| Slump (In) ASTM C143-10: | 2.25 | |
| *Apparent Air Content (%) ASTM C231-10: | 2.1 | |
| Unit Weight (pcf) ASTM C138-10: | | |
| Sample Temperature (°F) ASTM C1064-08: | | |
| Ambient Temperature (°F): | | |

Clouds Condition: Cloudy

Precipitation: Snow

Wind Condition:

Time

Batch Time: 8:33

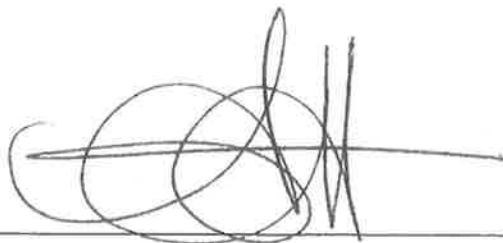
Sampled Time: 10:50

Finish Time: 11:10

Test Results

| Lab Id | Spec Id | Date Received | Test Date | Age (Days) | Nominal Specimen Size | Actual Area (In ²) | Compressive (lbs) | Strength (psi) | Break Type | Field Cure | Type of Cap | Percent of Req. |
|---------|---------|---------------|-----------|------------|-----------------------|--------------------------------|-------------------|----------------|------------|--------------------------|-------------|-----------------|
| 2014071 | A | 2/5/2014 | 2/9/2014 | 5 | 4x8 | 12.57 | 45360 | 3610 | 2 | <input type="checkbox"/> | Un | 120% |
| | B | 2/5/2014 | 2/10/2014 | 6 | 4x8 | 12.57 | 47600 | 3790 | 2 | <input type="checkbox"/> | Un | 126% |
| | C | 2/5/2014 | 2/11/2014 | 7 | 4.01x8 | 12.63 | 50860 | 4030 | 5 | <input type="checkbox"/> | Un | 134% |
| | D | 2/5/2014 | 3/4/2014 | 28 | 4.01x8 | 12.63 | 78820 | 6240 | 2 | <input type="checkbox"/> | Un | 208% |
| | E | 2/5/2014 | 3/4/2014 | 28 | 4.01x8 | 12.63 | 75300 | 5960 | 3 | <input type="checkbox"/> | Un | 199% |
| | F | 2/5/2014 | 3/4/2014 | 28 | 4.01x8 | 12.63 | 75860 | 6010 | 3 | <input type="checkbox"/> | Un | 200% |

Reviewed By: _____



Distribution: Client File: Supplier: Other: Addressee (2)
Email:

