SECTION 01 71 30
SITE CONDITIONS SURVEYS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements to document conditions of the Project Site and adjacent properties before construction begins and after completion of the Work. Methods include still photographs and digital video recordings.

1.2 RELATED SECTIONS

A. Section 31 10 00 – Site Preparation

B. Section 31 23 00 - Earthwork

1.3 SUBMITTALS

A. Submit all photographs and digital videos of the pre-construction conditions to Engineer for record purposes prior to, but not more than three weeks before, commencement of any construction activities.

1.4 CLOSEOUT SUBMITTALS

A. Complete and submit all digital videos and still photographs of the post-construction conditions to Engineer prior to final inspection by Owner and Engineer.

B. Submit six copies of the disk media.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Conduct thorough preconstruction and post-construction site conditions surveys of the entire Project. Site conditions surveys shall consist of photographs and digital video recordings. Sufficient photographs, supplemented by digital video, shall be provided and submitted to Engineer to resolve any damage claims, which may arise due to the construction of this Project. Site conditions surveys shall be adequate to ascertain preconstruction and post-construction conditions (including elevations) of all public and private property within and adjacent to the construction limits.

B. Digital video or photographic surveys shall include, but not be limited to, all access roads used to transport material or equipment to and from the Site and elevation of roadways, drives, walks, and buildings. Use spot elevation surveys to document the elevation on abutting

roadways, drives, and walks, taken at approximately 20-foot intervals and at the point of juncture with any structure to which they are attached or otherwise influenced by the Work. In addition, take elevations of all building slabs along the Project route.

C. Digital video recordings required as part of this Section and by Section 31 10 00 – Site Preparation and Restoration and Section 31 23 00 - Earthwork may be combined into a single set of media provided the requirements for videos specified in both Sections are met.

D. As a minimum, note preconstruction and post-construction conditions and perform digital video surveys of the following:
   1. Areas used to access the Site or haul materials and equipment to the Site.
   2. Access roads and ramps, both original and relocated locations and ultimately to the Site.
   3. All Work areas, including, but not limited to, access corridors, disposal areas, and staging areas.
   4. Any work completed by other contractors at the Site that will be impacted or otherwise affected by Work of this Project.

E. Supplement digital video surveys with still photographs and spot elevation surveys as required to document the original condition and location of existing features and facilities.

F. Provide digital video records in DVD-R format.

END OF SECTION

SECTION 01 71 50
PROTECTION AND RESTORATION OF EXISTING FACILITIES

1.1 GENERAL

A. Protect all existing utilities and improvements not designated for removal and restore damaged or temporarily relocated utilities and improvements to a condition equal to or better than they were prior to such damage or temporary relocation, in accordance with the Contract Documents.

B. Call Bluestakes before commencing any digging for location of underground utility lines and cable locations. The number is (800) 662-4111.

C. Provide temporary 6-foot chain link fencing panels for protection of all open excavations and trenches within public streets, residential areas, and all other locations with the exception of unimproved open areas where excavations and/or pipeline trenches that can be safely sloped in accordance with current OSHA standards to provide safe access without the use of shoring devices. Temporary fencing panels shall fully enclose open excavations and trenches, and shall remain in place during all non-working hours.

D. Provide temporary caps over all large diameter pipe during non-working hours to prevent unauthorized access.

1.2 RIGHTS-OF-WAY

A. Do not perform any work that would affect any oil, gas, sewer, or water pipeline; any telephone, telegraph, or electric transmission line; any fence; or any other structure. Do not enter upon the rights-of-way involved until notified by Engineer that Owner has secured authority therefore from the proper party.

B. After authority has been obtained, give said party due notice of intention to begin work, if required by said party, and remove, shore, support or otherwise protect such pipeline, transmission line, ditch, fence, or structure or replace the same.

C. When two or more contracts are being executed at one time on the same or adjacent land in such manner that work on one contract may interfere with that on another, the Owner will determine the sequence and order of the Work. When the territory of one contract is the necessary or convenient means of access for the execution of another contract, such privilege of access or any other reasonable privilege may be granted by Owner to the Contractor so desiring, to the extent, amount, in the manner, and at the times permitted and in full conformance with the conditions of the Contract Documents.

D. No such decision as to the method or time of conducting the Work or the use of territory shall be made the basis of any claim for delay or damage, except as provided for temporary suspension of the Work in the General Conditions of the Contract.

1.3 PROTECTION OF STREET OR ROADWAY MARKERS

A. Do not destroy, remove, or otherwise disturb any existing survey markers or other existing street or roadway markers without proper authorization. Do not begin pavement breaking

or excavation until all survey or other permanent marker points that will be disturbed by the construction operations have been properly referenced. Accurately replace survey markers or points disturbed after all street or roadway resurfacing has been completed.

1.4 RESTORATION OF PAVEMENT

A. General: Replace all paved areas cut or damaged during construction with similar materials of equal thickness to match the existing adjacent undisturbed areas, except where specific resurfacing requirements have been called for in the Contract Documents or in the requirements of the agency issuing a permit. The pavement restoration requirement to match existing sections shall apply to all components of existing sections, including sub-base, base and pavement. Temporary and permanent pavement shall conform to the requirements of the affected jurisdictional agency. Neatly saw cut pavements, which are subject to partial removal, in straight lines. Refer to Division 32 for specific pavement restoration requirements.

B. Temporary Resurfacing: Wherever required by the public authorities having jurisdiction place temporary surfacing promptly after backfilling and maintain such surfacing for the period of time fixed by said authorities before proceeding with the final restoration of improvements.

C. Permanent Resurfacing: In order to obtain a satisfactory junction with adjacent surfaces, saw cut back and trim the edge so as to provide a clean, sound, vertical joint before permanent replacement of an excavated or damaged portion of pavement. Damaged edges of pavement along excavations and elsewhere shall be trimmed back by saw cutting in straight lines. All pavement restoration and other facilities restoration shall be constructed to finish grades compatible with adjacent undisturbed pavement. Refer to plans for minimum dimension of T-patch replacement width over disturbed pipeline trenches in paved areas.

D. Pavement Crown: In areas where pipeline trenching impacts an existing crown of asphalt, survey, and submit to Engineer documentation showing the pre-construction location of the crown prior to trenching. Replace the crown of asphalt to its pre-construction location to the satisfaction of the governing agency and Engineer.

E. Restoration of Sidewalks or Private Driveways: Wherever sidewalks or private roads have been removed for purposes of construction, place suitable temporary sidewalks or roadways promptly after backfilling and maintain them in satisfactory condition for the period of time fixed by the authorities having jurisdiction over the affected portions before proceeding with the final restoration. If no such period of times is so fixed, maintain said temporary sidewalks or roadways until the final restoration thereof has been made.

F. Restoration of Curb and Gutter: Wherever curb and gutter, including driveway and sidewalk approaches, have been removed for purposes of construction, replace these improvements following construction to the specific dimension and requirements of the authority having jurisdiction. Replace improvements, including required ADA access details to the latest version of the authoritive standard regardless of their preconstruction condition.

1.5 EXISTING UTILITIES AND IMPROVEMENTS

A. General. Protect underground utilities and other improvements, which may be impaired during construction operations, regardless of whether or not the utilities are indicated on the Drawings. Take all possible precautions for the protection of unforeseen utility lines to provide for uninterrupted service and to provide such special protection as may be necessary.

B. Except for utilities specifically located on the Drawings, be responsible for exploratory excavations (potholing) as deemed necessary to determine the exact locations and depths of utilities, which may interfere with Work. Perform all such exploratory excavations as soon as practicable after Notice to Proceed and, in any event, a sufficient time in advance of construction to avoid possible delays to the Work's progress. When such exploratory excavations show the utility locations as shown on the Drawings to be in error, so notify Engineer. Refer to plans for minimum advance distance that potholing must be performed prior to pipeline trenching work.

C. The number of exploratory excavations required shall be that number which is sufficient to determine the alignment and grade of the utility.

D. Utilities to be Moved: In case it becomes necessary to move the property of any public utility or franchise holder, such utility company or franchise holder will, upon request of the Contractor, be notified by Owner to move such property within a specified reasonable time. When utility lines that are to be removed are encountered within the area of operations, notify Engineer a sufficient time in advance for the necessary measures to be taken to prevent interruption of service.

E. Utilities to be Removed: Where the proper completion of the Work requires temporary or permanent removal and/or relocation of an existing utility or other improvement which is indicated, remove and, without unnecessary delay, temporarily replace or relocate such utility or improvement in a manner satisfactory to Engineer and the owner of the facility. In all cases of such temporary removal or relocation, restoration to the former location shall be accomplished in a manner that will restore or replace the utility or improvement as nearly as possible to its former locations and to as good or better condition as found prior to removal.

F. Owner's Right of Access: Owner and owners of public utilities and franchises reserve right to enter at any time upon any public street, alley, right-of-way, or easement for the purpose of making changes in their property made necessary by the Work of this Contract.

G. Underground Utilities Indicated: Existing utility lines that are indicated or the locations of which are made known prior to excavation and that are to be retained, and all utility lines that are constructed during excavation operations shall be protected from damage during excavation and backfilling and, if damaged, shall be immediately repaired or replaced unless otherwise repaired by the owner of the damaged utility. If the owner of the damaged facility performs its own repairs, reimburse said owner for the costs of repair.

H. Underground Utilities Not Indicated: In the event of damage to existing utility lines that are not indicated or the locations of which are not made known prior to excavation, make a verbal report of such damage immediately to Engineer and a written report thereof promptly

thereafter. Notify the utility owner of the damage. If directed by Engineer, repairs shall be made under the provisions for changes and extra work contained in the General Conditions.

I. Damages. Costs of locating and/or repairing damage not due to failure to exercise reasonable care, and removing or relocating such utility facilities not indicated in the Contract Documents with reasonable accuracy, and for equipment on the project which was actually working on that portion of the Work which was interrupted or idled by removal or relocation of such utility facilities, and which was necessarily idled during such Work will be paid for as extra Work in accordance with the provisions of the General Conditions.

J. Approval of Repairs: All repairs to a damaged utility or improvement are subject to inspection and approval by an authorized representative of the utility or improvement owner before being concealed by backfill or other work.

K. Fire Hydrants: Keep all fire hydrants and water control valves free from obstruction and available for use at all times.

L. Maintaining in Service: Unless indicated otherwise, all oil and gasoline pipelines, power, and telephone or the communication cable ducts, gas and water mains, irrigation lines, sewer lines, storm drain lines, poles, and overhead power and communication wires and cables encountered along the line of the Work shall remain continuously in service during all the operations under the Contract, unless other arrangements satisfactory to the Engineer are made with the owner of said pipelines, duct, main, irrigation line, sewer, storm drain, pole, or wire or cable. Be responsible for and repair all damage due to construction operations. The provisions of this Section shall not be abated even in the event such damage occurs after backfilling or is not discovered until after completion of the backfilling.

M. Utility Service Laterals: Utility service laterals are not shown on the plans. Anticipate that there are no less service laterals than there are homes where project trenches are located in the vicinity of a street between a home and the utility main. Protect in place, or remove and replace to the satisfaction of the utility owner, all utility service laterals encountered during construction. Duration of utility service outages and public notification procedures shall conform to the standards of the controlling agency and these Contract documents.

1.6 TREES OR SHRUBS WITHIN STREET RIGHTS-OF-WAY AND PROJECT LIMITS

A. General: Except where trees or shrubs are indicated to be removed, exercise all necessary precautions so as not to damage or destroy any trees or shrubs, including those lying within street rights-of-way and project limits. Do not trim or remove any trees unless such trees have been approved for trimming or removal by the jurisdictional agency or Owner. Trim or replace existing trees and shrubs which are damaged during construction using the services of a certified tree company under permit from the jurisdictional agency and/or the Owner.

B. Trimming; symmetry of the tree shall be preserved; no stubs or splits or torn branches left; clean cuts shall be made close to the trunk or large branch. Do not use spikes for climbing live trees. Cuts over 1-1/2 inches in diameter shall be coated with a tree paint product that is waterproof, adhesive, and elastic, and free from kerosenes, coal tar, creosote, or other material injurious to the life of the tree.

C. Replacement: Immediately notify the jurisdictional agency and/or Owner if any tree or shrub is damaged by construction operations. If, in the opinion of said agency or Owner, the damage is such that replacement is necessary, replace the tree or shrub at no additional expense to Owner. The tree or shrub shall be of a like size and variety as the one damaged, or, if of a small size, the pay to the owner of said tree a compensatory payment acceptable to the tree or shrub owner, subject to the approval of the jurisdictional agency or Owner. The size of the tree or shrub shall not be less than 1-inch diameter nor less than 6 feet in height. Planting of replacement trees and shrubs shall be in accordance with the recommendations of the nursery furnishing the plants. Unless otherwise indicated, water and maintain the replacement trees and shrubs for 6 months after planting.

1.7 LAWN AREAS

A. Repair lawn or landscaped areas damaged during construction to match the pre-construction condition to the satisfaction of the land owner and Owner. Use high quality sod to restore all lawn areas. Location and quality of irrigation system equipment shall be confirmed prior to construction. Where lawn irrigation systems have been removed or damaged during construction, be responsible for replacement of systems in kind to the satisfaction of the land owner. Anticipate that pressurized irrigation systems are present in all maintained lawn areas that will be impacted by construction. Verify proper operation of the irrigation system with land owner as required for maintenance of newly installed sod prior to transferring of watering responsibilities.

1.8 UNIMPROVED AREAS

A. Remove and stockpile topsoil prior to construction in accordance with Division 31 specifications. Replace topsoil prior to restoration of unimproved areas.

B. Unimproved areas, including unclassified open spaces, fields, and unimproved rights-of-way, damaged during construction shall be repaired to match pre-construction conditions to the satisfaction of the land owner and Owner. At a minimum, unimproved areas shall be smoothed and finished graded with topsoil to match preconstruction topography, and reseeded using a native seed mix acceptable to the land owner and Owner.

C. All slopes greater than 2H : 1V shall be protected with erosion control matting prior to reseeding.

1.9 OTHER SURFACE IMPROVEMENTS

A. Conduct a pre-construction survey of all properties that will be impacted by construction operations. All improvements that have the potential to be impacted by construction, including but not limited to fencing, landscaping, boulders, retaining walls, irrigation systems, and other public and/or private improvements, shall be protected in place, or if necessary, removed and replaced with like kind or better quality following construction.

1.10 NOTIFICATION BY CONTRACTOR

A. Prior to any excavation in the vicinity of any existing underground facilities, including all water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications, or television cables; all traffic signal and street lighting facilities; and

all roadway and state highway rights-of-way, notify the owners or agencies responsible for such facilities not less than three days nor more than seven days prior to excavation so that a representative of said owner or agencies can be present during such Work if they so desire.

B. When it is necessary to temporarily deny access to property, or when any utility service connection must be interrupted, give notices sufficiently in advance to enable the affected persons to provide for their needs. Notices shall conform to any applicable local ordinance and, whether delivered orally or in writing, shall include appropriate information concerning the interruption and instructions on how to limit inconvenience caused thereby.

C. Contact, cooperate with, and provide written notice (including Contractor's phone number) at least seven days prior to beginning Work on each street. The written notice shall include the approximate schedule and explanation of Work and shall be given to each homeowner, business, all emergency agencies, schools, and residents, which will be affected by the project; particularly in reference to temporary interruptions to vehicular access. At least twenty-four hours prior to initiation of Work, provide a second notice to confirm the scope of scheduled Work. Submit a copy of the notifications to Engineer, for approval, prior to the start of construction. Make verbal door-to-door communication prior to construction to remind all affected parties of the construction to take place. In addition, be responsible to answer and resolve any conflicts that may arise between a homeowner or business owner and the construction personnel.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Contract closeout, including final cleaning, preparation, and submittal of closeout documents, warranties and bonds, and final completion certification.

B. Closeout submittals and submittal forms in both hard copy and electronic format.

1.2 RELATED SECTIONS

A. Section 01 45 00 – Quality Control.

B. Section 01 78 39 – Project Record Documents

1.3 SUBMITTALS

A. Closeout Documents: Submit the following closeout documents prior to making a written request for Final Completion.
   1. Project record drawings and documents per Section 01 78 39 – Project Record Documents.
   2. Shop drawings.
   3. Certificates of inspection and acceptance by local governing agencies having jurisdiction.
   4. Post construction survey record documents, where required.
   5. Quality Control reports per Section 01 45 00 – Quality Control.
   6. Final Operation and Maintenance Manuals.
   7. Maintenance stock items; spare parts and special tools.
   8. Written warranties and bonds where required.
   9. Release of liens or release of claims forms submitted by all subcontractors and suppliers, if requested by Owner.

B. Evidence of Compliance With Inspections and Other Requirements of Governing Authorities: Submit the following:
   1. Special Inspection Reports.
   2. Certificate of Occupancy, if applicable.
   3. Release from each affected property owner or agency indicating final acceptance.

C. Operation and Maintenance Manuals
   1. One percent of the contract price will be withheld from any monies due as progress payments, if at the 75 percent construction completion point, the approved *Operations and Maintenance Manual* complying with Section 01 33 20- Submittal Procedures has not been submitted. The aforementioned amount will be withheld by Owner as the agreed, estimated value of the approved *Operations and Maintenance Manuals.* Any such retention of money for failure to submit the approved *Operations and Maintenance Manuals* on or before the 75 percent construction completion point

shall be in addition to the retention of any payments due under General Conditions of the Contract.

D. Final Change Order: A final Change Order shall be submitted and processed if required. Final payment and close-out procedures shall comply with requirements of the Contract Documents.

1.4 CLOSEOUT TIMETABLE

A. Establish dates for equipment testing, acceptance periods, and on-site instructional periods as required under the Contract Documents. Such dates shall be established not less than one week prior to beginning any of the required activities, to allow Owner, Engineer, and their authorized representative's sufficient time to schedule attendance at such activities.

1.5 COMPLETION PROCEDURES

A. When Contractor believes Substantial Completion has been achieved, request in writing to Engineer that Substantial Completion be recognized as having been achieved and request that Owner issue a Certificate of Substantial Completion. Prior to making such request, the following must be complete:
   1. Work necessary for the safe, proper, and complete use or operation of the facility as intended.
   2. Punch list of items remaining to be completed, for submission with the request for issuance of a Certificate of Substantial Completion.
   3. Submit and receive acceptance of accurate record drawings for all work completed to date.
   4. Submit and receive acceptance of all specified warranties, bonds, guarantees and operation and *Operations and Maintenance Manuals*.
   5. Complete all required vendor training, testing, and where required, start-up.
   6. Deliver all required spare parts, maintenance stock items, and special tools.
   7. Complete equipment and communications system testing successfully.

B. Upon receipt of the request, Engineer and designated representatives will review the request, the Work, and the above requirements to determine whether Substantial Completion has been achieved. If this review fails to support Substantial Completion, Engineer will notify Contractor in writing citing the reasons for rejection. If Engineer determines that Substantial Completion has been achieved, the following procedures will be followed:
   1. Engineer, his/her representative, and user representatives will review the Work and the punch list to assure all deficiencies are noted on a final punch list.
   2. Engineer will schedule and conduct a pre-final walk-through of the facility with representatives of Owner, Engineer, Contractor, and others, for the purpose of formally reviewing the Work, the final punch list, and the readiness of the Work for use. A copy of the final punch list will be furnished to all participants and any additional items noted during the walk-through will be added to the list.
   3. Upon completion of the pre-final walk-through, Engineer will prepare a request to Owner establishing the date for Substantial Completion as date of the walk-through, provided the walk-through has verified that the Work is in fact ready for use and occupancy by Owner for its intended purpose. Upon approval of this request by Owner, the facility will be considered Substantially Complete.

C. Final Completion will be deemed to have occurred when Work is completed including the following:
   1. All final punch list items have been corrected, signed off by Contractor and Engineer, and demonstrated to Owner during a final walk-through.
   2. All updates to record drawings, and *Operations and Maintenance Manuals* have been made.
   3. Demobilization and site cleanup are complete.
   4. Facilities and/or equipment have been properly demonstrated to be functioning as required.
   5. Owner has received releases from all parties who are entitled to claims against the subject project, property, or improvement pursuant to the provisions of law.
   6. New permanent cylinders and key blanks for all locks have been provided to Owner.

D. Certificate of Final Completion
   1. When all items have been completed or corrected, submit written documentation to Engineer that the entire Work is complete in accordance with the Contract Documents and request final inspection.
   2. Upon completion of final inspection by Owner and Engineer, Owner will either prepare a Certificate of Final Completion of the entire Work or advise all parties of Work not satisfactorily complete. If necessary, repair or replacement and inspection procedures will be repeated until Owner accepts the Work and issues a Certificate of Final Completion.

E. Partial Utilization may be desired at Owner's option, as described in the General Conditions. If Partial Utilization is requested, the same procedure for completion of that portion of the Work as indicated in paragraphs A and B above, will be used.

1.6 CLOSE-OUT PROCEDURE

A. Engineer and Contractor shall meet and resolve all outstanding issues including, but not limited to:
   1. Claims and adjustments for time or costs
   2. Outstanding, unused allowances
   3. Procedures for handling warranty issues.

B. A Final Change Order shall be processed if required. Final payment and close out procedures shall comply with all requirements of the Contract Documents.

1.7 MAINTENANCE AND GUARANTEE

A. Comply with the maintenance and guarantee requirements contained in General Conditions of the Contract.

B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as a part of such required repair work, and any repair or resurfacing which becomes necessary by reason of such settlement shall likewise be considered as a part of such required repair work unless Contractor has obtained a statement in writing from the affected private authority or public agency releasing Owner from further responsibility in connection with such repair or resurfacing. Submit such release(s) to Engineer.

C. Make all repairs and replacements promptly upon receipt of written order from the Owner. If the Contractor fails to make such repairs or replacements promptly, the Owner reserves the right to do the Work and the Contractor and his surety shall be liable to the Owner for the cost thereof.

1.8 BOND

A. Furnish a Performance Bond as required by General Conditions of the Contract.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. Certificate of Final Completion of the Work by Owner will be withheld until requirements for final cleanup of the Project Site are complete as follows:
1. Perform final cleaning prior to inspections for final acceptance.
2. Employ skilled workers who are experienced in cleaning operations.
3. Use cleaning materials that are recommended by manufacturers of surfaces to be cleaned.
4. Avoid scratching, discoloring, and otherwise damaging surfaces being cleaned.
5. Broom clean and power wash exterior paved surfaces and rake clean other surfaces of sitework. Police yards and grounds to keep clean.
6. Remove dust, cobwebs, and traces of insects and dirt.
7. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, fixtures, and Equipment.
8. Remove nonpermanent protection and labels.

3.2 WASTE DISPOSAL

A. Remove temporary structures and facilities and arrange for and dispose of surplus materials, waste products, and debris as follows:
1. Prior to making disposal on private property, obtain written permission from owner of such private property.
2. Do not fill ditches, washes, or drainage ways which may create drainage problems.
3. Do not create unsightly or unsanitary nuisances during disposal operations.
4. Maintain disposal site in safe condition and good appearance.
5. Complete leveling and clean-up prior to final acceptance of the Work.

3.3 TOUCH-UP AND REPAIR

A. Touch up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for final acceptance.

B. Refinish or replace entire surfaces that cannot be touched-up or repaired satisfactorily.

3.4 DEMOBILIZATION

A. Demobilization shall include moving plant and equipment, field trailers, construction materials, debris, and so forth from the Site as well as performing final cleanup.
   1. Disturbed areas shall be restored to their original state or better.
   2. Permanent improvements damaged during construction operations shall be repaired or replaced at no additional cost to Owner.
   3. Remove all equipment, materials, waste, and debris from the site and restore site to original condition upon completion of construction.
   4. The work area shall be restored to its original or better condition and shall be inspected and approved by Engineer.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

SECTION 01 78 39
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Maintain at the Site for Owner, one record copy of the Drawings, Specifications, Operation and Maintenance manuals, coordination drawings, and Shop Drawings that are clearly marked with a red pen to indicate all changes and or revisions resulting from, but not limited to, the following:
   1. Actual Project as constructed.
   2. Addenda.
   3. Change Orders and other modifications.
   4. Engineer's instructions.
   5. Field revisions.
   6. Requests for Information (RFI).
   7. All other changes.

B. Give special attention to recording the horizontal and vertical location of all buried utilities that differ from the locations indicated, or which were not indicated on the Contract Drawings.

C. Record drawings shall be supplemented by any detailed sketches as necessary or directed to fully indicate the Work, as actually constructed.

D. Section Includes:
   1. Maintenance of Documents and Samples
   2. Marking Devices.
   3. Recording.
   4. Close-out Submittal Delivery.

1.2 RELATED SECTIONS

A. 01 77 00 - Project Closeout

1.3 MAINTENANCE OF DOCUMENTS AND SAMPLES

B. Store documents and samples in field office apart from documents used for construction.

C. Provide files and racks for storage of documents.

D. Provide locked cabinet or secure storage space for storage of samples.

E. Maintain documents in clean, dry, legible condition and in good order. Keep record documents separate from those used for construction.

F. Make documents and samples available at all times for reference by Engineer and Owner.

G. In the case of those drawings which depict the detail requirement for equipment to be assembled and wired in the factory, such as motor control centers and the like, the record drawings shall be updated by indicating those portions which are superseded by change order drawings or final shop drawings, and by including appropriate reference information describing the change orders by number and the shop drawings by manufacturer, drawing, and revision numbers.

H. During progress meetings, record documents may be reviewed to ascertain that changes have been recorded.

I. Updated Drawings, when provided by Engineer, will be substituted for the hand markups provided Contractor prints the applicable Drawings and inserts them into the record set each month.

J. Copies of the record drawings will be audited regularly by Engineer after the month in which the Notice to Proceed is given as well as on completion of the Work. Failure to properly maintain record drawings in a up-to-date condition may result in the withholding of payments due at the sole discretion of Owner.

1.4 MARKING DEVICES

A. Use a red color pen for recording all information to all documents defined herein.

1.5 RECORDING

A. Label each document "CONFORMING TO CONSTRUCTION RECORD" in neat large red printed letters.

B. Record information concurrently with construction progress, at the time the material or equipment is installed. Do not conceal any work until required information is recorded.

C. Drawings shall be legibly marked to record actual construction per the following:
   1. Record actual depths of various elements of foundations in relation to finish first floor datum.
   2. Record actual as-built depths, horizontal and vertical location, (at every direction change and a maximum of 100 feet intervals on straight runs), of underground pipes, duct banks, and other buried utilities. Reference horizontal location to Project coordinate system and vertical elevations to Project datum.
   3. Identify and record specific details of pipe connections, location of existing buried features and utilities located during excavation, and the final locations of piping, equipment electrical conduits, manholes, and pull boxes (horizontal coordinates and vertical elevation).
   4. Identify and record location of spare conduits including beginning, ending, and routing through pull boxes, and manholes. Record spare conductors, including number and size, within spare conduits, and filled conduits.
   5. Record actual schedules, lists, layout drawings, and wiring diagrams.
   6. Record field changes of dimension and detail.
   7. Record changes made by instruction from Engineer or by Change Order.
   8. Record details not on original Contract Drawings.

D. Specifications and Addenda shall be legibly marked to record:
   1. Manufacturer, trade name, catalog number, and supplier for each product and item of equipment actually installed.
   2. Changes made by instruction from Engineer or by Change Order.

E. Record potholing data and installation of marker balls.

F. All surveying for record documents shall be performed by a licensed surveyor.

1.6 CLOSEOUT SUBMITTALS

A. At Contract closeout, deliver complete record documents to Engineer as required in Section 01 77 00 - Project Closeout. Final payment will not be acted upon until the record drawings have been prepared and delivered to Engineer.

B. The information submitted will be incorporated by Engineer into final drawings to be provided to Owner. Be responsible for the accuracy of submitted construction information. Engineer will assume that the information provided by Contractor is correct and faithfully represents actual construction.

C. This submittal shall include the record paper set along with 2 CDs. Each CD shall contain .pdf files and .dwg files of each drawing.

D. Prepare submittal with transmittal letter containing:
   1. Date.
   2. Project title and number.
   3. Contractor's name and address.
   4. Title and number of each record as-built document.
   5. Signature of Contractor's authorized representative and a statement that certifies that the record documents are accurate and reflect what was actually installed during construction.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

DIVISION 02
EXISTING CONDITIONS

THIS PAGE INTENTIONALLY BLANK

SECTION 02 41 00
DEMOLITION, SALVAGE, AND RECONSTRUCTION

GENERAL

1.1 SUMMARY

A. The Contractor shall demolish, salvage, and reconstruct existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation facilities as indicated, in accordance with the Contract Documents.

1.2 COORDINATION

A. The Contractor shall carefully coordinate the Work in areas where existing facilities are interconnected with new facilities and where existing facilities remain operational. The Work as indicated is not all inclusive, and the Contractor shall be responsible to perform the reconstruction indicated plus that which can be reasonably inferred from the Contract Documents as necessary to complete the Project. The Specifications and Drawings identify the major facilities that shall be demolished and reconstructed, but auxiliary utilities such as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily shown. The Contractor shall comply with sequencing requirements in Section 01 14 40 - Construction and Schedule Constraints.

B. The Contractor shall note that the Drawings used to indicate demolition and reconstruction are based on record drawings of the existing facilities. These record drawings have been reproduced to show existing conditions and to clarify the scope of Work as much as possible. Prior to bidding, the Contractor shall conduct a comprehensive survey at the Site to verify the correctness and exactness of the Drawings, the scope of Work, and the extent of auxiliary utilities. A complete set of record drawings is available for review at the Project site.

C. While demolition and reconstruction are being performed, the Contractor shall provide adequate access for the continued operation and maintenance of equipment and treatment processes. The Contractor shall erect and maintain fences, warning signs, barricades, and other devices around the reconstruction as required for the protection of the Contractor's employees and the Owner's personnel at the plant. The Contractor shall remove such protection when reconstruction activities are complete, or as work progresses, or when directed by the Engineer.

1.3 CONTRACTOR SUBMITTALS

A. Demolition and reconstruction activities and procedures, including operational sequence, shall be submitted to the Engineer for approval. The procedures shall provide for safe conduct of the Work, careful removal and disposition of materials and equipment, protection of existing facilities which are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection and reconnection of utility services. The procedures shall include a detailed description and time schedule of the methods and equipment to be used for each operation and the sequence of operation. A storage plan for salvaged items shall be included.

1.4 DEMOLITION AND ABANDONMENT

A. Existing pavement, concrete, retaining walls, curb and gutter, sidewalks, buildings, yard structures, equipment, piping, valves, ductwork, duct banks, electrical gear, instrumentation, utilities, and related appurtenances such as anchors, supports, and hardware indicated or required to be demolished as part of the Work shall be removed and disposed of unless otherwise indicated. Removal of buried structures, utilities, and appurtenances includes the related excavation and backfill as required. Removed items shall be disposed of offsite by the Contractor.

1.5 SALVAGE

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances indicated to be salvaged shall be removed without any degradation in condition from that prior to removal. Salvaged items shall be stockpiled and protected on the Site at a location directed by the Engineer. The Contractor shall be responsible to properly safeguard the salvaged items against damage and loss during removal and handling.

B. Items to be salvaged include:

Item	Description
Aerators	From west side oxidation ditches
All electrical equipment (MCCs, variable frequency drive, panels, switch gears, conductors, PLCs, hardware, and HMI panels)	Site Wide

1.6 RELOCATION

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances required to be relocated shall be removed without any degradation in condition from that prior to removal. The Contractor shall be responsible to properly safeguard the relocated items against damage and loss during removal, handling, storage, and installation in the new location.

B. Items to be relocated include:

Item	Description
Trailer	Existing composting yard
Fuel Tanks	Located south of existing operations building
Belt Filter Presses	Existing dewatering building

1.7 REHABILITATION

A. Existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation Work disturbed or damaged by reconstruction activities shall be repaired and rehabilitated as indicated.

B. Damaged items shall be repaired or replaced with new items to restore items or surfaces to a condition equal to and matching that existing prior to damage.

C. In buildings with reconstruction work, the Contractor shall not use any Owner equipment (e.g., bridge cranes and monorails) unless authorized in advance in writing by the Engineer. Such authorization shall be subject to documentation by the Contractor of the load proposed to place on the equipment and be subject to Owner requirements for crane use for operating and maintenance needs. Any damage to a crane shall be repaired or replaced to the Engineer's satisfaction.

1.8 DISPOSAL

A. The Contractor shall be responsible for the offsite disposal of debris resulting from reconstruction in compliance with local, state, and federal codes and requirements.

PRODUCTS (NOT USED)

EXECUTION

A. GENERAL

B. The Contractor shall coordinate demolition and reconstruction Work with the Owner and Engineer. Unless otherwise indicated, the Contractor shall be responsible for the sequence of activities. Work shall be performed in accordance with applicable safety rules and regulations.

C. The Contractor shall verify that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned are rendered inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with demolition and reconstruction.

D. The Contractor shall take precautions to avoid damage to adjacent facilities and to limit the Work activities to the extent indicated. If reconstruction beyond the scope indicated is required, the Contractor shall obtain approval from the Engineer prior to commencing.

3.2 PROTECTION OF EXISTING FACILITIES

A. Before beginning any reconstruction, the Contractor shall carefully survey the existing facilities and examine the Specifications and Drawings to determine the extent of reconstruction and coordination with the Work. Existing facilities not subject to reconstruction shall be protected and maintained in accordance with Section 01 71 50 – Protection and Restoration of Existing Facilities. Damaged existing facilities shall be repaired to the previous condition or replaced.

B. Persons shall be afforded safe passages around areas of demolition.

C. Structural elements shall not be overloaded. The Contractor shall be responsible for shoring, bracing, or adding new supports as may be required for adequate structural support as a result of Work performed under this Section. The Contractor shall remove temporary protection when the Work is complete or when so authorized by the Engineer.

D. The Contractor shall carefully consider bearing loads and capacities before placement of equipment and material on Site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, the Contractor shall consult with the Engineer prior to the placement of such equipment or material.

3.3 DEMOLITION, SALVAGE, AND RELOCATION

A. The Contract Documents indicate existing facilities to be demolished, salvaged, and/or relocated. Auxiliary utilities including such services as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily indicated. The Contractor shall verify the scope of the Work to remove the equipment indicated; coordinate its shutdown, removal, replacement, or relocation; and submit an outage plan in accordance with Section 01 14 40 - Construction and Schedule Constraints. The removal of existing facilities for demolition, salvage, and relocation shall include the following requirements:

1. Equipment supports, including concrete pads, baseplates, mounting bolts, and support hangers, shall be removed. Damage to the existing structure shall be repaired as indicated.
2. Exposed piping including vents, drains, and valves shall be removed. Where exposed piping penetrates existing floors and walls, the piping, including wall thimbles, shall be removed to a minimum depth of 2-inches. Resultant openings in the structure shall be repaired as indicated.
3. Electrical control panels, junction boxes, motor control centers, and local switches and pushbuttons shall be removed.
4. Exposed electrical conduits and associated wiring shall be removed. Resultant openings in structures shall be repaired as indicated.
5. Connections to embedded electrical conduits shall be removed a minimum of 2-inches inside the finished surface of the existing structure. Wiring shall be removed and the resulting openings shall be repaired as indicated.
6. Associated instrumentation devices shall be removed.
7. Auxiliary utility support systems shall be removed.
8. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.
9. Asphalt and concrete pavement, curbs, and gutters shall be removed as necessary to perform reconstruction. The limits of removal shall be sawcut. When the required improvements have been constructed, new asphalt and concrete pavement, curbs, and gutters shall be placed to match the original unless otherwise indicated.
10. Footings, foundation walls, below-grade construction and concrete slabs on grade shall be demolished and removed to a depth, which will not interfere with new construction, but not less than 36-inches below existing ground surface or future ground surface, whichever is lower.
11. Below-grade areas and voids resulting from demolition of structures shall be completely filled. Fill and compaction shall be in accordance with Section 31 23 00 - Earthwork. After fill and compaction, surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as indicated.
12. When existing pipe is removed, the Contractor shall plug the resulting open ends whether or not so indicated. Where removed piping is exposed, the remaining piping shall be blind-flanged or fitted with a removable cap or plug.

13. When existing piping is removed from existing structures, the Contractor shall fill resulting openings in the structures and repair any damage such that the finished rehabilitated structure shall appear as a new homogeneous unit with little or no indication of where the new and old materials join. The openings in water-bearing structures shall be filled with non-shrink grout to be watertight and reinforced as required or indicated. In locations where the surface of the grout will be exposed to view, the grout shall be recessed approximately 1/2-inch and the recessed area filled with cement mortar grout.
14. Electrical reconstruction shall be conducted by the Contractor in a safe and proper manner to avoid injury from electrical shock to the Owner's and Contractor's personnel. Electrical equipment to be shut off for a period of time shall be tagged, locked out, and sealed with a crimped wire and lead seal and made inoperable. At no time shall electrical wiring or connections, which are energized or could become energized be accessible to Contractor, Owner, or other personnel without suitable protection or warning signs.

B. The Contractor shall perform a functional test of existing equipment that is relocated and reinstalled to ensure the equipment functions in the manner documented during the initial inspection. The Contractor shall inform the Engineer in writing a minimum of 5 Days prior to the functional testing in order for the Owner and Engineer to witness the test. If, in the opinion of the Engineer, the relocated equipment does not function in a satisfactory manner, the Contractor shall make repairs and modifications necessary to restore the equipment to its original operating condition at no additional cost to the Owner.

3.4 ABANDONMENT

A. Existing facilities to be abandoned shall be prepared as indicated. Where existing buried piping is to be abandoned, the Contractor shall remove the abandoned pipe for a distance of 5-feet from any connecting structures. Openings at the existing structures shall be repaired. The remaining pipe shall be capped at both ends prior to backfill. Buried piping, 12-inches diameter or greater shall be completely sand-filled prior to closure of the piping ends.

3.5 REHABILITATION

A. Certain areas of existing structures, piping, conduits, and the like will be affected by Work necessary to complete modifications under this Contract. The Contractor shall be responsible to rehabilitate those areas affected by its construction activities.

B. Where new rectangular openings are to be installed in concrete or concrete masonry walls or floors, the Contractor shall score the edges of each opening (both sides of wall or floor slab) by saw-cutting clean straight lines to a minimum depth of 1-inch and then chipping out the concrete. Alternately, the sides of the opening (not the corners) may be formed by saw cutting completely through the slab or wall. Saw cuts deeper than 1-inch (or the depth of cover over existing reinforcing steel, whichever is less) shall not be allowed to extend beyond the limits of the opening. Corners shall be made square and true by a combination of core drilling and chipping or grinding. Necessary precautions shall be taken during removal of concrete to prevent debris from falling into or entering adjacent tanks in service or from damaging adjacent equipment or piping. Saw cuts allowed to extend beyond the opening shall be repaired by filling with non-shrink grout. The concrete around any exposed

reinforcement steel shall be chipped back and exposed reinforcement steel cut a minimum of 2-inches from the finished face of the new opening and be painted with epoxy paint. The inside face of the new opening shall be grouted with an epoxy cement grout to fill any voids and cover the exposed aggregate and shall be trowel-finished to provide a plumb and square opening.

C. Where new piping is installed in existing structures, the Contractor shall accurately position core-drilled openings in the concrete as indicated or otherwise required. Openings shall be of sufficient size to permit a final alignment of pipelines and fittings without deflection of any part and to allow adequate space for satisfactory packing where pipe passes through the wall to provide watertightness around openings so formed. The boxes or cores shall be provided with continuous keyways to hold the filling material in place, and they shall have a slight flare to facilitate grouting and the escape of entrained air during grouting. Before placing the non-shrink grout, concrete surfaces shall be sandblasted, thoroughly cleaned of sand and any other foreign matter, and coated with epoxy bonding compound.

D. Pipes, castings, or conduits shall be grouted in place by pouring in grout under a head of at least 4-inches. The grout shall be poured or rammed or vibrated into place to fill completely the space between the pipes, castings, or conduits, and the sides of the openings so as to obtain the same watertightness as through the wall itself. The grouted casings shall then be water cured.

E. In locations where the surface of the grout will be exposed to view, the non-shrink grout shall be recessed approximately 1/2-inch and the recessed area filled with cement mortar grout.

F. When new piping is to be connected to existing piping, the existing piping shall be cut square and ends properly prepared for the connection. Any damage to the lining and coating of the existing piping shall be repaired. Dielectric insulating joints shall be installed at interconnections between new and existing piping.

G. Where existing equipment, piping, and supports, electrical panels and devices, conduits, and associated appurtenances are removed, the Contractor shall rehabilitate the affected area such that little or no evidence of the previous installation remains. Openings in concrete floors, walls, and ceilings from piping, conduit, and fastener penetrations shall be filled with non-shrink grout and finished to match the adjacent area. Concrete pads, bases associated with equipment, supports, and appurtenances shall be removed by chipping away concrete and cutting any exposed reinforced steel and anchor bolts a minimum of 2-inches below finished grade and be painted with epoxy paint. The area of concrete to be rehabilitated shall be scored by saw cutting clean, straight lines to a minimum depth of 1-1/2 inches, and concrete within the scored lines removed to a depth of 1-1/2 inches (or the depth of cover over reinforcing steel, whichever is less). The area within the scored lines shall be patched with non-shrink grout to match the adjacent grade and finish. Abandoned connections to piping and conduits shall be terminated with blind flanges, caps, and plugs suited for the material, type, and service of the pipe or conduit.

H. Existing reinforcement to remain in place shall be protected, cleaned, and extended into new concrete. Existing reinforcement not to be retained shall be cut-off as follows:

1. Where new concrete joins existing concrete at the removal line, reinforcement shall be cut-off flush with the concrete surface at the removal line.

2. Where the concrete surface at the removal line is the finished surface, the reinforcement shall be cut back 2-inches below the finished concrete surface, the ends painted with epoxy paint and the remaining holes patched with a cement mortar grout.

I. Where existing handrailing is removed, post embedments and anchors shall be removed and post holes shall be filled with non-shrink grout flush to the floor surface. At the point of continuation of existing handrailing, a new post with rail connections matching the existing handrailing system shall be installed. New posts in existing concrete floors shall be installed in core-drilled socket holes and the annular space between the post and hole filled with non-shrink grout.

3.6 DISPOSAL

A. Demolition and removal of debris shall minimize interference with roads, streets, walks, and other adjacent occupied or used facilities, which shall not be closed or obstructed without permission from the Owner. Alternate routes shall be provided around closed or obstructed traffic ways.

B. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these structures shall remain prior to placing of backfill in the areas from which structures were removed.

C. Refuse, debris, and waste materials resulting from demolition and clearing operations shall not be burned.

3.7 OCCUPANCY AND POLLUTION CONTROL

A. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the area. The Contractor shall comply with government regulations pertaining to environmental protection.

B. Water shall not be used if it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

3.8 CLEANING

A. During and upon completion of Work, the Contractor shall promptly remove tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by Work in a clean, approved condition.

B. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as directed by the Engineer or governing authorities, and adjacent areas shall be returned to condition existing prior to start of Work.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

DIVISION 03
CONCRETE

THIS PAGE INTENTIONALLY BLANK

SECTION 03 01 30
CONCRETE REPAIRS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all materials, labor, equipment, tools, etc., required for the repair, renovation, and replacement of concrete and/or reinforcing steel as indicated on the Drawings, specified herein, and determined by field survey.

B. The Contractor, in conjunction with the Engineer, shall determine the extent of cracked or deteriorated concrete to be rehabilitated and/or resurfaced. A summary of the work to be performed shall be submitted to the Engineer for review, and such summary shall be approved by the Engineer prior to commencement of the Work.

C. Concrete repairs include the following:

1. Unit price bid items for concrete repair as indicated on Sheet GS-01.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01 20 00 - Measurement and Payment

B. Section 33 01 30.82 – Polymeric Rehabilitation of Buried Concrete Structures

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Shall be as specified in Section 01 42 00 - References.

B. ICRI CSP - International Concrete Repair Institute Concrete Surface Profile.

1.04 SUBCONTRACTOR/APPLICATOR QUALIFICATIONS

A. The Contractor shall furnish the name of all subcontractors/applicators which he proposes to use for this work, including necessary evidence and/or experience records to ascertain their qualifications in the application of epoxy, urethane, and polymer-modified repair materials.

B. Approved applicator qualifications shall include a minimum of 5 years of experience in applying epoxy, urethane, and polymer-modified and cement-based repair materials like those materials specified in this Section.

C. A letter from the manufacturer of the specified materials, on the manufacturer's letterhead, signed by an officer of the company, stating that the subcontractor/applicator has been trained in the proper techniques for applying the product, including surface preparation and mixing, placing, curing, and caring for the manufacturer's products shall be submitted. This letter shall further state that the subcontractor/applicator is on the manufacturer's approved list of contractors.

1.05 SUBMITTALS

A. Material certifications and technical data sheets on all grouts, mortars, epoxy resins, aggregates and repair products specified in this Section.

B. Subcontractor/Applicator qualifications as specified in Section 1.04.

C. Shop Drawings detailing any planned deviation from the proposed construction sequence and/or method of repair.

D. The Contractor, based on their experience in their profession, and/or recommendation from product manufacturers, may submit to the Engineer for approval, alternative materials and/or methods of work to assure the durability and watertight integrity of the repair work performed.

E. Detailed repair procedures for each repair type.

F. Letter from repair material manufacturer(s) certifying that all repair materials to be used to create single repairs are compatible for use together.

1.06 ADDITIONAL GUARANTEE

A. The Contractor shall guarantee all repair work performed under this Contract against defects in workmanship resulting in leakage and/or failure of concrete bond for a period of three (3) years from the date of the Certificate of Substantial Completion.

PART 2 – MATERIALS

2.01 WATER

A. The water used for mixing concrete repair products shall be clear, potable, and free of deleterious substances.

2.02 AGGREGATE

A. All aggregate shall conform to ASTM C-33. The aggregate supplier shall submit to the Engineer documentation that the proposed aggregates comply with ASTM C-33 and the requirements listed below:

B. Pea Gravel - Pea gravel shall meet the gradation and material requirements of Standard Size 14 as defined by ASTM C-33. Pea gravel shall be clean and free from deleterious matter and shall contain no limestone.

2.03 ANTI-CORROSION REBAR COATING

A. Anti-corrosive coating shall be a two-component, polymer-modified cementitious material such as "Sika Armatec 110 EpoCem " manufactured by Sika Corp., Lyndhurst, NJ, Atlanta, GA, “Duralprep A.C.” by the Euclid Chemical Company, or “MasterEmaco P 124” by BASF Corporation.

2.04 EPOXY BONDING AGENT

A. Epoxy bonding agent shall conform to ASTM C-881 Type I, II, IV or V; Grade 2 for epoxy resin adhesives, depending on the application. The class of epoxy bonding agent shall be suitable for all ambient and substrate temperatures. The epoxy resin shall be "Sikadur Hi-Mod Series" as manufactured by the Sika Corp, Lyndhurst, NJ, "Duralbond" as manufactured by Euclid Chemical Company, Cleveland, OH, "Euco #452 Series" by the Euclid Chemical Company, or "MasterEmaco ADH series" by BASF Corporation.

2.05 TYPE I CRACK REPAIR - CEMENTITIOUS SURFACE SEAL (NOT USED)

2.06 TYPE II CRACK REPAIR – EPOXY INJECTION CRACK REPAIR

A. Type II Crack Repair – Epoxy Injection Crack Repair shall be a two-component, 100% solids, high-modulus, low viscosity, moisture insensitive epoxy adhesive designed for structural repair. The epoxy adhesive shall be "Sikadur 52" manufactured by Sika Corp., Lyndhurst, NJ, "Duralcrete LV" manufactured by Euclid Chemical Company, Cleveland, OH, "Eucopoxy Injection Resin" by the Euclid Chemical Company, or "MasterInject 1500" by BASF Corporation.

2.07 TYPE III CRACK REPAIR - WATERPROOF INJECTION GROUT

A. Type III Crack Repair - Waterproof Injection Grout shall be a one-component, water-activated, extra-low viscosity polyurethane or methacrylic acrylate hydrophilic injection grout capable of 400% expansion. Injection grout shall form a tough flexible foam seal that is impenetrable to water. Hydrophilic injection grout shall be "MasterInject 1210" manufactured by BASF Corporation, "Prime Flex 900 XLV" manufactured by Prime Resins, Conyers, GA, "AV-333 Injectaflex" manufactured by Avanti International, Webster, TX, or "DeNeef Sealfoam PURe" or "Gelacryl Superflex" manufactured by Grace Construction Products/GCP Applied Technologies or "SikaFix HH Hydrophilic" manufactured by Sika Corp., Lyndhurst, NJ,. Hydrophobic injection grout shall be "MasterInject 1230" manufactured by BASF Corporation, "Prime Flex 940" manufactured by Prime Resins, Conyers, GA, "Sikafix HHLV or "Sikafix HH+" manufactured by Sika Corp., Lyndhurst, NJ, "AV-248-LV Flexseal LV" manufactured by Avanti International, Webster, TX, or "DeNeef Flex SLV one or PURe" manufactured by Grace Construction Products.

2.08 SPALL REPAIR PATCHING MATERIAL

A. All spall repairs not requiring formwork shall be repaired using a two-component, polymer-modified cementitious mortar and shall have a minimum 28-day compressive strength of 7,000 psi. Spall repair mortar for use in horizontal applications shall be "Sikatop 122 Plus" manufactured by Sika Corp., Lyndhurst, NJ, "Eucocrete Supreme" or "Duraltop Flowable Mortar" by the Euclid Chemical Company, or "MasterEmaco T-302" or "MasterEmaco T310CI" by BASF Construction Chemicals. Spall repair mortar for use in vertical and overhead applications shall be "Sikatop 123 Plus" manufactured by Sika Corp., Lyndhurst, NJ, "Verticoat or Verticoat Supreme" by the Euclid Chemical Company, or "MasterEmaco N 425" or "MasterEmaco N 400" by BASF Corporation.

B. All spall repairs requiring formwork shall be repaired using a two-component, polymer-modified cementitious mortar/pea gravel mixture and shall have a minimum 28-day compressive strength of 7,000 psi. Spall repair mortar shall be "SikaTop 111 PLUS" manufactured by Sika Corp., Lyndhurst, NJ, "Eucocrete Supreme" manufactured by Euclid Chemical Company, Cleveland, OH, or "MasterEmaco T 310 CI" by BASF Corporation.

2.09 EXPANSION JOINT MEMBRANE REPAIR SYSTEM

A. Expansion joint repair system shall be a flexible rubber sealing strip secured to the concrete substrate with an epoxy adhesive. System shall be provided by a single manufacturer, installed per manufacturer's recommendations and shall be "Sikadur Combiflex" manufactured by Sika Corp., Lyndhurst, NJ or Engineer approved equal. Minimum width of waterproof membrane patch shall be twelve (12) inches unless shown otherwise on Contract Drawings.

2.10 WATERSTOP REPAIR SYSTEM

A. Waterstop repair system shall consist of a continuous, watertight, structural sealing compression joint system capable of withstanding 25% tension, 50% compression and 2-inches total movement while functioning as a watertight seal between concrete substrate headers. Waterstop Repair System shall be provided by a single manufacturer and shall be either:

1. Preformed, impermeable, closed cell, low-density, UV stable foam sealing strip system secured to concrete with a bonding agent. System shall be "CEVA 100 System" as manufactured by Chase Construction Products, "Wabo Evazote System", or approved equal. Foam sealing strip and epoxy bonding agent shall be provided by the same manufacturer as a system and shall consist of "Phyzite 380" foam sealing strip with either "EVA-POX BONDER #1", "EVA-POX UNDERWATER BONDER #47", or "EVA-POX COLD CURE #41" bonding agent, or Evazote UV foam sealing strip with "Wabo Evazote Bonder" or "Wabo Evazote Cold Cure Bonder. Bonding agent shall be as recommended by the manufacturer based on substrate conditions at the time of installation.

2. Preformed flexible neoprene profile system secured to concrete with a bonding agent. System shall be "JP-Series Profile" by D.S. Brown Company, "Jeene Bridge Series Seal" or "Wabo Compression Seal" by Watson Bowman Acme/BASF.

2.11 CEMENT BASED TEXTURED COATING (NOT USED)

2.12 OTHER MATERIALS (NOT USED)

2.13 STORAGE OF MATERIALS

A. The Contractor shall provide an area for repair material storage free from exposure to moisture in any form, before, during, and after delivery to the site. Manufactured materials shall be delivered in unbroken containers labeled with the manufacturer's name and product type. All mortar products shall be stored on raised platforms. Materials susceptible to damage by freezing shall be stored in a dry, heated, insulated area. Any material that has hardened,

partially set, become caked and/or has been contaminated or deteriorated shall be rejected. All aggregates shall be stored in clean bins, scows or platforms.

PART 3 – INSTALLATION

3.01 GENERAL REQUIREMENTS

A. No repair work shall be undertaken when ambient temperatures are below manufacturer's safe recommendations. No admixtures, except those required by the manufacturer, shall be used in the repairs specified herein.

B. All products shall be applied in strict accordance with manufacturer's recommendations. The Contractor shall furnish and install safe scaffolding and ladders for the Engineer's prework inspection, the repair work activities, and the Engineer's final inspection.

C. Sandblast or waterblast (3000-5000 psi waterjet) or use low impact hand chipping tools to clean deteriorated areas to remove all loose concrete, existing coatings, unsound material, debris, and laitance. All surfaces shall be clean, free of dirt, grease, loose particles, and deleterious substances and shall be prepared according to manufacturer's requirements.

3.02 EPOXY BONDING AGENT

A. An epoxy bonding agent shall be used when applying fresh concrete to previously placed concrete unless otherwise recommended by the manufacturer.

B. Existing concrete surfaces shall be roughened (1/16” or CSP 5 minimum profile) unless otherwise recommended by the manufacturer prior to application of bonding agent. Concrete surface shall be clean and sound, free of all foreign particles and laitance. Repair material shall be placed while bonding agent is still tacky. If bonding agent cures prior to placement of repair material, bonding agent shall be reapplied.

C. Repairing concrete with epoxy mortars shall conform to all the requirements of ACI 503.4 "Standard Specification for Repairing Concrete with Epoxy Mortars" (latest edition), except as modified herein.

3.03 ANTI-CORROSION REBAR COATING

A. Reinforcing steel cut or exposed during demolition and/or repair operations shall be sandblasted and cleaned prior to coating with an anti-corrosive coating. Anti-corrosive coating shall be applied as soon as the reinforcement is exposed and cleaned. Coating shall thoroughly cover all exposed parts of the steel and shall be applied according to manufacturer's recommendations.

3.04 TYPE I CRACK REPAIR – CEMENTITIOUS SURFACE SEAL (NOT USED)

3.05 TYPE II CRACK REPAIR – EPOXY INJECTION

A. Vertical and Overhead Surfaces

1. Where indicated on the Drawings, or as directed by the Engineer, existing structural cracks 1/4" wide or narrower shall be repaired by pressure injecting Type II Crack Repair material into the prepared crack. Seal crack surface using epoxy resin binder and install injection ports per manufacturer's recommendations. Holes drilled for injection ports shall not cut rebar. If rebar is encountered during drilling, the hole shall be abandoned and relocated, and the abandoned hole shall be patched immediately with non-shrink grout flush with the surface of the existing concrete. Once the surface sealing material has fully cured, inject crack with Type II Crack Repair material using standard pressure injection equipment as directed by the manufacturer.

B. Horizontal Surfaces

1. Where indicated on the Drawings, or as directed by the Engineer, existing structural cracks 1/4" wide or narrower shall be repaired using Type II Crack Repair by pressure injecting Type II Crack Repair material into the prepared crack. Seal crack surface using epoxy resin binder and install injection ports per manufacturer's recommendations. Holes drilled for injection ports shall not cut rebar. If rebar is encountered during drilling, the hole shall be abandoned and relocated, and the abandoned hole shall be patched immediately with non-shrink grout flush with the surface of the existing concrete. Once the surface sealing material has fully cured, inject crack with Type II Crack Repair material using standard pressure injection equipment as directed by the manufacturer.

2. Where indicated on the Drawings, or as directed by the Engineer, existing structural cracks wider than 1/4" shall be repaired by gravity feeding Type II Crack Repair material into the prepared crack. First rout the concrete surface to form a 1/4" wide by 1/4" deep v-notch and clean the crack to remove all loose and foreign particles. Fill the crack with clean, dry sand and then pour structural crack repair binder into V-notch, completely filling crack. As binder penetrates crack, additional binder shall be applied to the V-notch.

3.06 TYPE III CRACK REPAIR – WATERPROOF INJECTION GROUT

A. Existing, leaking cracks 1/4" or smaller, identified as nonstructural by the Engineer, shall be repaired by pressure injecting a Type III Crack Repair material into the prepared crack. Seal crack surface with epoxy binder and install injection ports per manufacturer's recommendations. Holes drilled for injection ports shall not cut rebar. If rebar is encountered during drilling, the hole shall be abandoned and relocated, and the abandoned hole shall be patched immediately with non-shrink grout flush with the surface of the existing concrete. Once the surface sealing material has cured, clean, potable water shall be injected into the ports to flush the crack and provide the water necessary for chemical reaction of the grout. Immediately following injection of water, inject the crack with Type III Crack Repair material using standard pressure injection equipment as directed by the manufacturer.

B. All existing, leaking cracks larger than 1/4", not identified as structural by the Engineer, shall be repaired by first soaking oakum rope or open cell backer rod in waterproof injection grout, and then tightly packing the soaked oakum into the crack so as to completely fill the crack.

3.07 SPALL REPAIR PATCHING MATERIAL

A. All voids or spalled areas to be repaired shall be chipped back to sound concrete a minimum 1/8" deep, with a minimum surface profile of CSP-5, cleaned and repaired with spall repair patching material according to manufacturer's recommendations. All patching shall provide a final finished surface which is flat, level and even with the existing concrete surface. Repair mortar shall not be feathered to meet existing concrete surface. Prior to commencing repair surface preparation, saw cut or grind a 1/2" deep groove around the perimeter around the repair area, perpendicular to the finished concrete surface to provide a square shoulder to the repair area. Repair areas shall be formed using clean, straight rectangular edges where possible. Final patching on horizontal surfaces shall receive a broom finish consistent with the finish on the existing structure.

3.08 EXPANSION JOINT REPAIR SYSTEM

A. Thoroughly clean the concrete substrate and apply Expansion Joint Repair System according to the manufacturer's recommendations.

3.09 WATERSTOP REPAIR SYSTEM

A. Remove all existing expansion joint sealant, backer rod, and expansion joint filler material as required to install the waterstop repair system.

B. Prepare existing concrete surfaces as required by the manufacturer.

C. Apply bonding agent to existing concrete and foam sealing strip or neoprene profile, and insert into expansion joint, as required by the manufacturer.

3.10 CEMENT BASED TEXTURED COATING (NOT USED)

3.11 CURING

A. All repair products shall be cured in strict accordance with manufacturer recommendations. Wet curing is preferred where possible.

3.12 WORK IN CONFINED SPACES

A. The Contractor shall provide and maintain safe working conditions for all employees and subcontractors. Fresh air shall be supplied continuously to confined spaces through the combined use of existing openings, forced-draft fans and temporary ducts to the outside, or by direct air supply to individual workers. Fumes shall be exhausted to the outside from the lowest level of the confined space. Electrical fan motors shall be explosion-proof if in contact with fumes. No smoking or open fires shall be permitted in or near areas where volatile fumes may accumulate.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Provide cast-in-place concrete work as shown on Contract Drawings and as specified herein.

B. Section includes:
1. Concrete Materials.
2. Proportioning and Mixing.
3. Ready Mixed Concrete.
4. Curing Materials.
5. Expansion Joint Filler.
6. Waterstops.
7. Liquid Floor Hardener.
8. Preparing for Concreting.
9. Placing of Concrete.
10. Finishing.
11. Curing.
12. Field Quality Control.

1.2 RELATED SECTIONS

A. Section 03 11 00 – Concrete Forming.

B. Section 03 20 00 – Concrete Reinforcing.

C. Section 03 60 00 – Grouting.

D. Section 07 14 00 – Fluid-Applied Waterproofing.

1.3 REFERENCES

A. American Concrete Institute (ACI) standards, most recent editions:

ACI 211	Standard Practice for Selecting Proportions for Concrete
ACI 212	Chemical Admixtures
ACI 117	Standard Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete for Buildings
ACI 305	Recommended Practice for Hot Weather Concreting
ACI 306	Recommended Practice for Cold Weather Concreting

ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures

B. ASTM International (ASTM) standards, most recent editions:

ASTM C31	Standard Specification Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specifications for Concrete Aggregates
ASTM C39	Test for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C94	Standard Specifications for Ready-Mixed Concrete
ASTM C143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C150	Standard Specifications for Portland Cement
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C260	Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C586	Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks as Concrete Aggregates (Rock-Cylinder Method)
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C827	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)

ASTM C1293	Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
ASTM C1567	Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM D412	Test Methods for Rubber Properties in Tension
ASTM D624	Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D746	Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D747	Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam
ASTM D1751	Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2240	Test Method for Rubber Property - Durometer Hardness
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate

C. International Concrete Repair Institute (ICRI) standards, latest editions:

Guideline No 310.1R	Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
Guideline No 320.2R	Guide for selecting and specifying Materials for repair of Concrete Surfaces

D. NSF International (NSF), most recent edition:

NSF 61	Drinking Water System Components, Health Effects

E. U. S. Army Corps of Engineers standards, most recent editions:

CRD-C 572	PVC Waterstops

1.4 DEFINITIONS

A. Construction Joints: Fresh concrete placed against a hardened concrete surface; joint between two pours is called a construction joint. Unless otherwise indicated, provide construction joints with a waterstop and sealant groove of the shape indicated.

B. Expansion Joints: To allow concrete to expand freely, space provided between two pours, formed as indicated. Space is made by placing filler joint material against the first pour; acts as a form for the second pour.

C. Control Joints: Provide weakened plane in concrete, where shrinkage cracks will likely occur. A groove, shape and dimensions indicated in Drawings, formed or saw-cut in concrete. Groove is filled with joint sealant material.

D. Laitance: In placement of concrete, accumulation of small inert particles of cement and aggregate on surface, caused by excess of water that, when it evaporates, leaves a thin layer, causing weakened plane for subsequent pour.

E. Alkalies: Term "alkalies" referred to herein is defined as sum of percentage of sodium oxide and 0.658 times percentage of potassium oxide ($Na_20+0.658K_20$). These oxides shall be oxide content determined in accordance with ASTM C114.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Product data:
   1. Concrete mix design(s) proposed for use. Proposed concrete mix design submittal to include the following information:
      a. Sieve analysis and source identification of fine and coarse aggregates. Include sand equivalency.
      b. Source test results for aggregate organic impurities.
      c. Source test results for deleterious aggregate per ASTM standards.
      d. Proportioning of all materials.
      e. Type of cement with mill certificate for cement.
      f. Slump.
      g. Air Content.
      h. Brand, type, ASTM designation, and quantity of each admixture proposed for use.
      i. 28-day cylinder compressive test results of trial mixes per ACI 350 and as indicated herein.
      j. Shrinkage test results.
      k. Standard deviation value for concrete production facility.
   2. Manufacturer and type of joint filler, joint sealant, curing agent, and chemical floor hardener.
   3. Waterstops:
      a. Provide manufacturer's current test reports with written material certification.

b. Provide samples of extruded or molded sections of each size or shape to be used in the Work. Samples shall represent in all aspects, the material to be furnished under this Contract.
c. Provide sample of fabricated cross-construction of each size or shape of waterstop to be used. Fabricate samples so that material and workmanship represent the materials to be furnished in the Work.
d. Provide manufacturer's written certification as an integral part of the shipping form, to show that the material shipped to Work meets or exceeds the physical property requirements specified.

4. Manufacturer and type of bonding and patching mortar and bonding adhesive used at construction joints.
5. Pour plan for superplastisized concrete pours.

1.6 CONCRETE CONFERENCE

A. A meeting to review the detailed requirements of the Contractor's proposed concrete design mixes and to determine the procedures for producing proper concrete construction shall be held no later than 14 days after the notice to proceed.

B. All parties involved in the concrete work shall attend the conference, including the following:
1. Contractor's representative
2. Testing laboratory representative
3. Concrete subcontractor
4. Reinforcing steel subcontractor and detailer
5. Concrete supplier
6. Admixture manufacturer's representative

C. The conference shall be held at a mutually agreed upon time and place. The Engineer shall be notified no less than 5 days prior to the date of the conference.

1.7 QUALITY ASSURANCE

A. Preconstruction Testing: Perform all preliminary and trial batch laboratory tests on cement, aggregates, and concrete.

B. Testing Agencies: The testing laboratory shall meet or exceed the requirements of ASTM C1077.

1.8 DELIVERY, STORAGE AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Mixing, transporting, handling, placing, curing and testing of concrete in accordance with applicable ACI and ASTM specifications and as specified.

C. Storage of material:
1. Cement:
a. Protect cement from exposure to moisture until used.
b. Do not use if caked or lumpy.

c. Store sacked cement to permit access for inspection and sampling.

2. Aggregate:
   a. Store to prevent segregation and contamination with other sizes or foreign materials.
   b. Obtain samples for testing from aggregates at point of batching.
   c. Do not use frozen or partially frozen aggregates.
   d. Do not use the bottom 6 inches of stockpiles in contact with ground.
   e. Allow sand to drain until moisture content is uniform prior to use.
3. Admixtures:
   a. Protect from contamination, evaporation, freezing, or damage.
   b. Maintain within temperature range recommended by manufacturer.
   c. Completely mix solutions and suspensions prior to use.

D. Delivery:
1. Prepare a delivery ticket for each load of ready-mix concrete delivered to the project. Truck operator shall hand ticket to Engineer at time of delivery, which shows the following information for each load:
   a. Mix identification mark.
   b. Quantity delivered (by volume).
   c. Amount of each material in batch.
   d. Outdoor temperature in the shade.
   e. Time at which cement was added.
   f. Amount of water added at jobsite by Contractor.
   g. Amount of superplastisizer added where applicable.

1.9 SITE ENVIRONMENTAL REQUIREMENTS

A. When temperature is below 40°F or is likely to fall below 40°F during 24-hour period after placing concrete, heat materials, (not in excess of 140°F) including both water an aggregates and protect concrete so that temperature of the concrete is between 50°F and 90°F for 24-hour period after placing concrete.

B. During hot weather, shade materials from sun and use cool water so temperature of concrete does not exceed 90°F at time of placing concrete.

C. Placing of concrete is not permitted where, in opinion of Engineer, wind, rain or inadequate facilities furnished by Contractor prevents proper finishing or curing of concrete.

1.10 COORDINATION

A. Coordination with placement of reinforcing steel, embedded items, and other Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Expansion joint fillers:
    a. Ceramar, WR Meadows, Inc.
    b. Rubatex Corporation
    c. Williams Products, Inc.
    d. Engineer approved equal.
2. Membrane Curing Compound.
    a. 1100-Clear, WR Meadows, Inc.
    b. Dry-Chem Rez Cure (J-11-W), Dayton Superior.
    c. L&M Cure R, L&M Construction Chemicals, Inc
    d. Engineer approved equal.
3. Evaporation Retardant:
    a. AquaFilm, Dayton Superior.
    b. Eucobar, Euclid Chemical Company.
    c. MasterKure ER50 by Master Builders.
    d. Engineer approved equal.
4. Waterstops, Plastic Serrated Type:
    a. Vinylex Corporation.
    b. Greenstreak, Inc.
    c. W. R. Meadows, Inc.
    d. Engineer approved equal.
5. Waterstops, Plastic Adhesive Type:
    a. Synko-Flex, Henry Company.
    b. Engineer approved equal.
6. Waterstops, Hydrophilic Type
    a. Adcor ES, WR Grace,
    b. Hydro-Flex, Henry Company.
    c. Hydrotite, Greenstreak, Inc.
    d. Engineer approved equal.
7. Bonding agent:
    a. Armatek 110 EpoCem, Sika Corporation
    b. Engineer approved equal.
8. Set Controlling Admixtures:
    a. For air temperature at the time of placement over 80°F; set-retarding;
        1) Plastocrete, Sika Corporation
        2) Pozzolith 300R, Master Builders.
        3) Engineer approved equal.
    b. For air temperature at the time of placement under 40°F: Non-corrosive set accelerating;
        1) Plastocrete 161FL by Sika Corporation.
        2) Pozzutec 20 by Master Builders.
9. Air-entraining Agent:
    a. Micro-Air, Master Builders.
    b. Daravair 1000, WR Grace.
    c. Sika AEA-15, Sika Corporation.
    d. Engineer approved equal.
10. Pigments for Underground Conduit Banks:
    a. Arizona Oxides, #1835.
    b. Bayer, Bayferrox #130.
    c. Davis, #117.

d. As currently approved by governing agency.

11. Liquid Chemical Floor Hardener:
    a. Surfhard, Euclid Chemical Company, Cleveland, Ohio.
    b. Burke-O-Lith, EDOCO.
    c. Solidus Hardener, Lambert Corporation.
    d. Engineer-approved equal.

2.2 MATERIALS

A. Portland cement: Comply with ASTM C150, Type II or V.
   1. Portland cement shall contain not more than 0.60 percent equivalent alkalies.
   2. Single brand of cement used throughout Work; brand approved by Engineer.

B. Fly Ash: Not permitted

C. Fly Ash: ASTM C618, Class F including supplementary optional requirements relating to reactive aggregates and alkalis, and loss on ignition (LOI) not to exceed 5 percent
   1. Maximum of 25 percent replacement at 1.0 pounds of fly ash per pound of cement replaced.

D. Coarse Aggregate: Conforming to ASTM C33 and as noted below.
   1. Clean, hard, durable gravel, crushed gravel, crushed rock or combination thereof.
   2. Reactivity: Non-reactive or below innocuous behavior level.
   3. Prepare and handle coarse aggregates in two or more size groups for combined aggregates with maximum size greater than 3/4 inch.
   4. When aggregates are proportioned for each batch of concrete, combine the size groups.
   5. Obtain coarse aggregates from sources approved by Engineer.

E. Combined Aggregates: Well graded from course to fine sizes; uniformly graded between screen sizes to produce a concrete that has optimum workability and consolidation characteristics. Where a trial batch is required for a mix design, the final combined aggregate gradation will be established during the trial batch process.

F. Fine Aggregates: Natural or combination of natural and manufactured sand that is hard and durable.
   1. Lightweight Sand for Fine Aggregate: Not permitted.
   2. Sand Equivalency: Tested in accordance with ASTM D2419; not less than 80 percent for an average of 3 samples; not less than 80 percent for an individual test.
   3. Gradation: In accordance with ASTM C33; 15 to 30 percent passing number 50 screen; 5 to 10 percent passing number 100 screen.
   4. Fineness Modulus: Not over 3.00.
   5. Reactivity: Non-reactive or below innocuous behavior level.
   6. Obtain fine aggregates from sources approved by Engineer

G. Water: Clean and free from objectionable quantities of organic matter, alkali, salts and other impurities, as determined by Engineer.

H. Admixtures:

1. Maximum total water soluble chloride ion content contributed from all ingredients of concrete including water, aggregates, cementitious materials, and admixtures by weight percent of cement:
   a. 0.06 For prestressed concrete.
   b. 0.10 For all other concrete.
2. Do not use calcium chloride.
3. Provide admixtures of same type, manufacturer, and quantity as used in establishing required concrete proportions in the mix design.
4. Air entraining admixtures: ASTM C260.
5. Water reducing admixtures:
   a. Comply with ASTM C494, Type A.
   b. Concrete not to contain more than one water-reducing admixture.
   c. Conform to applicable provisions of ACI 212.3R.
   d. Follow manufacturer's instructions.
   e. Use chloride free admixtures only.
6. Set controlling admixtures with or without water-reducing properties.
   a. ASTM C494, Types B through E.
   b. Conform to applicable provisions of ACI 212.3R.
   c. Do not use retarding or accelerating admixtures unless specifically approved in writing by Engineer and at no additional cost to Owner.
   d. Follow manufacturer's instructions.
   e. Use chloride free admixtures only.
7. High Range Water Reducers:
   a. In accordance with ASTM C494, Type F.
   b. Conform to applicable provisions of ACI 212.3R.
   c. Locations for use of high range admixtures shall be as shown on the Contract Drawings. Do not use high range admixtures in other locations unless specifically approved by Engineer and at no additional cost to Owner.
   d. Add to concrete at the jobsite after all other ingredients have been mixed and initial slump has been verified.
   e. Added by a technician certified by manufacturer of the product.
   f. Added at the site unless written permission is given by Engineer to add the product at plant.
   g. Mixing: Minimum 70 revolutions or 5 minutes after addition of high-range water reducer.
   h. Slump before Addition: Maximum 2 inches.
   i. Slump after Addition: Minimum of 6 inches and maximum of 10 inches.
8. Pigments for Underground Conduit Banks: Pigment shall be added to concrete encasing electrical duct banks as required by governing agency.

I. Curing Materials
1. Polyethylene sheet for use as concrete curing blanket shall be white and shall have a nominal thickness of 6 mils. The loss of moisture when determined in accordance with the requirements of ASTM C156 shall not exceed 0.055 grams per square centimeter of surface.
2. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, having a nominal thickness of 2 mils and permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU B 790A

(1) (2). The loss of moisture, when determined in accordance with the requirements of ASTM C156, shall not exceed 0.055 gram per square centimeter of surface.

3. Polyethylene-coated burlap for use as concrete curing blanket shall be 4 mils thick, white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of moisture, when determined in accordance with the requirements of ASTM C156, shall not exceed 0.055 gram per square centimeter of surface.
4. Membrane Curing Compound (with fugitive dye added): ASTM C309, Type 1-D, Class B. Sodium silicate compounds shall not be allowed.

J. Expansion Joint Filler
1. Provide expansion joints in concrete construction where shown on Contract Drawings.
2. Expansion Joint Filler: Preformed, non-extruding, resilient type, constructed of cellular sponge rubber, extending full thickness of slab, in accordance with ASTM D1751 or ASTM D1752, Type I.

K. Grout: As specified in Section 03 60 00 – Grouting.

L. Waterstop, Plastic Serrated Type:
1. Extruded elastomeric polyvinyl chloride compound; containing plasticizers, resins, stabilizers and other materials necessary to meet requirements of Specifications.
   a. Store waterstops to permit free circulation of air around waterstop material.
   b. Provide special fittings fabricated for splices and joints.
   c. In accordance with Specification CRD-C572.

	VALUE	ASTM STD.
PHYSICAL PROPERTY, SHEET MATERIAL		
Tensile Strength-minimum (psi)	1750	D412, Die C
Ultimate Elongation-minimum (%)	350	D412, Die C
Low Temp. Brittle-maximum (°F)	-35	D746
Stiffness in Flexure-minimum (psi)	400	D747
ACCELERATED EXTRACTION (CRD-C572)		
Tensile Strength-minimum (psi)	1500	D412, Die C
Ultimate Elongation-minimum (%)	300	D412, Die C
EFFECT OF ALKALIES (CRD-C572)		
Change in Weight (%)	+.25/-.10	-----
Change in Durometer, Shore A	+5	D2240
FINISHED WATERSTOP		
Tensile Strength minimum (psi)	1400	D412, Die C
Ultimate Elongation minimum (%)	280	D412, Die C

   d. Style:
      1) Centerbulb, 7/8 inch OD, 6 inches long.
      2) Flat Strip, 6 inches long unless noted otherwise.

M. Waterstop, Plastic Adhesive Type: Non expansive plastic adhesive strip type conformable, manufactured solely for the purpose of preventing water from passing through construction joints.

1. Primer as recommended by waterstop manufacturer.

N. Waterstop, Hydrophilic Type: Expansive, conformable blended rubber based material.
1. Primer as recommended by waterstop manufacturer.

O. Liquid Chemical Floor Hardener:
1. Colorless, aqueous solution of containing magnesium fluosilicate combined with a wetting agent.
a. Premeasured, premixed, and packaged at the factory
b. Not less than 2 pounds fluosilicate per gallon.
c. Provide material which does not react with, inhibit, or otherwise interfere with adhesives and bonding of future floor finishes.

P. Elastomeric Bearing Materials:
1. Rubber bearing pads shall be furnished with the dimensions, material properties, and elastomer grade as required by the Drawings and in accordance with ASTM D2240, Type A, Shore 30 or 40 Durometer.
2. Prepare concrete support surfaces and adhere pads to concrete per manufacturer's recommendations.

Q. Waterproofing: Refer to Section 07 14 00 – Fluid-Applied Waterproofing.

2.3 EQUIPMENT

A. On-Site Batch Plants:
1. Direct weighing equipment approved by Engineer for measuring cement and aggregate. Scales certified by Bureau of Weights and Measures. Certification current within 6 months.
2. Equip mixer with suitable water meter or other measuring device approved by Engineer.
a. Meter capable of measuring water in variable amounts within a tolerance of 1 percent.
b. Water feed control mechanism capable of being locked in position to deliver constantly supply of specified amount of water to each batch of concrete.
c. Meter equipped with setback register with a readily visible vertical face and double hands indicating in cubic feet and decimals.
d. Provide with positive, quick-acting cut-off valve in the water line to the mixer. Operating mechanism must not leak when valves are closed.
3. Batch mixer of an approved type and size, designed to ensure uniform distribution of all component materials throughout the mass during the mixing operation. Install and use a batch timer and counter, including lock release and audible indicator on each concrete mixer.

B. Concrete Pumps:
1. Provide pumping equipment with two cylinders, designed to operate with only one cylinder in case one is not functioning. In lieu of this requirement, provide a standby pump on the site during pumping.
a. Minimum Diameter of Hose (conduit): 4 inches.
b. Aluminum conduits for conveying the concrete will not be permitted.

C. Vibrators:

1. Internally vibrated, high speed power vibrators of an approved immersion type. In sufficient numbers with standby units as required.

D. Truck Mixers:

1. At the Contractor's option, ready-mixed concrete may be used meeting the requirements as to materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C94, including the following supplementary requirements.
2. Ready-mixed concrete shall be delivered to the site of the Work, and discharge shall be completed within 90 minutes after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever is first.
3. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.
4. Mix each batch of concrete in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.
5. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the specified slump is 3 inches or less, or if they differ by more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the Work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.
6. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the Engineer.

2.4 REINFORCEMENT STEEL

A. Provide in accordance with Section 03 20 00 – Concrete Reinforcing.

2.5 CONCRETE MIXES

A. General: Concrete shall be composed of cement, admixtures, aggregates and water. These materials shall be of the qualities specified and in accordance with ACI 301 specifications. The exact proportions in which these materials are to be used for different parts of the Work will be determined during the trial batch. In general, the mix shall be designed to produce a

concrete capable of being deposited so as to obtain maximum density and minimum shrinkage and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items. The proportions shall be changed whenever necessary or desirable to meet the required results at no additional cost to the Owner. All changes shall be subject to review by the Engineer.

B. Fine Aggregate Composition:

1. In mix designs for structural concrete, the percentage of fine aggregate in total aggregate by weight shall be as indicated in the following table:

Fineness Modulus	Maximum Percent
2.7 or less	41
2.7 to 2.8	42
2.8 to 2.9	43
2.9 to 3.1	44

2. In all other concrete, the maximum percentage of fine aggregate of total aggregate, by weight, shall not exceed 50.

C. Concrete compressive strength, aggregate size and slump in accordance with the following:

Type of Construction	Compressive Strength (psi)	Aggregate Gradation (ASTM C33)	Slump in Inches (Max.)	Max W/C Ratio (by Weight)
Structure walls and top slabs.	4,500	#67 (3/4")	4	0.45
Structure footings; foundations and bottom slabs.	4,500	#467 (1-1/2")	4	0.45
Reinforced concrete encasements; thrust blocks	4,000	#467 (1-1/2")	4	0.50
Site Slabs; Curb and gutter	4,000	#67 (3/4")	4	0.50
Lean Concrete	3,000	#467 (1-1/2")	5	0.60
Site underground conduit banks: Min. 3 lbs. red pigment/sack cement	3,000	#8 (3/8")	5	0.60

1. Compressive Strength: minimum at 28 days of age.
2. Slump as shown above shall be plus or minus 1 inch.
   a. Slump to be measured before addition of any plasticizing agents at the job site.
   b. Measure at point of discharge of the concrete into the concrete member per ASTM C143.
   c. Concrete of lower than maximum slump may be used provided it can be properly placed and consolidated.

d. For pumped concrete, provide additional water at batch plant to allow for slump loss due to pumping. Provide only enough additional water so that slump of concrete at discharge end of pump hose does not exceed maximum slump specified above.

3. Minimum cement content:
   a. Reinforced Concrete: Six sacks Portland Cement per cubic yard.
   b. Unreinforced Concrete: Five sacks Portland Cement per cubic yard.
4. Air content: Provide air entrainment resulting in a total air content of 4 to 7 percent for all types of construction.
   a. Air content to be measured in accordance with ASTM C231, ASTM C173, or ASTM C138.
   b. Air may be omitted from interior slabs to be trowel finished.

D. Selection of Proportions:
1. General: Proportion ingredients to produce proper workability, durability, strength, and other required properties. Prevent segregation and collection of excessive free water on the surface.
2. Pan stair fill:
   a. Coarse aggregate: 100 percent passing a 1/2 inch sieve.
   b. Proportions:
      1) One sack cement.
      2) 150 pounds coarse aggregate.
      3) 150 pounds fine aggregate (sand).
      4) Adjust mix to obtain satisfactory finishing.
3. Submit mix design data for approval as required by this specification Section.
4. Proportion mixture to provide desired characteristics using one of the methods described below:
   a. Method 1 (Trial Mix): Per ACI 350, Chapter 5, except as modified herein.
      1) Air content within range specified above.
      2) Record and report the temperature of trial mixes.
      3) Proportion trial mixes per ACI 211.1.
   b. Method 2 (Field Experience): Per ACI 350, Chapter 5, except as modified herein.
      1) Field test records must be acceptable to Engineer to use this method.
      2) Test records shall represent materials, proportions, and conditions similar to those specified herein.
   c. Required average strength to exceed the specified 28-day compressive strength by the amount determined or calculated in accordance with the requirements of ACI 350, using the standard deviation of the proposed concrete production facility.
5. Shrinkage Limitation
   a. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age shall be 0.036 percent or 0.042 percent, respectively per ASTM C157. Use a mix design for construction that has first met the trial batch shrinkage requirements. Shrinkage limitations apply only to structural concrete.

2.6 SOURCE QUALITY CONTROL

A. Trial Batch: Based on submitted concrete mixes for each class of concrete.

B. Aggregates:

1. Fine and coarse aggregates shall be tested in accordance with ASTM C1260 or ASTM C1293 to show compliance with ASTM C33 for alkali-silica reactivity and the aggregates shall be non-reactive.
2. Fine and coarse aggregates shall be tested in accordance with ASTM C1260 or ASTM C1293 to show compliance with ASTM C33 for alkali-silica reactivity and shall be non-reactive unless employing the following additional measures:
    a. When the above test results show the aggregates to be reactive, and fly ash or other supplementary cementing material (SCM) is approved for use in order to control alkali-aggregate reactivity, the proposed concrete mixture shall be tested in accordance with ASTM C1567 and produce expansion results of less than 0.10 percent at 14 days.
    b. When a lithium admixture is approved for use in order to control alkali-aggregate reactivity, the proposed concrete mixture shall be tested in accordance with ASTM C1293 and produce expansion results of less than 0.04 percent at one year.
3. The fine and coarse aggregates shall be tested in accordance with ASTM C586 to show compliance with ASTM C33 for alkali-carbonate reactivity and shall be non-reactive.
4. The fine aggregate shall be tested in accordance with ASTM C40 to show compliance ASTM C33 for organic impurities.
5. The fine and coarse aggregate shall be tested in accordance with ASTM C88 to show compliance with ASTM C33.
6. The fine and coarse aggregate shall be tested in accordance with ASTM C142 to show compliance with ASTM C33.
7. The fine and coarse aggregate shall be tested in accordance with ASTM C123 to show compliance with ASTM C33.
8. The fine and coarse aggregate shall be tested in accordance with ASTM C117 to show compliance with ASTM C33.
9. The coarse aggregate shall be tested in accordance with ASTM C131 to show compliance with ASTM C33.
10. In addition to initial aggregate testing, each type of aggregate shall be tested at no increased cost to the Owner for conformance to ASTM C33 under any of the following conditions:
    a. Concrete placement extending longer than six months.
    b. There is a noticeable change in aggregate appearance, consistency, or ease of excavation.
    c. The aggregate supplier changes pits, or locations in the original pit.
11. If the test results fail to meet the requirements of ASTM C33 and this Section, the Engineer may stop the placement of concrete, and may require additional testing of aggregates or field and trail batch testing of concrete to verify conformance to ASTM C33 and the strength and shrinkage requirements of this Section.
12. The Engineer may conduct any additional testing of aggregates at anytime during the concrete placement period. Depending on the test results, testing cost shall be paid by the Contractor or Owner, according to the General Conditions. If test data fails to

conform to ASTM C33, the Engineer may stop the placement of concrete or take corrective actions as indicated above.

PART 3 - EXECUTION

3.1 PREPARING FOR CONCRETING

A. Earth surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. Surface shall be free from standing water, mud and debris at the time of placing concrete.

B. Construct forms to the shape, lines and dimensions of members shown on Drawings and sufficiently tight to prevent leakage of mortar. Take special care when forming concrete containing high range water reducing agents. Brace and tie forms to maintain position and shape.

1. Before placing concrete containing superplastisizing agents, Contractor shall submit a Pour Plan to Engineer for approval. The Engineer may require additional manpower or equipment for these pours as required to limit defects in the concrete. The Pour Plan shall include the following:
   a. Number of crew members and assignment of each.
   b. Number of vibrators to be used.
   c. Number of vibrators in reserve.
   d. Time of day and anticipated duration of pour.
   e. Type and capacity of pumping equipment if used.

C. Provide slabs and beams of minimum indicated depth when sloping foundation base slabs or elevated floor slabs to drains.

1. For slabs on grade, slope top of subgrade to provide floor slabs of minimum uniform indicated depth.
2. Do not place floor drains through beams.

D. Unless otherwise indicated, provide exterior corners in concrete members with 3/4-inch chamfers. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

E. Complete all formwork, installation of parts to be embedded, reinforcement and surface preparation prior to placing concrete.

1. Use setting diagrams, templates, and instructions for locating and setting embedments and attachments.
2. Prior to placing concrete, position and support pipe, conduit, dowels and other ferrous items required to be embedded, to ensure a 2-inch minimum clearance between items and any part of concrete reinforcement.
3. Securing such items in position by wiring or welding to reinforcement is prohibited.
4. Electrical conduits and piping:
   a. Install between layers of reinforcement steel in walls and slabs with steel in both faces.
   b. Install under reinforcement steel in slabs with only one layer of steel.

F. Provide openings in formwork to accommodate other trades. Accurately place and securely support all items built into forms.

G. Waterstops:
   1. Preparation
      a. Uncoil waterstop minimum of 24 hours prior to installation for ease of handling and fabrication.
      b. Position waterstop to ensure proper distance from steel reinforcing bars and to prevent rock pockets and honeycomb.
      c. Clean concrete joint and waterstop after first pour to remove debris and dirt.
   2. Installation
      a. Position waterstop across joints as specified herein and as indicated on Drawings.
      b. Center waterstops on joint unless shown otherwise.
      c. When centerbulb is present at moving joints, ensure that it is not embedded.
      d. All waterstops fully continuous for the extent of the joint.
      e. Secure plastic serrated waterstop in correct position before concrete placement with hog rings and wire to adjacent reinforcing steel at 12-inch maximum spacing. Center-to-center spacing may be increased upon written request and approval of Engineer.
      f. Take suitable precautions and means to support and protect waterstops during the progress of the work.
      g. Carefully place concrete without displacing waterstop from proper position.

H. Construction, Expansion, and Contraction Joints:
   1. Provide at locations indicated or as approved by Engineer.
   2. Install construction joints in beams, slabs, and girders perpendicular to the planes of their surfaces.
   3. At least 48 hours shall elapse between placing of adjoining concrete construction.
   4. Before new concrete is placed against existing concrete, coat all construction joints with an approved bonding adhesive used and applied in accordance with manufacturer's instructions.

I. Thoroughly clean surfaces of metalwork to be in contact with concrete immediately before concrete is placed.

J. Remove ponded water from the excavation and moisten fill.

K. Remove laitance, tighten forms, roughen, clean, wet and slush hardened concrete with cement grout prior to placing fresh concrete at construction joints. Coat form surfaces with form release agents prior to placing reinforcing bars in forms.

3.2 CYLINDER STORAGE DEVICE

A. Provide and maintain a cylinder storage device at a protected location on the Site, acceptable to Engineer and as follows:
   1. Maintain concrete test cylinders at a temperature range of 60 degrees F to 80 degrees F for the initial 24-hour curing period.
   2. Once placed in the storage device, do not move the cylinders during this period.

3. Equip the storage device with an automatic 24-hour temperature recorder that continuously records on a time/temperature chart with an accuracy of ±1 degree F.
4. Have the storage device available at the point of use at least 24 hours before concrete placement.
5. A 24-hour test run may be required before placement of concrete.

B. Engineer may stop placement of concrete if the storage device cannot accommodate the required number of test cylinders.

C. Use water containing hydrated lime if water is to be in contact with cylinders.

3.3 PLACING OF CONCRETE

A. Notify Engineer not less than 24 hours in advance of the times and places at which Contractor intends to place concrete.

B. Place concrete in compliance with ACI Specifications and requirements of this Section.

C. Place concrete only in presence of duly authorized representative of Engineer.

D. Ready Mix Equipment:
1. Do not exceed manufacturer's rated capacity of the mixer.
2. Ensure sufficient mixing time for uniform distribution of materials.
3. Discharge all concrete from mixer prior to mixing new batch.
4. In accordance with ASTM C94.

E. Transporting:
1. Transport concrete from mixer to place of deposit by methods, which prevent segregation or loss of material.
2. Provide runways when wheelbarrows are used to transport concrete.
3. Do not wheel conveying equipment over reinforcement or support runways on reinforcement.

F. Placing:
1. Deposit concrete in continuous manner and as rapidly as possible within planned joints or sections.
2. Do not use concrete that has attained initial set or contained mixing water for more than 1 hour.
3. Uniformly distribute concrete during process of depositing and in no case move deposited concrete in forms more than 6 feet in horizontal direction.
4. Do not drop freely more than 5 feet in unexposed work or more than 3 feet in exposed work; where greater drops are required, use duct or other approved method.
5. Do not place concrete against icy or frost covered earth surfaces.

G. Compacting:
1. Compact by internal type vibrators supplemented by rodding and tamping as necessary, to maximum practicable density, free from pockets of coarse aggregate in such a manner that surfaces are smooth and free from voids.
2. Avoid excessive vibration of concrete; avoid segregation of aggregates.

3. Avoid disturbance of previous lifts where initial set has taken place.
4. Use of form vibrators or tapping of forms is prohibited.

H. Protection:
1. Protect all concrete against physical injury until final acceptance by Owner.
2. Protect concrete from reduced strength due to weather extremes.
3. When the temperature is below 40 Degrees F, or is likely to fall below 40 Degrees F during the 24-hour period after placing the concrete, follow the recommendations of ACI 306R, except as modified herein.
   a. Do not place concrete on frozen ground or in contact with forms or reinforcing bars coated with frost, ice, or snow.

Outdoor Temperature at Placement (In shade)	Concrete Temperature (At mixing)
Below 30 Degrees F	65 Degrees F
Between 30 and 45 Degrees F	60 Degrees F
Above 45 Degrees F	50 Degrees F

   b. Minimum concrete temperature at the time of mixing:
   c. Do not place heated concrete that is warmer than 80 Degrees F.
   d. If freezing temperatures are expected during curing, maintain the concrete temperature at or above 50 Degrees F for 72 hours, with additional requirements listed under Article 3.3 - Curing below.
   e. Do not allow concrete to cool suddenly.
   f. Calcium chloride will not be permitted as a concrete accelerator or to thaw frozen subgrade prior to concrete placement.
4. When the temperature is 90 Degrees F or above, or is likely to rise above 90 Degrees F within the 24-hour period after concrete placement; or when there is any combination of high air temperature, low relative humidity, and wind velocity which would impair concrete strength or quality, follow the recommendations of ACI 305R and the following:
   a. Keep concrete as cool as possible during placement and curing.
   b. Do not allow concrete temperature to exceed 90 Degrees F at placement.
   c. Prevent plastic shrinkage cracking due to rapid evaporation of moisture.
   d. Dampen subgrade and forms with cool water immediately prior to placement of concrete.
   e. Apply an evaporation retardant per manufacturer's instructions between placement and finishing operations.
   f. Protect the concrete with temporary wet covering during any appreciable delay between placement and finishing.
   g. Take appropriate precautions per ACI 305R when the actual or anticipated evaporation rate equals or exceeds 0.2 LBS/SF/HR as determined from ACI 305R.

3.4 CURING

A. Cure concrete for not less than 14 days after placing.

B. Leave forms in place at least 14 days, or until concrete has attained specified 28-day strength, unless otherwise approved by Engineer. If forms are allowed to be removed within 14 days of placing concrete, continue curing in accordance with other methods specified herein or as directed by Engineer.

C. Strictly follow careful procedures for the removal of forms and perform with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted.

D. Keep encasement concrete, concrete cradles and anchor blocks moist until covered. The surface shall be covered with moist earth not less than 4 hours, or more than 24 hours, after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 days after placement of concrete.

E. Concrete slabs may be cured by either of the following two methods:
   1. Method 1:
      a. After finishing slab, wet surface with a fine spray of water and cover with polyethylene-bonded waterproof paper sheeting.
      b. Lap sheets 4 inches at sides and ends and seal with adhesive tape to form a continuous watertight joint.
      c. Weigh sheeting down with wood planks to keep sheeting in contact with concrete.
      d. Repair or replace sheets immediately if damage occurs.
   2. Method 2:
      a. Cover concrete with water-saturated polyethylene-coated burlap curing mats and keep continuously wet for curing period.
      b. Lap sheets 4 inches at sides and ends and seal with adhesive tape to form a continuous watertight joint.
      c. Weigh sheeting down with wood planks to keep sheeting in contact with concrete.
      d. Repair or replace sheets immediately if damage occurs.

F. As an alternate to above referenced curing methods for formed and slab concrete, spray surface with liquid curing compound that does not affect bond of paint to concrete surface.
   1. Apply curing compound in accordance with manufacturer's instructions as soon as the concrete has hardened enough to prevent marring on unformed surfaces, and within 2 hours after completion of finish or stripping of forms, if stripped in less than 14 days.
      a. Maximum coverage rate of 200 square feet per gallon, applied in such a manner as to cover surface with a uniform film to seal thoroughly.
   2. Curing vertical surfaces with a curing compound:
      a. Cover vertical surfaces with a minimum of two coats of the curing compound.
      b. Apply the first coat of curing compound immediately after form removal. Vertical surface at the time of receiving the first coat shall be damp with no free water on the surface.
      c. Allow the preceding coat to completely dry prior to applying the next coat.
      d. Vertical surface is defined as any surface steeper than 1 vertical to 4 horizontal.
   3. Curing Compound: As specified herein.
   4. Take care to avoid damage to seal during curing period.

5. Repair broken or damaged seals occurring before expiration of curing period by application of additional curing compound over damaged portion.
6. Do not use curing film method where construction joints are to be made.
7. In hot weather, follow curing procedures outlined in ACI 305R and the following:
    a. Begin curing unformed surfaces immediately after finishing and continue for 24 hours. Curing shall consist of application and maintenance of water saturated material to all exposed surfaces; horizontal, vertical, and otherwise. After 24-hour interval, continue curing, using one of the following methods:
        1) Moist cure for six more days.
        2) Application of curing compound as specified above.
    b. Begin curing formed concrete immediately after placing. Curing shall consist of keeping forms continuously wet for 24 hours. Thereafter, continue curing, using one of the following methods:
        1) Loosen forms and position soaker hose so that water runs down along concrete surfaces. Continue for six more days.
        2) Strip forms and apply during compound as specified for vertical surfaces above. Do not allow concrete surfaces to dry prior to application of curing compound.
8. In Cold Weather, following curing procedures outlined in ACI 306R and the following:
    a. Water curing of concrete may be reduced to 6 days during periods when the mean daily temperature in the vicinity of the worksite is less than 40 degrees F; provided that, during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing shall be temporarily discontinued.
    b. Concrete cured by an application of curing compound will require no additional protection from freezing if the protection at 50 Degrees F for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces; otherwise the concrete shall be protected against freezing temperatures for 72 hours immediately following 72 hours protection at 50 Degrees F. Concrete cured by water curing shall be protected against freezing temperatures for 72 hours immediately following the 72 hours of protection at 50 Degrees F.
    c. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40 Degrees F in 24 hours. In the spring, when the mean daily temperature rises above 40 Degrees F for more than 3 successive days, the specified 72-hour protection at a temperature not lower than 50 degrees F may be discontinued for as long as the mean daily temperature remains above 40 Degrees F; provided, that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.
    d. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. Use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound; provided, that the use of curing compound for such surfaces is otherwise permitted by these Specifications.

3.5 TREATMENT OF SURFACE DEFECTS

A. As soon as forms are removed, all exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the Engineer. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall have them repaired as specified herein. Concrete containing extensive voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced. All repairs and replacements herein specified shall be promptly executed by the Contractor at its own expense.

B. All repairs shall be performed in accordance with the manufacturer's recommendations and with ICRI Guideline No 310.1R and Guideline No 320.2R. These guidelines shall be followed for removal geometry, exposing and undercutting of reinforcing steel, cleaning and repair of reinforcing steel, and edge and surface condition of concrete and shall be followed regardless of the amount of corrosion present or not present in the reinforcing steel.

1. Remove unsound deteriorated concrete from Work by high pressure water blasting machines capable of scoring concrete surfaces to minimum amplitude roughness of 3/16-inch. Remove to provide for minimum thickness specified for mortar. If reinforcing is exposed in this process, then additional concrete shall be removed until the surface is a minimum of 1-inch or 1 bar diameter behind the exposed reinforcing.
2. Clean exposed reinforcing bars of rust and other deleterious materials which may prevent bonding of the repair product.
3. Keep surface at saturated surface dry (SSD) condition for a minimum of 24-hours prior to placement of repair material.
4. Place and cure repair grout as specified in Section 03 60 00 – Grouting and in accordance with manufacturer's written recommendations.
5. For exposed walls, the cement shall contain such a proportion of white Portland cement as is required to make the color of the patch match the color of the surrounding concrete.

C. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. These holes then shall be repaired in an approved manner with dry-packed cement grout specified in Section 03 60 00 - Grouting. Holes left by form-tying devices having a rectangular cross-section, and other imperfections having a depth greater than their least surface dimension, shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout specified in Section 03 60 00 - Grouting.

D. All repairs shall be built up and shaped in such a manner that the completed Work will conform to the requirements of this Section, as applicable, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of said repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

E. Prior to filling any structure with water, all cracks that may have developed shall be "vee'd" as shown on the Drawings and filled with sealant conforming to the requirements of Section 07 92 00 – Joint Sealants. This repair method shall be done on the water bearing face

of members. Prior to backfilling, faces of members in contact with fill, which are not covered with a waterproofing membrane, shall also have cracks repaired as specified herein.

3.6 PATCHING HOLES IN CONCRETE

A. Patching Small Holes
1. Holes which are less than 12 inches in their least dimension and extend completely through concrete members, shall be filled as specified herein.
2. Small holes in members which are water-bearing or in contact with soil or other fill material, shall be filled with nonshrink grout specified in Section 03 60 00 - Grouting. Where a face of the member is exposed to view, the nonshrink grout shall be held back 2 inches from the finished surface. The remaining 2 inches shall then be patched according to the paragraph in Part 3 entitled "Treatment of Surface Defects."
3. Small holes through all other concrete members shall be filled with nonshrink grout, with exposed faces treated as above.

B. Patching Large Holes
1. Holes which are larger than 12 inches in their least dimension, shall have a keyway chipped into the edge of the opening all around, unless a formed keyway exists. The holes shall then be filled with concrete as specified herein.
2. Holes which are larger than 24 inches in their least dimension and which do not have reinforcing steel extending from the existing concrete, shall have reinforcing steel set in drilled holes and epoxy grout as specified in Section 03 60 00 – Grouting. The reinforcing added shall match the reinforcing in the existing wall unless shown.
3. Large holes in members which are water bearing or in contact with soil or other fill, shall have either a hydrophilic type or a plastic adhesive type waterstop material placed around the perimeter of the hole as specified herein, unless there is an existing waterstop in place.

3.7 CONCRETE FINISH

A. General: Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions shown are defined as tolerances and are specified herein. These tolerances are to be distinguished from irregularities in finish as described herein.

B. Aluminum finishing tools shall not be used.

C. Formed Surfaces:
1. Exterior buried surfaces require no treatment after form removal except for curing, repair of defective concrete, and treatment of surface defects.
2. Surfaces exposed to view shall be finished as specified under "Architectural Concrete Finish" below.

D. Surface holes larger than 1/2 inch in diameter or deeper than 1/4-inch are defined as surface defects in basins and exposed walls.

E. Unformed Surfaces: After proper and adequate vibration and tamping, all unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. Immediately after the concrete has been screeded, it shall be treated with a liquid evaporation retardant. The retardant shall be used again after each Work operation as necessary to prevent drying shrinkage cracks. The classes of finish specified for unformed concrete surfaces are designated and defined as follows:

1. Finish U1 – Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8 inch. No further special finish is required.
2. Finish U2 After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 1/4-inch. Joints and edges shall be tooled where shown or as determined by the Engineer.
3. Finish U3 After the floated surface (as specified for Finish U2) has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of all irregularities.
4. Finish U4 Steel trowel finish (as specified for Finish U3) without local depressions or high points. In addition, the surface shall be given a light broom finish with broom lines perpendicular to drainage unless otherwise shown. The resulting surface shall be rough enough to provide a nonskid finish.

F. Floor Hardener:

1. Apply to all exposed concrete floor surfaces.
2. Apply after concrete has cured minimum 7 days.
3. Apply in accordance with manufacturer's recommendations.
4. Keep floors covered and free of traffic and loads for a minimum of 10 days after completion.

3.8 ARCHITECTURAL CONCRETE FINISH

A. General: Architectural finish shall be required for permanently exposed concrete surfaces and in other locations where specifically called out on the Drawings.

1. Immediately after the forms have been stripped, the concrete surface shall be inspected and any poor joints, voids, rock pockets, or other defective areas shall be repaired and all form-tie holes filled as indicated herein.
2. Architectural finishes shall not be applied until the concrete surface has been repaired as required and the concrete has cured at least 14 days.
3. All architecturally treated concrete surfaces shall conform to the accepted sample required herein in texture, color, and quality. It shall be the Contractor's responsibility to maintain and protect the concrete finish.

B. Smooth Concrete Finish

1. The concrete surface shall be wetted, and a grout shall be applied with a brush. The grout shall be made by mixing one part Portland cement and one part of fine sand that will pass a No. 16 sieve with sufficient water to give it the consistency of thick paint.

The cement used in said grout shall be 1/2 gray and 1/2 white Portland cement, as determined by the Engineer. The freshly applied grout shall be vigorously rubbed into the concrete surface with a wood float filling all small air holes. After all the surface grout had been removed with a steel trowel, the surface shall be allowed to dry and, when dry, shall be vigorously rubbed with burlap to remove completely all surface grout so that there is no visible paint-like film of grout on the concrete. The entire cleaning operation for any area shall be completed the day it is started, and no grout shall be left on the surface overnight.

2. Cleaning operations for any given day shall be terminated at panel joints. It is essential that the various operations be carefully timed to secure the desired effect which is a light-colored concrete surface of uniform color and texture without any appearance of a paint or grout film.
3. In the event that improper manipulation results in an inferior finish, rub such inferior areas with carborundum bricks.
4. Before beginning any of the final treatment on exposed surfaces, treat in a satisfactory manner a trial area of at least 200 square feet in some inconspicuous place selected by the Engineer and shall preserve said trial area undisturbed until the completion of the job.

3.9 WATERPROOFING

A. Apply waterproofing to exterior surface of all buried roof slabs and walls of underground concrete structures.

B. Refer to Section 07 14 00 – Fluid-Applied Waterproofing.

3.10 TOLERANCES:

A. Construction Tolerances: Set and maintain concrete forms and perform finishing operations so as to ensure that the completed Work is within the tolerances specified herein. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the specified permissible variation from lines, grades, or dimensions shown. Where tolerances are not stated in the Specifications, permissible deviations will be in accordance with ACI 117.

1. The following non-cumulative construction tolerances are hereby established and apply to finished walls and slab unless otherwise shown:

Item	Tolerance
Variation of the constructed linear outline from the established position in plan.	In 10 feet: 1/4 inch In 20 feet or more: 1/2 inch
Variation from the level or from the grades shown.	In 10 feet: 1/4 inch In 20 feet or more: 1/2 inch
Variation from plumb.	In 10 feet: 1/4 inch In 20 feet or more: 1/2 inch
Variation in the thickness of slabs and walls.	Minus 1/4 inch Plus 1/2 inch
Variation in the locations and sizes of slabs and wall openings.	Plus or minus 1/4 inch

3.11 FIELD QUALITY CONTROL

A. General
   1. Tests on component materials and for slump, temperature, air content, compressive strength and shrinkage of concrete will be performed as specified herein.
   2. The cost of all laboratory tests for qualification of mix designs on cement, aggregates, and concrete, including strength and shrinkage testing will be borne by Contractor. The cost of all field testing during construction, including slump, temperature, air, strength and shrinkage will also be borne by Owner. However, Contractor will be charged for the cost of any additional tests and investigation on work performed which does not meet the Specifications.
   3. Provide access for Engineer to aggregate stockpiles for concurrent sampling during construction.
   4. Provide access for Engineer to batch plant for monitoring batching procedures during construction.
   5. Concrete for testing shall be supplied by Contractor at no additional cost to Owner, and Contractor shall provide assistance to Engineer in obtaining samples, and disposal and cleanup of excess material.
   6. Composite samples of concrete placed in the Work shall be taken in accordance with ASTM C172 from the first placement of each class of concrete and at the following minimum frequency for each class:
      a. Not less than one sample per day on which concrete it placed.
      b. Not less than one sample for each 100 cubic yards of concrete placed.
      c. Not less than one sample for each 5,000 square feet of surface area for slabs or walls.
      d. Not less than 5 samples from randomly selected batches for the Work.

B. Slump Tests
   1. Perform in accordance with requirements of ASTM C143 at frequency indicated for sampling above.

C. Temperature Tests
   1. Test concrete temperature per ASTM C1064 at frequency indicated for sampling above.

D. Air Content Tests
   1. Test air content per ASTM C231 at frequency indicated for sampling above.

E. Shrinkage Tests
   1. Drying shrinkage tests will be made for the first placement of each class of structural concrete, and during construction every 3 months to insure continued compliance with these Specifications. A minimum of 1 test per structure shall be made regardless of the timing.
   2. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gage length of 10 inches, fabricated, cured, dried and measured in accordance with ASTM C157.
   3. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage test value by more than 25 percent.

a. If the required shrinkage limitation is not met during construction, take any or all of the following actions, at no additional cost to the Owner, for securing the specified shrinkage requirements. These actions may include changing the source or aggregates, cement and/or admixtures; reducing water content; washing of aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

F. Field Compression Tests
1. Field compression test specimens will be made at the frequency indicated for sampling above.
2. Each set of test specimens will be a minimum of five cylinders.
3. Compression test specimens for concrete shall be made in accordance with ASTM C31. Specimens shall be 6-inch diameter by 12-inch high cylinders.
4. Compression tests shall be performed in accordance with ASTM C 39. One test cylinder will be tested at 7 days and two at 28 days. The remaining cylinders will be held to verify test results, if needed.

G. Evaluation and Acceptance of Concrete
1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 350 and as specified herein.
2. A statistical analysis of compression test results will be performed according to the requirements of ACI 214. The standard deviation of the test results shall not exceed 640 psi, when ordered at equivalent water content as estimated by slump.
3. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for all subsequent batches of the type of concrete affected.
4. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 psi below or the average of any three consecutive tests being below the specified compressive strength is 1 in 100. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard of deviation.
5. All concrete which fails to meet the ACI requirements and these Specifications, is subject to removal and replacement at no increase in cost to the Owner.

3.12 APPLICATION OF LOADS

A. Do not allow traffic, construction equipment, or materials of any kind to be placed on elevated concrete slabs until the concrete has attained a minimum age of 7 days and 80% of the minimum specified 28-day strength as proven by concrete strength tests.

B. Do not place backfill against cantilevered walls until the concrete has attained a minimum age of 7 days and 100% of the minimum specified 28-day concrete strength as proven by concrete strength tests.

C. Do not place backfill against walls that are tied to elevated slabs or decks until the both the slabs and walls have attained a minimum age of 7 days and 80% of the minimum specified 28-day strength as proven by concrete strength tests.

3.13 SCHEDULES

A. Grout: As specified in Section 03 60 00 – Grouting.

B. Unformed Concrete Surfaces: Apply finish as follows.

Area	Finish
Grade slabs and foundations to be covered with concrete or fill material	U1
Floors to be covered with grouted tile or topping grout	U2
Slabs not water bearing	U4
Slabs to be covered with built-up roofing	U2
Interior slabs and finished floors, without architectural finishes	U4
Interior slabs and finished floors with architectural finishes	U3
Top surface of walls	U3

END OF SECTION

SECTION 03 60 00
GROUTING

PART 1 - GENERAL

1.1 SUMMARY

A. Work includes various types of cementitious grout to be provided and installed per the Contract Documents

B. Section includes the following types of grout:
1. Cement grout.
2. Nonshrink grout.
3. Epoxy grout.
4. Grout for repair of concrete.
5. Pump and motor grout.
6. Concrete topping gout and concrete fill.

1.2 REFERENCES

A. American Concrete Institute (ACI) standards, most recent editions:

ACI 318	Building Code Requirements for Reinforced Concrete
ACI 308	Standard Practice for Curing Concrete

B. American Society for Testing and Materials (ASTM) standards, most recent editions:

ASTM C78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C94	Standard Specifications for Ready-Mixed Concrete
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
ASTM C307	Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
ASTM C348	Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars
ASTM C469	Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
ASTM C531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.

ASTM C579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
ASTM C827	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear
ASTM C884	Standard Test Method for Thermal Compatibility Between Concrete and an Epoxy-Resin Overlay
ASTM C939	Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C1090	Standard Test Method for Measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout
ASTM C1107	Packaged Dry, Hydraulic Cement Grout (Nonshrink)
ASTM C1181	Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts
ASTM C1202	Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C1339	Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D696	Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C With a Vitreous Silica Dilatometer
ASTM E329	Standard Specification for Agencies Engaged in Construction Inspection and/or Testing

C. International Concrete Repair Institute (ICRI) standards, latest editions:

Guideline No 310.1R	Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
Guideline No 320.2R	Guide for selecting and specifying Materials for repair of Concrete Surfaces

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Product Data:
   1. Submit certified test results verifying the compressive strength, shrinkage, and expansion requirements indicated herein.
   2. Submit manufacturer's literature containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of nonshrink and epoxy grout used in the Work.

C. Certification:
   1. Provide manufacturer's independent certification of compliance with ASTM C1107 without modification to the standard methods certifying that the Class B or C grout's post-hardening non-shrink properties are not based on gas expansion.
   2. Provide Manufacturer's certification that grouts have strengths of 3500 psi at 1 day, 6500 psi at 3 days and 7500 psi at 28 days when cured at 72 degrees F as well as meeting the 3, 7, and 28-day strengths when tested and cured at the 45 degree F and 95 degree F limits and all other requirements of ASTM C1107.
   3. The Contractor shall engage an independent testing laboratory to run a 24-hour grout evaluation in accordance with ASTM C1107 of each grout submitted for approval showing compliance with all aspects of the evaluation. Submit results to the Engineer for review.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Maintain all materials clean, dry and protected against dampness, freezing and foreign matter.
   1. Store non-shrink grout materials in temperature controlled environments above 40 degrees F and below 90 degrees F.
   2. Store epoxy grout components in temperature controlled environments above 60 degrees F and below 90 degrees F.

C. Deliver epoxy resin, hardener, and aggregate in sealed pre-measured containers, palletized and shrink-wrapped to prevent shipping damage.

D. Immediately remove from the Project site any cement-based grout material which becomes damp or otherwise defective.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Nonshrink, nonmetallic grout:
      a. 5 Star Grout, Five Star Products, Inc.

b. Masterflow 928, BASF Building Systems, Inc.
c. NS Grout, Euclid Chemical Company.
d. Sika Grout 212, Sika Corporation.
e. Engineer approved equal.

2. Epoxy grout:
a. HP Epoxy Grout, Five Star Products, Inc.
b. Masterflow 648 CP Plus, BASF Building Systems, Inc.
c. E^3-Flowable, Euclid Chemical Company.
d. Sikadur 42 Grout-Pak, Sika Corporation.
e. Engineer approved equal.

3. Grout for pumps and motors:
a. Escoweld, ITW Polymer Technologies.
b. Chockfast Red, ITW Polymer Technologies.
c. DP Epoxy Grout, Five Star Products, Inc.
d. Engineer approved equal.

2.2 CEMENT GROUT

A. Cement grout shall be composed of one-part cement, three parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white Portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 days shall be 4,500 psi.

B. Cement grout materials shall be as specified in Section 03300 – Cast-in-Place Concrete.

2.3 NONSHRINK GROUT

A. Non-shrink grout shall be a prepackaged, inorganic, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water.

B. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.

C. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout herein shall be that recommended by the manufacturer for the particular application. All grouts (Grade B or C) shall be tested for height change of the hardened grout at 1, 3, 14, and 28 days in accordance with ASTM C1090 and shall be tested for compression at 1, 3, 7, and 28 days in accordance with the modified ASTM C109 testing procedure.

D. Class A non-shrink grouts: Not used.

E. Class B or C high precision, fluid, extended working time, non-shrink grouts:
1. Minimum 28-day compressive strength of 7500 PSI.
2. No shrinkage (0.0 percent) and a maximum of 4.0 percent expansion in the plastic state when tested in accordance with ASTM C827.
3. No shrinkage (0.0 percent) and a maximum of 0.2 percent expansion in the hardened state
4. When mixed to a fluid consistency of 20 to 30 seconds per ASTM C939 at temperature extremes of 45 to 90 degrees F shall have an extended working time of 30 minutes when tested in accordance with ASTM C1107.

F. Application:

1. Class B or C non-shrink grout shall be used for grouting under all base plates for structural steel members, grouting under all equipment base plates except for pumps and motors, and at all locations where grout is required by the Contract Documents except where epoxy grout or grout for pumps and motors is specifically required. Class B or C non-shrink grout shall be used in place of Class A non-shrink grout for all applications. Class B or C non-shrink grout shall not be used for dry packing applications or repair of concrete.

2.4 EPOXY GROUT

A. Epoxy grout shall be a pourable, nonshrink, 100 percent solids system. The epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all premeasured and prepackaged. The resin component shall not contain any nonreactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application.

B. The mixed epoxy grout system shall have a minimum working life of 45 minutes at 75 degrees F.

C. The epoxy grout shall develop a compressive strength of 5,000 psi in 24 hours and 10,000 psi in 7 days when tested in accordance with ASTM C579, Method B. There shall be no shrinkage (0.0 percent) and a maximum 4.0 percent expansion when tested in accordance with ASTM C827.

D. The epoxy grout shall exhibit a minimum effective bearing area of 95 percent. This shall be determined by testing in accordance with ASTM C1339, for bearing area and flow.

E. The peak exotherm of a 2-inch diameter by 4-inch high cylinder shall not exceed 95 degrees F when tested with 75 degree F material at laboratory temperature. The epoxy grout shall exhibit a maximum thermal coefficient of 30 x 10-6 inches/inch/degree F when tested according to ASTM C531 or ASTM D696.

F. Application:

1. Epoxy grout shall be used to embed all anchor bolts and reinforcing steel required to be set in grout and for all other applications in the Contract Documents where grout type is not specifically indicated.

2.5 GROUT FOR REPAIR OF CONCRETE

A. Vertical, overhead, and shotcrete applications:

1. Shall not produce a vapor barrier.
2. One component, reoplastic, cement based, shrinkage compensated, non-expansive, gray concrete product.
3. Sprayable, extremely low permeability, sulfate resistant, easy to use and requiring only the addition of water.

4. Free of chlorides and other chemicals causing corrosion with the following properties:
    a. Minimum Slant Shear Bond Strength: 2500 PSI at 28 days when tested in accordance with ASTM C882.
    b. Minimum Compressive strength: 6,500 PSI at 28 days when tested in accordance with ASTM C109.
    c. Minimum Tensile Bond Strength: 200 PSI at 28 days per ASTM C307.
    d. Minimum Flexural Strength: 1,200 PSI when tested in accordance with ASTM C348.
    e. Modulus of Elasticity: 3.6E6 PSI when tested in accordance with ASTM C469.
    f. Maximum Rapid Chloride Permeability: 772 coulombs when tested in accordance with ASTM C1202.

B. Horizontal and formed applications:
1. Shall not produce a vapor barrier.
2. One component, reoplastic, cement-based, shrinkage compensated, non-expansive, gray concrete product.
3. Flowable, extremely low permeability, sulfate resistant, easy to use and requiring only the addition of water.
4. Free of chlorides and other chemicals causing corrosion with the following properties:
    a. Minimum Shear Bond Strength: 2150 PSI at 7 days.
    b. Minimum Compressive Strength: 6000 PSI at 7 days when tested in accordance with ASTM C109.
    c. Minimum Flexural Strength: 770 PSI at 28 days when tested in accordance with ASTM C78.
    d. Maximum Chloride Permeability: 1,000 coulombs when tested in accordance with ASTM C1202.
    e. Modulus of Elasticity: 4.8E6 PSI when tested in accordance with ASTM C469.

2.6 GROUT FOR PUMPS AND MOTORS

A. Grout for pumps and motors shall be epoxy grouts meeting the following minimum requirements:
1. Creep shall be less than 0.005 in/in when tested by ASTM C1181 method. The test shall be at 70 degrees F and 140 degrees F with a load of 400 PSI.
2. Linear shrinkage shall be less than 0.080 percent and thermal expansion less than 17E-6 in/in/degree F when tested by ASTM C531.
3. The compressive strength shall be a minimum of 12,000 PSI in 7 days when tested by ASTM C579 Method B, modified.
4. Bond strength of grout to Portland cement concrete shall be greater than 2,000 PSI when using ASTM C882 test method.
5. Grout shall pass the thermal compatibility test when overlaid on Portland cement concrete using test method ASTM C884.
6. Tensile strength and modulus of elasticity shall be determined by ASTM D638. The tensile strength shall not be less than 1,700 PSI and the modulus of elasticity shall not be less than 1.8E6 PSI.
7. Peak exothermic temperature shall not exceed 110 degrees F when a specimen 6 inches in diameter by 12 inches high is used. Gel time shall be at least 150 minutes.

8. The grout shall be suitable for supporting precision machinery subject to high impact and shock loading in industrial environments while exposed to elevated temperatures as high as 150 degrees F, with a load of 2,000 PSI.

B. Primer, if required, shall conform to the written recommendations of the grout manufacturer.

C. Surface preparations shall conform to the written recommendations of the grout manufacturer.

D. Placement and Curing
1. Placement and curing procedures shall be in accordance with the written recommendations of the grout manufacturer.
2. A grouting performance demonstration/training session shall be conducted by the grout manufacturer's representative prior to foundation and baseplate preparation and the first grouting on site. This training session shall demonstrate proper preparation and installation methods and that the grouting material meets the strength requirements.

2.7 CONCRETE TOPPING GROUT AND CONCRETE FILL

A. Grout for topping of slabs and concrete fill for built up surfaces of tank, channel, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures as necessary, with strength as specified above.

B. Where concrete topping is deeper than 6 inches, it will be considered "Concrete Fill" and may be placed using either grout as specified herein or "lean concrete", as specified in Section 03300 – Cast-In-Place Concrete, when approved by Engineer.

2.8 CURING MATERIALS

A. Curing materials shall be as specified in Section 03300 – Cast-In-Place Concrete for cement grout and as recommended by the grout manufacturer for prepackaged grouts.

2.9 CONSISTENCY

A. Use grouts with the consistency necessary to completely fill space to be grouted for the particular application. Where "dry pack" is called for in the Contract Documents, use grout with a consistency such that the grout is plastic and moldable but will not flow.

B. Regardless of consistency called for on the Contract Documents, the type of grout to be used shall be as indicated herein for the particular application.

2.10 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement will not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the grout manufacturer.

PART 3 - EXECUTION

3.1 PERPARATION

A. All surface preparation, curing, and protection of cement grout shall be as indicated in Section 03300 – Cast-In-Place Concrete. The finish of the grout surface shall match that of the adjacent concrete.

B. Do not place grout on concrete or masonry substrates until those substrate materials have attained 28-day design strength unless authorized by Engineer.

3.2 MANUFACTURER'S SERVICES

A. The manufacturer of nonshrink grout and epoxy grout shall provide onsite technical assistance upon request.

B. Coordinate with the manufacturer all demonstrations, training sessions, and applicable site visits. The grout manufacturer shall conduct onsite, demonstration and training sessions for bleed tests, mixing, flow cone measurements, cube testing, application, and curing for each category and type of grout.

C. Training by the manufacturer is required for all types of grout installations. Grout manufacturer's representative shall train Contractor to perform the grout Work including mixing of grouts to required consistency, testing, placing, and curing on actual project base plates, tie holes, rock pockets, and other applications.

3.3 GROUTING PROCEDURES

A. Prepackage Grouts: All mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

B. Base Plate Grouting:
   1. For base plates, the original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a 1 inch thickness of grout or a thickness as indicated on the Contract Drawings.
   2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout. The mixture shall be of a trowelable consistency and tamped or rodded solidly into the space between the plate and the base concrete. A backing board or stop shall be provided at the back side of the space to be filled with grout. Where this method of placement is not practical or where required by Engineer, alternate grouting methods shall be submitted for acceptance by Engineer.

C. Concrete Topping Grout:
   1. All mechanical, electrical, and finish Work shall be completed prior to placement of concrete topping or concrete fill. The base slab shall be given a roughened textured surface by sandblasting or hydroblasting exposing the aggregates to ensure bonding to the base slab.

2. The minimum thickness of grout topping and concrete fill shall be one inch. Where the finished surface of concrete fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 6-inches wide by 1-1/2 inches deep.
3. The base slab shall be thoroughly cleaned and wetted prior to placing topping and fill. No topping concrete shall be placed until the slab is complete free from standing pools or ponds of water. A thin coat of neat Type II cement grout shall be broomed into the surface of the slab just before topping of fill placement. The topping and fill shall be compacted by rolling or tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade.
4. Concrete topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.
5. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping and fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement or mixture of dry cement and sand shall be applied to the surface.

D. Grout for Repair of Concrete
1. All repairs shall be performed in accordance with the manufacturer's recommendations and with ICRI Guideline No 310.1R and Guideline No 320.2R. These guidelines shall be followed for removal geometry, exposing and undercutting of reinforcing steel, cleaning and repair of reinforcing steel, and edge and surface condition of concrete and shall be followed regardless of the amount of corrosion present or not present in the reinforcing steel.
2. Remove unsound deteriorated concrete from Work by high pressure water blasting machines capable of scoring concrete surfaces to minimum amplitude roughness of 3/16-inch. Remove to provide for minimum thickness specified for mortar. If reinforcing is exposed in this process, then additional concrete shall be removed until the surface is a minimum of 1-inch or 1 bar diameter behind the exposed reinforcing.
3. Clean exposed reinforcing bars of rust and other deleterious materials which may prevent bonding of the repair product.
4. Keep surface at saturated surface dry (SSD) condition for a minimum of 24-hours prior to placement of repair material.
5. Place material in accordance with Manufacturer's written recommendations.
6. Cure material continuously for 7-days with water fog nozzles or other applications which provide a continuous wet curing of the repaired area in accordance with ACI 308.

E. CONSOLIDATION
1. Grout shall be placed in such a manner, for the consistency necessary for each application, so as to assure that the space to be grouted is completely filled.

END OF SECTION

DIVISION 31
EARTHWORK

THIS PAGE INTENTIONALLY BLANK

SECTION 31 10 00
SITE PREPARATION

GENERAL

1.1 SUMMARY

A. The Work of this Section includes all those measures required during the Contractor's initial move onto the site to protect existing fences, structures and associated improvements, streets, and utilities downslope of construction areas from damage due to boulders, trees or other objects dislodged during the construction process: clearing, grubbing and stripping; and regrading of areas to receive embankment fill.

B. The Contractor is required to protect and preserve all things designated to remain. Where Contractor's operation causes damage or injury to trees and plants designated to remain, an arborist or other qualified professional shall be employed by the Contractor, at no additional cost to the Owner, to repair the damage or provide adequate replacement to the Owner's satisfaction where damage is beyond repair.

1.2 SITE INSPECTION

A. Prior to moving onto the Project site, the Contractor shall inspect the site conditions and review maps of the existing plant site and off-site pipeline routes and facilities delineating the Owner's property and right-of-way lines.

B. Contractor shall submit photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site preparation.

C. The Contractor shall identify and accurately locate utilities and other subsurface structural, electrical, and mechanical conditions. Existing conditions shall be incorporated into the record drawings for the project.

1.3 DEFINITIONS

A. The following definitions apply to the Work of this Section:
   1. Clearing is defined as cutting trees, removing fences and posts, removing curbs and other improvements to prepare the site for grubbing and stripping.
   2. Grubbing is defined as the below grade part of clearing to remove roots, small piping, irrigation systems, etc., to prepare the site for stripping.
   3. Stripping is defined as removing a surface layer of soil and organic material, sod, topsoil, and other unsuitable material as defined in Section 31 23 00 – Earthwork, to a depth that earthwork can proceed.

PRODUCTS (NOT USED)

EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Locate and clearly flag trees and vegetation to remain or to be relocated.

D. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TREE PROTECTION

A. Erect and maintain a temporary fence around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete.
   1. Do not store construction materials, debris, or excavated material within drip line of remaining trees.
   2. Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.

B. Do not excavate within drip line of trees, unless otherwise indicated.

C. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
   1. Cover exposed roots with burlap and water regularly.
   2. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
   3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
   4. Cover exposed roots with wet burlap to prevent roots from drying out. Backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Engineer.
   1. Employ a qualified arborist, licensed in jurisdiction where project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
   2. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist.

3.3 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Owner will arrange to shut off indicated utilities when requested by Contractor.
2. Arrange to shut off indicated utilities with utility companies.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
1. Notify Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer's written permission.

C. Excavate for and remove underground utilities indicated to be removed.

3.4 PRIMARY PLANT SITE ACCESS

A. Develop any necessary access to the site, including barrier facilities to be installed at the beginning of construction in order to prohibit entry of unauthorized persons.

B. Utility Interference: Where existing utilities interfere with the Work of this Section, notify the Engineer and work around the interferences until a directive is issued.

3.5 CLEARING, GRUBBING, AND STRIPPING

A. All construction areas shall be cleared of grass and weeds to at least a depth of six inches and cleared of structures, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the Work, create a hazard to safety, or impair the Work's subsequent usefulness or obstruct its operation. Loose boulders within 10 feet of the top of cut lines shall be incorporated in landscaping or removed from the site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction, as directed by the Engineer.

B. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove all stumps, roots, buried logs, and all other objectionable material. Debris or waste shall be totally removed if they are found on the site. All objectionable material from the clearing and grubbing process shall be removed from the site and wasted in approved safe locations in compliance with state and federal regulations.

C. The area to be affected by construction that have not been pre-excavated to the subgrade elevation shall be removed and placed in the designated stockpile areas, and/or incorporated into landscaped areas or other nonstructural embankments.

D. For all areas that have not been previously disturbed, including staging areas and temporary construction easements, topsoil-salvaging operation shall immediately follow clearing operations. The area shall be stripped of topsoil to a depth of 8 inches. Unsuitable materials, specified in Section 31 23 00, shall not be considered topsoil. The Contractor shall strip to the depth indicated regardless of the material encountered. All stripped topsoil shall be stockpiled within stripped areas in stockpiles not to exceed 15 feet in height. Vegetation shall be ground or chipped to a mulching consistency and mixed with the stripped soil. Stockpiles shall be placed away from high construction traffic areas and shall be fenced and signed to prevent accidental use as fill prior to topsoil replacement.

E. Upon completion of Work within the construction areas stripped of topsoil, the stored topsoil shall be respread over the disturbed areas. Topsoil shall be spread in about a 6-inch layer. Respread topsoil shall match the existing terrain as much as possible. Interfaces between restored disturbed areas and undisturbed areas shall be chain dragged to eliminate obvious edges. All tracks and equipment marks shall be chain dragged or hand raked away. Replaced topsoil shall be thoroughly watered for dust control upon completion of the respreading operations. Once topsoil replacement has been completed, no vehicles or other motorized equipment shall be allowed to travel on the finished surface.

F. Unless otherwise indicated, native trees larger than three inches in diameter at the base shall not be removed without the Engineer's approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way, if not necessary for the Contractor's choice of means and methods, shall be arranged with the property owner and be removed and replaced at no increased cost to the Owner.

G. Except in areas to be excavated, holes and other holes resulting from Work of this section shall be backfilled with suitable material in accordance with Section 31 23 00 – Earthwork.

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   1. Unless existing full-depth joints coincides with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

3.7 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 31 23 00
EARTHWORK

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall perform all earthwork indicated and required for construction of the Work, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

29 CFR 1926	OSHA Safety and Health Regulations for Construction
ASTM C150	Portland Cement
ASTM D 422	Method for Particle-Size Analysis of Soils
ASTM D 1556	Test Method for Density of Soil in Place by the Sand-Cone Method
ASTM D 1557	Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3) (2,700 kN-m/m^3)
ASTM D 1633	Test Method for Compressive Strength of Molded Soil-Cement Cylinders
ASTM D 2419	Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D 2487	Classification of Soils for Engineering Purposes
ASTM D 2901	Test Method for Cement Content of Freshly Mixed Soil Cement
ASTM D 2922	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods
ASTM D 4253	Test Methods for Maximum Index Density of Soils using a Vibratory Table
ASTM D4254	Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D 4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D4832	Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
ASTM D 5971	Practice for Sampling Freshly Mixed Controlled Low Strength Material (CLSM)
ASTM D 6023	Test Method for Unit Weight, Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low Strength Material (CLSM)
ASTM D 6024	Test Method for Ball Drop on Controlled Low Strength Material (CLSM) to Determine Suitability for Load Application
ASTM D 6103	Test Method for Flow Consistency of Controlled Low Strength Material (CLSM)

1.3 CONTRACTOR SUBMITTALS

A. The Contractor's attention is directed to the provisions of Subpart P, 29 CFR 1926 of the OSHA Safety and Health Standards for Construction, which relate to protection of employees in excavations. The Contractor shall submit, for information to the Engineer, the project excavation plan and the name of the Contractor's competent person, prior to commencing any excavation.

B. Submit samples of all materials proposed to be used in the work in accordance with the requirements in Section 01 33 20 – Submittal Procedures. Sample sizes shall be as determined by the testing laboratory.

C. Submit dewatering and water removal plan prior to performing any dewatering or water removal.

PART 2 - PRODUCTS

2.1 SUITABLE FILL AND BACKFILL MATERIAL REQUIREMENTS

A. General: Fill, backfill, and embankment materials shall be suitable material.

B. Suitable Materials: Suitable material is defined as selected or processed clean, well graded earth material, sands and gravels free of excessive fines, less than 20 percent rock and boulders larger than 4 inches, grass, roots, brush, vegetation, or other deleterious materials.

C. Fill and backfill materials within 6 inches of any structure or pipe shall be smaller than 1 inch in any dimension.

1. Suitable materials may be obtained from onsite excavations, may be processed onsite materials, or may be imported. If imported materials are required by this Section or to meet the quantity requirements of the Project, provide the imported materials at no additional expense to the Owner, unless a unit price item is included for imported materials in the bidding schedule. Onsite materials shall be stockpiled and segregated prior to use.

2. The following types of suitable materials are defined:

Type A (Granular Backfill): Crushed rock or gravel, and sand well graded and readily compacted, non-plastic, meeting the following gradation requirements:

Sieve Size	Percentage Passing
1-inch	100
No. 40	15 - 60
No. 200	0 - 15

Type B (Crushed Rock): Manufactured angular, crushed rock, non-plastic, meeting the following gradation requirements:

Sieve Size	Percentage Passing
1 – inch	95 – 100
½ - inch	25 – 50
3/8 – inch	0 – 10
No. 4	0 – 5
No. 200	0 – 1

Squeegee and pea gravel are not acceptable as Type B material.

Type C (Sand Backfill): Sand non-plastic, meeting the following gradation requirements:

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	80 - 100
No. 10	30-50
No. 40	10-30
No. 200	7 - 15

Squeegee and pea gravel are not acceptable as sand backfill.

Type D (Select Backfill): Suitable material that can be readily compacted and meets the requirements of AASHTO M 145 classification A-1-a, non-plastic, well graded with a maximum particle size of 2 inches.

Sieve Size	Percentage Passing
2-inch	100
No. 10	30-50
No. 40	15-30
No. 200	0 - 15

Type E (Pea Gravel Backfill): Crushed rock or gravel with 100 percent passing a 1/2-inch sieve and not more than 10 percent passing a No. 4 sieve.

Type F (Drainrock): Crushed rock or gravel conforming to one of the following gradation requirements, as shown on the Drawings or approved by the Engineer:

	Percentage Passing		
Sieve Size	3-inch Max.	2-inch Max.	3/4-inch Max.
3-inch	100	-	-

2-inch	90 - 100	100	-
1-1/2 inch	70 - 100	90 – 100	-
3/4 inch	0 - 50	0 – 15	100
1/2-inch	-	-	95 - 100
3/8-inch	0 - 10	0 - 5	70 - 100
No. 4	0 - 25	-	-
No. 8	0 - 5	-	-
No. 200	0 - 3	-	0 - 3

Type G (Type II Aggregate Base): Well-graded, clean, hard, tough, durable, and sound mineral aggregates consisting of crushed stone, or crushed gravel, free of organic matter and contamination from chemical or petroleum products meeting State specification requirements and conforming to the following Table and gradations:

Aggregate Properties			
	Aggregate Class		
	A	**B**	
Dry Rodded Unit Weight	Not less than 75 lb/ft^3		AASHTO T 19
Liquid Limit/Plastic Index	Non-plastic	PI ≤ 6	AASHTO T 89 AASHTO 90
Aggregate Wear	Not to exceed 50 percent		AASHTO T 96
Gradation	Table 2		AASHTO T 11 AASHTO T 27
CBR with a 10 lb surcharge measured at 0.20 inch penetration	70% Minimum	N/A	AASHTO T 193
Two Fractured Faces	50% Min	N/A	AASHTO T 335

Sieve Size	Percentage Passing
1 ½ -inch	100
1-inch	90 - 100
3/4-inch	70 - 85
1/2-inch	65 - 80
3/8-inch	55 - 75
No. 4	40 - 60
No. 16	25 - 40
No. 200	7 - 11

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

Sieve Size	Percentage Passing
1-inch	100
3/4 inch	90 - 100
3/8-inch	40 - 100
No. 4	25 - 40
No. 8	18 - 33
No. 30	5 - 15

No. 50	0 - 7
No. 200	0 - 3

Type I: (Levee Material): Clayey sand to sandy clay obtained from off-site borrow sources or from onsite excavations, processed to the extent required to produce a material with a maximum size of 4 inches, well-graded from coarse to fine, and free from roots, sticks, organic matter, concrete, asphalt and other deleterious material. Levee material shall meet the following gradation requirements:

Sieve Size	Percentage Passing
4-inch	100
No. 4	50 - 70
No. 200	30 - 50

Type J (Cement-Treated Backfill): Material which consists of Type F material, or any mixture of Types B, C, G, and H materials which has been cement-treated so that the cement content of the material is not less than 5 percent by weight when tested in accordance with ASTM D 2901. The ultimate compressive strength at 28 days shall be not less than 400 psi when tested in accordance with ASTM D 1633.

Type K (Topsoil): Stockpiled topsoil material which has been obtained at the site by removing soil to a depth as defined in Section 31 10 00 - Site Preparation. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris.

Type M (Aggregate Subbase): Crushed rock aggregate subbase material non-plastic that can be compacted readily by watering and rolling to form a stable base. The sand equivalent value shall not be less than 18 and shall meet one of the following gradation requirements, as shown on the Drawings or approved by the Engineer:

	Percentage Passing	
Sieve Size	3-inch Max.	2-inch Max.
3-inch	100 -	
2-inch	90 - 100	100
1-1/2 inch	-	95 - 100
1-inch	70 - 90	-
No. 4	30 - 65	30 - 65
No. 16	15 - 40	15 - 40
No. 200	2 - 12	2 - 12

Type N (trench plug): Low permeable fill material, a nondispersable clay material having a minimum plasticity index of 10.

Type O (Controlled Low Strength Material (CLSM)): CLSM shall consist of a mixture of portland cement, aggregate, fly ash, water, and approved admixtures conforming to the following requirements:

3. Portland Cement: ASTM C150, Type V.
4. Aggregate: Clean imported sand and gravel or selected material from the excavation, imported material, or a combination thereof as approved by the Engineer. Maximum

aggregate size shall be 1 to 3 inches. The soluble sulfate content of aggregate in the mixture shall not exceed 0.3 percent by dry weight.

5. Water: Potable quality.
6. Fly Ash: Class C, ASTM C 618 or approved alternate.
7. The minus 200 sieve fraction shall be nonplastic, as defined by ASTM D 4318. By this standard, a soil is considered nonplastic if either the liquid or plastic limit cannot be determined, or if the plastic limit is equal to or greater than the liquid limit.
8. Proportion the CLSM to be a flowable, nonsegregating, self-consolidating low shrink slurry. The Contractor shall determine the materials and proportions used to meet the requirements of these Specifications.
9. The unconfined compressive strength at 7 days shall be a minimum of 100 psi and a maximum of 300 psi. Contractor shall form a minimum of six test cylinders with proposed materials to confirm design strength and mix design. Four of the cylinders shall be broken at 7 days in conformance with applicable concrete cylinder specifications and results provided to Engineer. The remaining two cylinders shall be broken by Contractor at discretion of Engineer. Initial mix design and cylinder breaks shall be completed at least 21 days prior to use of the material on the jobsite. Final mix approval and use of the material shall not occur prior to confirmation of strength by the cylinder breaks.
10. The temperature of the CLSM discharged into the trench shall be below 90 degrees F.
11. CLSM backfill under concrete structures shall be protected during curing as specified Section 03300 - Cast-in-Place Concrete.
12. CLSM shall be tested in accordance with ASTM D 4832, ASTM D 5971, ASTM D 6023, and ASTM D6103

Type P: (Suitable Trench Backfill): Suitable material that can be readily compacted, with less than 35 percent passing the No. 200 sieve and a plasticity index of 10 or less.

2.2 UNSUITABLE MATERIAL

A. Unsuitable materials include but are not limited to the materials listed below.
   1. Soils which, when classified under ASTM D 2487 - Classification of Soils for Engineering Purposes, fall in the classifications of Pt, OH, CH, MH, or OL.
   2. Soils which cannot be compacted sufficiently to achieve the density indicated for the intended use.
   3. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, slag, and any material which may be classified as hazardous or toxic according to applicable regulations.
   4. Soils that contain greater concentrations of chloride or sulfate ions, or have a soil resistivity or pH less than the existing onsite soils.
   5. Topsoil, except as allowed below.

B. [All unsuitable excavated material shall be disposed off site.]

2.3 USE OF FILL, BACKFILL, AND EMBANKMENT MATERIAL TYPES

A. Use the types of materials as designated herein for all required fill, backfill, and embankment construction hereunder.

B. Where these Specifications conflict with the requirements of any local agency having jurisdiction or with the requirements of a pipe material manufacturer, notify the Engineer immediately. In case of conflict between types of pipe embedment backfills, use the agency-specified backfill material if that material provides a greater degree of support to the pipe, as determined by the Engineer. In case of conflict between types of trench or final backfill types, use the agency-specified backfill material if that material provides the greater in-place density after compaction.

C. Fill and backfill types shall be used in accordance with the following provisions:

1. Embankment fills shall be constructed of Type P material, as defined herein, or any mixture of Type P and Type A through Type F materials.
2. Pipe zone backfill, as defined under "Pipe and Utility Trench Backfill" below, shall consist of the following materials for each pipe material listed below.
    a. Mortar coated pipe, concrete pipe, and uncoated ductile iron pipe shall be provided with Type A or C material in the pipe zone.
    b. Coal tar enamel coated pipe, polyethylene encased pipe, tape wrapped pipe, and other non-mortar coated pipe shall be backfilled with Type C material in the pipe zone.
    c. Plastic pipe and vitrified clay pipe shall be backfilled with Type C material in the pipe zone.
    d. Where pipelines are installed on grades exceeding 4 percent, and where backfill materials are graded such that there is less than 10 percent passing a No. 4 sieve, trench plugs of Type J or N material shall be provided at maximum intervals of 200 feet unless indicated otherwise.
    e. Type O material shall be used in the pipe zone where shown on plans, specified, or required by the Engineer for special crossings or other locations, or where otherwise approved.
    f. Type E material will not be allowed for backfill within the pipe zone.
3. Trench zone backfill for pipelines as defined under "Pipe and Utility Trench Backfill" shall be Type D backfill material.
4. Final backfill material for pipelines under paved areas, as defined under "Pipe and Utility Trench Backfill" shall be Type G backfill material. Final backfill under areas not paved shall be the same material as that used for trench backfill.
5. Trench backfill and final backfill for pipelines under structures shall be Type A or B, except where concrete encasement is required by the Contract Documents.
6. Aggregate base materials under pavements shall be Type G material constructed to the thicknesses indicated. Aggregate subbase shall be Type M material.
7. Backfill around structures shall be Type P material, or Types A through Type F materials, or any mixture thereof, except as shown.
8. Backfill materials beneath structures shall be as follows:
    a. Drainrock materials under hydraulic structures or other water retaining structures with underdrain systems shall be Type H material.
    b. Under concrete hydraulic structures or other water retaining structures without underdrain systems, Types F, G or H materials shall be used.
    c. Under structures where groundwater must be removed to allow placement of concrete, Type F material shall be used. Before the Type F material is placed, filter type geotextile fabric shall be placed over the exposed foundation.
    d. Under all other structures, Type F, G or H material shall be used.

9. Backfill used to replace pipeline trench overexcavation shall be a layer of Type F material with a 6-inch top filter layer of Type E material or filter fabric to prevent migration of fines for wet trench conditions or the same material as used for the pipe zone backfill if the trench conditions are not wet.

2.4 PIPELINE MARKING TAPE

A. Metallic Tape: Tape shall be minimum 5.5 mils thick aluminum foil imprinted on one side, encased in high visibility inert polyethylene jacket. Tape shall be a minimum of 6 inches wide. Imprinted lettering shall be 1 inch tall, permanent black, as indicated. Joining clips shall be manufacturer's standard tin or nickel coated. Tape shall be as manufactured by Reef Industries (Terra "D"), Allen (Detectatape), or equal.

B. Plastic Tape: Tape shall be minimum 4-mil thick polyethylene which is impervious to alkalais acids, and chemicals and solvents which are likely in the soil. Tape shall be a minimum of 6 inches wide and lettering shall be 1-inch tall permanent black on a colored background. Tape shall be manufactured by Reef Industries (Terra Tape), Allen (Markline), or equal.

C. Warning Tape: Warning tape manufactured for marking and identifying underground utilities continuously inscribed with a description of utility, colored as follows:
1. Red; Electric.
2. Yellow; Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water Systems.
5. Green: Sewer Systems.

2.5 MATERIALS TESTING

A. All soils testing of samples submitted by the Contractor will be done by a testing laboratory of the Owner's choice and at the Owner's expense. At its discretion, the Engineer may request that the Contractor supply samples for testing of any material used in the work.

B. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Method for Particle-Size Analysis of Soils.

C. Determination of sand equivalent value will be performed using ASTM D 2419 - Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

D. Unified Soil Classification System: References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487. The Contractor shall be bound by all applicable provisions of said ASTM D 2487 in the interpretation of soil classifications.

E. The testing for chloride, sulfate, resistivity, and pH will be done by a testing laboratory of the Owner's choice and at the Owner's expense.

PART 3 - EXECUTION

3.1 EXCAVATION – GENERAL

A. General: Except when specifically provided to the contrary, excavation shall include the removal of all materials of whatever nature encountered, including rock and all obstructions of any nature that would interfere with the proper execution and completion of the Work. The removal of said materials shall conform to the lines and grades indicated or ordered. Unless otherwise indicated, the entire construction site shall be stripped of all vegetation and debris, and such material shall be removed from the site prior to performing any excavation or placing any fill. Furnish, place, and maintain all supports and shoring that may be required for the sides of the excavations. Excavations shall be sloped or otherwise supported in a safe manner in accordance with safety requirements of the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).

B. Maximum Length of Open Trench: The maximum length of open trench in urban and rural areas shall not exceed 500-feet at each pipe installation heading beyond the end of the installed pipeline, or the requirements of the agency with jurisdiction, whichever is lesser.

C. Construction Delays: In the case of any construction delay in excess of five calendar days, whether Contractor or Owner caused, the Contractor shall backfill the excavation, install temporary paving including temporary traffic markings, and restore traffic to pre-construction condition to minimize disruption to traffic and the community at no additional cost to the Owner.

D. Removal and Exclusion of Water: Remove and exclude water, including storm water, groundwater, irrigation water, and wastewater, from all excavations. Dewatering wells, well points, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level at least 2 feet below the bottom of excavations before the excavation work begins at each location. Water shall be removed and excluded until backfilling is complete and all field soils testing has been completed.

3.2 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION

A. Excavation Beneath Structures and Embankments: Except where otherwise indicated for a particular structure or ordered by the Engineer, excavation shall be carried to the grade of the bottom of the footing or slab. Where indicated or ordered, areas beneath structures or fills shall be overexcavated. The subgrade areas beneath embankments shall be excavated to remove not less than the top 6 inches of native material and where such subgrade is sloped, the native material shall be benched. When such overexcavation is indicated, both overexcavation and subsequent backfill to the required grade shall be performed. When such overexcavation is not indicated but is ordered by the Engineer, such overexcavation and any resulting backfill will be paid for under a separate unit price bid item if such bid item has been established; otherwise payment will be made in accordance with a negotiated price. After the required excavation or overexcavation has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

B. Excavation Beneath Concrete Reservoirs: Excavation under reservoirs shall extend to the bottom of the drainrock layer. After such excavation has been completed, the exposed surface shall be rolled with heavy compaction equipment to 95 percent of maximum density and then graded to provide a reasonably smooth surface for placement of the drainrock. Areas under the reservoir upon which fill is to be placed shall be scarified to a depth of 6 inches, brought to optimum moisture content, and compacted to obtain 95 percent of maximum density with moisture content within plus and minus 2 percent of the optimum moisture content.

C. Excavation Beneath Paved Areas: Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the bottom of the paving thickness. After the required excavation has been completed, the top 12 inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

D. Notification of Engineer: Notify the Engineer at least 3 days in advance of completion of any structure excavation and allow the Engineer a review period of at least 1 day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

3.3 PIPELINE AND UTILITY TRENCH EXCAVATION

A. General: Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with widths as indicated.

B. Trench Bottom: Except when pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe zone. Excavations for pipe bells and welding shall be made as required.

C. Open Trench: The maximum amount of open trench permitted in any one location shall be [500 feet, or the length necessary to accommodate the amount of pipe installed in a single day, whichever is greater]. All trenches shall be fully backfilled at the end of each day or, in lieu thereof, shall be protected in accordance with Section 01 71 50 – Protection of Existing Facilities. The Contractor shall provide temporary 6-foot chain link fencing panels for protection of all open excavations and trenches within public streets, residential areas, and all other locations with the exception of unimproved open areas where excavations and/or pipeline trenches that can be safely sloped in accordance with current OSHA standards to provide safe access without the use of shoring devices. Temporary fencing panels shall fully enclose open excavations and trenches, and shall remain in place during all non-working hours.

D. Trench Overexcavation: Where trenches are indicated to be overexcavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade of the bottom of the pipe bedding.

E. Overexcavation: When ordered by the Engineer, whether indicated on the Drawings or not, trenches shall be overexcavated beyond the depth and/or width shown. Such overexcavation

shall be to the dimensions ordered. The trench shall then be backfilled to the grade of the bottom of the pipe bedding. Overexcavation less than 6 inches below the limits on the Drawings shall be done at no increase in cost to the Owner. When the overexcavation ordered by the Engineer is 6 inches or greater below the limits shown, or wider, additional payment will be made. Said additional payment will be made under separate unit price bid items for overexcavation if such bid items have been established; otherwise payment will be made in accordance with a negotiated price.

F. Where pipelines are to be installed in embankments, fills, or structure backfills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.

G. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield so that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls. If the trench walls cave in or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.

3.4 OVEREXCAVATION NOT ORDERED OR INDICATED

A. Any overexcavation carried below the grade ordered or indicated, shall be backfilled to the required grade with the indicated material and compaction. Such work shall be performed at no additional cost to the Owner.

3.5 EXCAVATION IN LAWN AREAS

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

3.6 EXCAVATION IN VICINITY OF TREES

A. Except where trees are indicated to be removed, trees shall be protected from injury during construction operations. No tree roots over 2 inches in diameter shall be cut without express permission of the Engineer. Trees shall be supported during excavation by any means previously reviewed by the Engineer.

3.7 BACKFILL – GENERAL

A. Backfill shall not be dropped directly upon any structure or pipe. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed. Backfill around water retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed. Structures shall not be constructed on CLSM backfill until the CLSM has obtained a 7-day minimum cure.

B. Except for drainrock materials being placed in overexcavated areas or trenches, backfill shall be placed after all water is removed from the excavation, and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.

C. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally. Do not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

D. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have all loose sloughing, or caving soil and rock materials removed. All materials disturbed from their intact condition that are 4 inches or larger in least dimension or aggregates of soil material thicker than 4 inches shall be removed from the excavation walls and base prior to placing pipe or any backfill material. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

3.8 PLACING AND SPREADING OF BACKFILL MATERIALS

A. Backfill materials shall be placed and spread evenly in layers. When compaction is achieved using mechanical equipment, the layers shall be evenly spread so that the depth of each uncompacted layer shall not exceed 8 inches of compacted thickness.

B. During spreading, each layer shall be thoroughly mixed as necessary to promote uniformity of material in each layer. Pipe zone backfill materials shall be manually spread around the pipe so that when compacted the pipe zone backfill will provide uniform bearing and side support.

C. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.

D. Where the backfill material moisture content is too high to permit the indicated degree of compaction the material shall be dried or mixed with drier material until the moisture content is satisfactory.

3.9 COMPACTION OF EARTH FILL, BACKFILL, AND EMBANKMENT MATERIALS

A. Each layer of Types A, B, C, G, H, I, and K backfill materials as defined herein, where the material is graded such that at least 10 percent passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content.

B. Each layer of Type E and J backfill materials shall be compacted by means of at least 2 passes from a flat plate vibratory compactor. When such materials are used for pipe zone backfill, vibratory compaction shall be used at the top of the pipe zone or at vertical intervals of 24 inches, whichever is the least distance from the subgrade.

C. Fill on reservoir and structure roofs shall be deposited at least 30 days after the concrete roof slab has been placed. Equipment weighing more than 10,000 pounds when loaded shall not

be used on a roof. A roller weighing not more than 8,000 pounds shall be used to compact fill on a roof.

D. Pipe zone backfill materials that are granular, shall be compacted by using vibratory compactors.

E. Equipment weighing more than 10,000 pounds shall not be used closer to structure walls than a horizontal distance equal to the depth of the fill at that time. Hand operated power compaction equipment shall be used where use of heavier equipment is impractical or restricted due to weight limitations.

F. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand operated, vibratory compactors and rollers. After completion of at least 2 feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.

G. Compaction Requirements: The following compaction test requirements shall be in accordance with ASTM D 1557, method C. Compaction shall be obtained with the moisture content within plus or minus 2 percent of the optimum moisture content. Where agency or utility company requirements govern, the highest compaction standards shall apply.

Location or Use of Fill	Percentage of Maximum Density
Pipe embedment backfill for flexible pipe	90
Pipe bedding and overexcavated zones under bedding for flexible pipe, including trench plugs	90
Pipe embedment backfill for steel yard piping	---
Pipe embedment backfill for rigid pipe	90
Pipe zone backfill portion above embedment for rigid pipe	90
Pipe bedding and overexcavated zones under bedding for rigid pipe	90
Final backfill, beneath paved areas or	

structures	95
Final backfill, not beneath paved areas or structures	85
Trench zone backfill, beneath paved areas and structures, including trench plugs	95
Trench zone backfill, not beneath paved areas or structures, including trench plugs	90
Embankments and fills	90
Embankments and fills beneath paved areas or structures	95
Backfill beneath structures and hydraulic structures	95
Backfill and fill around structures on reservoir or structure roof	90
Topsoil (Type K material)	80
Aggregate base or subbase (Type G or M material)	95

3.10 PLACEMENT OF CLSM

A. Following placement and anchoring of the pipe, remove all loose soil from trench walls and floor. Remove any unstable soil at the top of the trench, which might fall into the trench during placement of the CLSM.

B. Deliver the CLSM to the trench in ready mix trucks and utilize pump or chutes to place the CLSM in the trench. Direct CLSM to one side of the pipe, taking care not to displace the pipe at any time. Continue placing CLSM on one side of the pipe until CLSM has gone under the pipe and up the other side to a depth of 1.5 feet above the pipe bottom. Use at least two hand-held vibrators to continuously liquefy and move CLSM into all voids. Adjust water in mixture to maintain fluid consistency but maintain strength requirements. Continue placing CLSM on both sides of the pipe continuously using two vibrators for every 30 feet of pipe run.

C. Maintain stability of pipe throughout CLSM placement. CLSM will likely require placement in lifts to prevent pipe flotation. No movement of the pipe caused by flotation will be allowed. If any movement occurs, the CLSM material shall be removed and the pipe placed back on line and grade. Any damage to the pipeline system caused by movement of the pipe shall be removed and/or repaired in full conformance with these Contract Documents at no additional cost to the Owner. Remove all sloughed material or other debris from top of previously placed CLSM.

3.11 PIPE AND UTILITY TRENCH BACKFILL

A. Pipe Zone
   1. The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane 6 inches below the bottom surface of the pipe and a plane at a point 12 inches above the top surface of the pipe. The bedding is defined as that portion of pipe zone backfill material between the bottom of the trench and the bottom of the pipe. The embedment is defined as that portion of the pipe zone material between the bedding and a plane at a point 6 inches above the top surface of the pipe.
   2. After compacting the bedding, perform a final trim using a string line for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe. Excavation for pipe bells and welding shall be made as required.
   3. The pipe zone shall be backfilled with the indicated backfill material. Exercise care to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.
   4. If a moveable trench shield is used during backfill operations the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer. Do not displace the pipe or backfill while the shield is being moved.

B. Trench Zone: After the pipe zone backfills have been placed, backfilling of the trench zone may proceed. The trench zone is defined as that portion of the vertical trench cross-section lying between a plane 12 inches above the top surface of the pipe and a plane at a point 18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade.

C. Marking Tape Installation
   1. Continuously install metallic marking tape along the pipe at a depth of 3 feet below finish grade.
   2. Continuously install plastic marking tape along the pipe at the elevation indicated on the Drawings.

D. Final Backfill: Final backfill is all backfill in the trench cross-sectional area within 18 inches of finished grade, or if the trench is under pavement, all backfill within 18 inches of the roadway subgrade.

3.12 FILL AND EMBANKMENT CONSTRUCTION

A. The area where a fill or embankment is to be constructed shall be cleared of all vegetation, roots and foreign material. Following this, the surface shall be scarified to a depth of 6 inches, moisture conditioned, and rolled or otherwise mechanically compacted. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers. Each layer shall be moistened or aerated, as necessary. Unless otherwise approved by the Engineer, the depth of each uncompacted layer shall not exceed 8 inches of compacted thickness. The embankment, fill, and the scarified layer of underlying ground shall be compacted to 95 percent of maximum density under structures and paved areas, and 90 percent of maximum density elsewhere.

B. When an embankment or fill is to be made and compacted against hillsides or fill slopes steeper than 5H:1V, the slopes of hillsides or fills shall be horizontally benched to key the embankment or fill to the underlying ground. A minimum of 12 inches normal to the slope of the hillside or fill shall be removed and recompacted as the embankment or fill is brought up in layers. Material thus cut shall be recompacted along with the new material at no additional cost to the Owner. Hillside or fill slopes 5H:1V or flatter shall be prepared in accordance with Paragraph A, above.

C. Where embankment or structure fills are constructed over pipelines, the first 4 feet of fill over the pipe shall be constructed using light placement and compaction equipment that does not damage the pipe.

D. The finish graded surface of the drainrock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs. Where needed to protect slopes and prevent movement of the drainrock, spray asphalt on the finished drainrock surface in accordance with Section 32 12 16 - A. C. Pavement and Base.

3.13 FIELD TESTING

A. General: All field soils testing will be done by a testing laboratory of the Owner's choice at the Owner's expense except as indicated below.

B. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557. Field density in-place tests will be performed in accordance with ASTM D 1556 or by such other means acceptable to the Engineer.

C. In case the test of the fill or backfill show noncompliance with the required density, perform remedies as may be required to ensure compliance. Subsequent testing to show compliance shall be by a testing laboratory selected by the Owner, paid by the Contractor, at no additional cost to the Owner.

D. Provide test trenches and excavations including excavation, trench support, and groundwater removal for the Owner's field soils testing operations. The trenches and excavations shall be provided at the locations and to the depths required by the Owner. All Work for test trenches and excavations shall be provided at no additional cost to the Owner.

E. Frequency of Testing
   1. Backfill around structures and in embankments shall be tested every 300 square ft of each lift of placement.
   2. CLSM shall be tested each batch being placed or every 300 cubic yards that is placed.
   3. Pipe backfill shall have one test every 80 feet (2 joints) of backfill placed.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

SECTION 31 23 19
DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes construction dewatering.

1.3 PERFORMANCE REQUIREMENTS

A. The Contractor shall provide all labor, materials, and equipment necessary to dewater site excavations, in accordance with the requirement of the Contract Documents.

B. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
   1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
   2. Prevent surface water from entering excavations by grading, dikes, or other means.
   3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
   4. Remove dewatering system if no longer needed.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction, specifically per those requirements outlined in the UPDES General Permit.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.

B. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
   1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
   1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
   2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
   1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
   1. Maintain free water level below bottom of excavation during construction.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

SECTION 31 23 26
FLOWABLE FILL

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install flowable fill, complete and in place, in accordance with the Contract Documents.

B. Flowable fill refers to a cementitious slurry consisting of a mixture of fine aggregate or filler, water, and cementitious material(s), which is used as a fill or backfill in lieu of compacted earth. Flowable fill is sometimes referred to as controlled density fill (CDF), controlled low strength material (CLSM), lean concrete slurry, and unshrinkable fill.

C. Place flowable fill where indicated on the Drawings. With approval of the Engineer, normal flowable fill with high slump, non-segregating consistency that readily flows and fills voids and difficult-to-reach places may also be used for the following purposes:
   1. Pipe zone fill.
   2. Trench zone fill.
   3. Pipe abandonment.
   4. Structure backfill.
   5. Structure cavity fill.

1.2 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM C33	Standard Specifications for Concrete Aggregates
ASTM C94	Standard Specifications for Ready-Mixed Concrete
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C150	Standard Specifications for Portland Cement
ASTM C260	Specification for Air-Entraining Admixtures for Concrete Compounds for Curing Concrete
ASTM C403	Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

ASTM D 4832	Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

1.3 DEFINITIONS

A. Flowable fill: A mixture of cement, pozzolan, coarse and fine aggregate, admixtures, and water, mixed in accordance with ASTM C94.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Product data.
   1. Flowable fill mix designs which show the proportions and gradations of materials proposed for each type of flowable fill indicated. Provide independent laboratory test results for each mix design verifying indicated properties.

C. Test and Evaluation Reports
   1. If Contractor proposes to provide lower strength flowable fill with aggregates that do not conform to ASTM C33, provide written testing program that will be used to control the variability of the aggregates. Testing program must be acceptable to Engineer.

D. Correlation Test Reports

1.5 QUALITY ASSURANCE

A. Preconstruction Testing will be performed by a testing laboratory selected by the Owner at the Owner's expense, except when otherwise specified herein or on the Drawings.

B. If tests of the flowable fill indicate non-compliance with these Specifications, make changes as may be required to achieve compliance. Perform and pay for subsequent testing to show compliance.

PART 2 - PRODUCTS

2.1 PERFORMANCE / DESIGN CRITERIA

A. Prepare flowable fill mixes within the following limits and as necessary to produce the indicated compressive strengths:
   1. Density: Between 110 pcf minimum and 145 pcf maximum.
   2. Slump: As required by for placement methods, which do not promote segregation; maximum of 10 inches.
   3. Compressive Strength: 28-day compressive strength to be between 100 psi minimum and 200 psi maximum per ASTM D4832.
   4. Entrained Air: Between 20 percent minimum and 30 percent maximum.
   5. Water reducing agent: Provide at Contractor's option as necessary.

2.2 MATERIALS

A. Cement: Provide per ASTM C150, Type I or Type II.

B. Pozzolan: Provide fly ash conforming to ASTM C618, Type C or Type F.

C. Aggregate:
   1. Provide aggregates free from organic matter and containing no more alkali, sulfates, or salts than the native materials at the Site.
   2. Provide aggregate consisting of a well-graded mixture of crushed rock, soil, or sand, with a nominal maximum size of 3/8 inch and conforming to the following sieve limits:

Sieve Size	Percent Passing
1/2-inch	100
3/8-inch	>70
No. 200	<12[1]

[1] If more than 5 percent of the aggregate passes the No. 200 sieve, the plasticity index must be less than 0.73 (liquid limit – 20), when tested in accordance with ASTM D4318.

D. Admixtures
   1. Air entraining admixture: ASTM C260.
   2. Water reducing admixture: ASTM C494

E. Water: Provide potable, clean, and free from objectionable quantities of silt, organic matter, alkali, salt, and other impurities.

PART 3 - EXECUTION

3.1 PREPARATION

A. Batch, mix, and deliver flowable fill per ASTM C94. Produce at a batch plant acceptable to the Engineer and delivered in transit mix trucks.

3.2 PLACEMENT

A. Place flowable fill by tailgate discharge, conveyor belts, pumps, or other appropriate means. Direct flowable fill in place by vibrator, shovel, or rod to fill crevices and pockets. Avoid over-consolidation that causes segregation of aggregates.

B. Temperature Limits:
   1. Flowable fill temperature at placement: 50 degrees F to 90 degrees F.
   2. Air temperature at placement: Above 40 degrees F and rising.

3. Do not place flowable fill against frozen subgrade or other materials having a temperature less than 32 degrees F.

C. Place flowable fill continuously against fresh material unless otherwise approved by the Engineer. When new material is approved to be placed against existing flowable fill, conform to the following:
1. Clear the area of all loose and foreign material.
2. Soak the surface of the existing material a minimum of 1 hour before placement of fresh material but do not create standing water.

D. Flowable fill Placement for Piping:
1. Place pipe on soil pads.
2. Place bedding under the pipe from one side and vibrate as necessary, so that the flowable fill flows to the opposite side.
3. Add flowable fill to both sides of the pipe and vibrate until it fills the space between the pipe and the excavated trench bottom.
4. Deposit flowable fill in such a manner as to avoid uplift. Deposit in final position to avoid disturbing the pipe trench or causing foreign material to mix with the cement slurry.
5. Do not place pipe zone backfill until the flowable fill has reached initial set.
6. Pipes placed on steep slopes may require a stiffer mix to prevent flowable fill from flowing down the trench.
7. Vibrate as necessary to ensure that the flowable fill fills all voids.

3.3 FINISHING

A. Finish flowable fill smooth and to the grade indicated on the Drawings or as directed by the Engineer. Finish free from fins, bulges, ridges, offsets, and honeycombing.
1. Finishing by wood float, steel trowel, or similar methods is not required.

3.4 CURING

A. Maintain flowable fill damp for a minimum of 7 days or until final backfill is placed.

3.5 PROTECTION

A. Protect flowable fill from temperatures below 40 degrees F for a minimum of 72 hours after placement.

B. Protect flowable fill from running water, rain, or other damage until the material has been accepted and final fill completed.

3.6 FIELD QUALITY CONTROL

A. Correlation Testing:
1. Perform a field correlation test for each mix of flowable fill used in pipe zones, trench zones, or backfill used in amounts greater than 100 cu yd, or when flowable fill is required to support traffic or other live loads on the fill less than 7 days after placing the flowable fill.

2. Perform field correlation tests in a test pit similar in cross section to the Work and at least 10 feet long at a location near the Work, acceptable to the Engineer. Test under the following standards:
   a. Compression Testing: ASTM D4832.
   b. Setting Test: ASTM C403.
   c. Density Test: ASTM C138
3. Perform all laboratory and field tests on samples taken from the same flowable fill batch mix at Contractor's expense and in accordance with the following schedule:
   a. Perform tests once each 2 hours during the first 8 hours.
   b. Perform tests once each 8 hours during the first week (after the first 8 hours).
   c. Perform tests once each 24 hours (after the first week) until the flowable fill reaches its design strength.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

SECTION 31 32 19
GEOTEXTILES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install geotextiles, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM D 4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon-Arc Type Apparatus.
ASTM D 4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D 4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
ASTM D 4884	Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Sewn Geotextiles.
ASTM D 4886	Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method).

1.3 DEFINITIONS.

A. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.

B. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile provided.

C. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile provided.

D. Nondestructive Sample: Sample representative of finished geotextile, prepared for testing without destruction of geotextile.

E. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

F. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D 4884.

G. Woven geotextile: A geotextile fabric composed of polymeric yarn interlaced to form a planar structure with uniform weave pattern.

H. Nonwoven geotextile: A geotextile fabric composed of a pervious sheet of polymeric fibers interlaced to form a planar structure with uniform random fiber pattern.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Product Data.
1. Manufacturer's material specifications and product literature.
2. Installation drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.
3. Description of proposed method of geotextile deployment, sewing equipment, sewing methods, and provisions for holding geotextile temporarily in place until permanently secured.

C. Samples.
1. Geotextile: One-piece, minimum 18-inches long, taken across full width of roll of each type and weight of geotextile. Label each with brand name and furnish documentation of lot and roll number from which each sample was obtained.
2. Field Sewn Seam: 5-foot length of seam, 12-inches wide with seam along center, for each type and weight of geotextile.
3. Securing Pin and Washer: 1 each.

D. Certificates.
1. Certification from geotextile manufacturer that products satisfy the indicated requirements.
2. Field seam efficiency test results.

1.5 DELIVERY, STORAGE AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Deliver each roll with sufficient information attached to identify manufacturer and product name or number.

C. Handle products in manner that maintains undamaged condition.

D. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in a way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

PART 2 - PRODUCTS

2.1 WOVEN GEOTEXTILE

A. Woven geotextile shall be composed of polymeric yarn interlaced to form a planar structure with uniform weave pattern. Products shall be calendared or finished so that yarns will retain their relative position with respect to each other.

B. Polymeric yarn shall be long-chain synthetic polymers (polyester or polypropylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.

C. Sheet Edges: Selvaged and finished to prevent outer material from separating from sheet.

D. Unseamed Sheet Width: Minimum 12 feet.

E. Nominal Weight per Square Yard: 6 ounces.

F. Physical Properties: Conform to physical property requirements below:

Property	Requirement	Test Method
Apparent Opening Size (AOS)	No. 10 to No. 100 U.S. Standard Sieve Size	ASTM D4751
Water Permittivity	0.02 to 3.34 $Sec.^{-1}$, MinARV	ASTM D4491 (Falling Head)
Vertical Water Flow Rate	10 to 150 gpm/sq ft, MinARV	
Wide Width Strip Tensile Strength	60 to 1,500 MinARV	ASTM D4595
Wide Width Strip Elongation	14 to 60 percent, MaxARV	ASTM D4595
Trapezoidal Tear Strength	30 to 200 lb, MinARV	ASTM D4533
Puncture Strength	50 to 250 lb, MinARV	ASTM D4833
Abrasion Resistance	5 to 25 percent loss, 250 cycles, MaxARV	ASTM D4886
Ultraviolet Radiation Resistance	70 to 90 percent strength retention, MinARV after 500 hours	ASTM D4355

2.2 NONWOVEN GEOTEXTILE

A. Nonwoven geotextile shall be composed of a pervious sheet of polymeric fibers interlaced to form a planar structure with uniform random fiber pattern. Products shall be calendared or finished so that yarns will retain their relative position with respect to each other.

B. Polymeric yarn shall be long-chain synthetic polymers (polyester, polypropylene, or polyethylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.

C. Geotextile Edges: Selvaged or finished to prevent outer material from separating from sheet.

D. Unseamed Sheet Width: Minimum 6 feet.

E. Nominal Weight Per Square Yard: 8 ounces.

F. Physical Properties: Conform to physical property requirements below:

Property	Requirement	Test Method
Apparent Opening Size (AOS)	Max No. 80 U.S. Standard Sieve Size	ASTM D4751
Water Permittivity	1.4 $sec.^{-1}$, MinARV	ASTM D4491 (Falling Head)
Vertical Water Flow Rate	95 gpm/sq ft, MinARV	
Grab Tensile Strength	205 MinARV	ASTM D4632
Grab Tensile Elongation	50 percent, MaxARV	ASTM D4632
Trapezoidal Tear Strength	80 lb, MinARV	ASTM D4533
CBR Puncture Strength	500 lb, MinARV	ASTM D6241
Ultraviolet Radiation Resistance	70 percent strength retention, MinARV after 500 hours	ASTM D4355

Property	Requirement	Test Method
Apparent Opening Size (AOS)	Max No. 40 U.S. Standard Sieve Size	ASTM D4751
Water Permittivity	0.70 $sec.^{-1}$, MinARV	ASTM D4491
Tensile Strength	180 lbs, MinARV	ASTM D4632
Elongation at failure (%)[1]	$\geq$50	ASTM D4632
Puncture Strength	80 lb	ASTM D4833

Property	Requirement	Test Method
Ultraviolet Radiation Resistance	70 percent strength retention, MinARV after 500 hours	ASTM D4355

1. Minimum average roll value (weakest principal direction)

2.3 SEWING THREAD

A. Sewing thread shall be polypropylene, polyester, or Kevlar thread with durability equal to or greater than durability of geotextile sewn.

2.4 SECURING PINS

A. Securing pins shall be steel rods or bars conforming to the following:
1. 3/16-inch diameter.
2. Pointed at one end; head on other end, sufficiently large to retain washer.
3. Minimum Length: 12-inches.

B. Steel Washers for Securing Pins:
1. Outside Diameter: Not less than 1-1/2 inches.
2. Inside Diameter: 1/4-inch.
3. Thickness: 1/8-inch.

C. Steel Wire Staples:
1. U-shaped.
2. 10-gauge.
3. Minimum 6-inches long.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Laying Geotextile
1. Notify the Engineer whenever geotextiles are to be placed. Do not place geotextile prior to obtaining Engineer's approval of underlying materials.
2. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

B. Orientation on Slopes
1. Orient geotextile with long dimension of each sheet parallel to direction of slope.
2. Geotextile may be oriented with long dimension of sheet transverse to direction of slope only if sheet width, without unsewn seams, is sufficient to cover entire slope and anchor trench and extend at least 18-inches beyond toe of slope.

C. Joints.
1. Unseamed Joints.
a. Overlap unseamed joints to the following dimensions unless otherwise indicated:
b. Foundation/Subgrade Stabilization: Minimum 18-inches.

c. Riprap: Minimum 18-inches.
d. Drain Trenches: Minimum 18-inches, except overlap shall equal trench width if trench width is less than 18-inches.
e. Other Applications: Minimum 12-inches.

2. Sewn Seams.
a. Use sewn seams wherever stress transfer from one geotextile sheet to another is necessary. Sewn seams, as approved by Engineer, also may be used instead of overlap at joints for applications that do not require stress transfer.
b. Seam efficiency shall be minimum 70 percent.
c. Type: "J" type seams are preferred, but flat or butterfly seams are acceptable.
d. Stitch Count: Minimum 3 to maximum 7 stitches per inch.
e. Stitch Type: Double-thread chain stitch, Type 401, Federal Standard No. 751a.
f. Stitch Location: 2-inches from geotextile sheet edges, or more if necessary to develop required seam strength.
g. Sewing Machines: Capable of penetrating 4 layers of geotextile.

D. Securing Geotextile.
1. Secure geotextile during installation as necessary with sand bags or other means approved by Engineer.
2. Securing Pins
a. Insert securing pins with washers through geotextile, midway between edges of overlaps and 6-inches from free edges.
b. Spacing:

Slope	Maximum Pin Spacing (Feet)
Steeper than 3:1	2
3:1 to 4:1	3
Flatter than 4:1	5

c. Install additional pins across each geotextile sheet as necessary to prevent slippage of geotextile or to prevent wind from blowing geotextile out of position.
d. Push each securing pin through geotextile until washer bears against geotextile and secures it firmly to subgrade.
3. For underdrain applications (geotextile cushion over PVC or rubber waterproof membrane liner) do not use pins, staples or other securing methods that would damage waterproof membrane liner.

E. Placing Products over Geotextile.
1. Notify Engineer before placing material over geotextile. Do not cover installed geotextile prior to receiving authorization from the Engineer to proceed.
2. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as indicated below.

F. Installing Geotextile in Trenches.
1. Place geotextile in a way that will completely envelope granular drain material to be placed in trench and with indicated overlap at joints. Overlap geotextile in direction

of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.

2. After granular drain material is placed to grade, fold geotextile over top of granular drain material, unless otherwise indicated. Maintain overlap until overlying fill or backfill is placed.

G. Riprap Applications.

1. Overlap geotextile at each joint with upstream sheet of geotextile overlapping downstream sheet. Sew joints where wave run-up may occur.

H. Geotextile-Reinforced Earth Wall Applications.

1. Sew exposed joints; extend sewn seams minimum 3-feet behind face of wall.
2. Protect exposed geotextile from damage and deterioration until permanent facing is applied.

I. Silt Fence Applications.

1. Install geotextile in one piece or continuously sewn to make one piece, for full length and height of fence, including portion of geotextile buried in toe trench.
2. Install bottom edge of sheet in toe trench and backfill in a way that securely anchors geotextile in trench.
3. Securely fasten geotextile to a wire mesh backing and each support post in a way that will not result in tearing of geotextile when fence is subjected to service loads.
4. Promptly repair or replace silt fence that becomes damaged.

3.2 REPAIRING GEOTEXTILE

A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile. Repair damaged geotextile by placing patch of undamaged geotextile over damaged area plus at least 18-inches in all directions beyond damaged area. Remove interfering material as necessary to expose damaged geotextile for repair. Sew patches or secure them with pins and washers, as indicated above for securing geotextile, or by other means approved by Engineer.

3.3 REPLACING CONTAMINATED GEOTEXTILE

A. Protect geotextile from contamination that would interfere, in Engineer's opinion, with its intended function. Remove and replace contaminated geotextile with clean geotextile.

3.4 FIELD QUALITY CONTROL

A. Testing: Test seam efficiency by preparing and testing minimum of one set of nondestructive samples per acre of each type and weight of geotextile provided for the Work. Test according to ASTM D4884 and submit written results to Engineer.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

DIVISION 32
EXTERIOR IMPROVEMENTS

THIS PAGE INTENTIONALLY BLANK

SECTION 32 12 16
A.C.PAVEMENT AND BASE

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall perform all work associated with A.C. Pavement and Base, as shown and specified herein including all labor, materials, equipment supplies and facilities associated with providing of finished product satisfying all the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

AASHTO M 82	Cut-Back Asphalt (Medium Curing Type)
AASHTO M 140	Emulsified Asphalt
AASHTO M 208	Cationic Emulsified Asphalt
AASHTO M 226	Viscosity Graded Asphalt Cement
ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 692	Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 977	Emulsified Asphalt
ASTM D 1073	Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 1557	Moisture-Density Relations of Soils and Soil - Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in (45-mm) Drop7
ASTM D 2027	Cutback Asphalt (Medium Curing Type)
ASTM D 2397	Cationic Emulsified Asphalt
ASTM D 2726	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures using Saturated Surface-Dry Specimens.
ASTM D 3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3515	Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 20 – Submittal Procedures. Include materials testing reports, job-mix formulas, and other pertinent information satisfactory to the Engineer.

B. Prior to Delivery to Site:
   1. Mix Design: Submit current mix design dated within one year of submittal listing:
      a. Date of mix design
      b. Asphalt cement source, type and chemical composition.
      c. Aggregate gradation target.
      d. Asphalt cement target percentage, dust to asphalt ratio, moisture sensitivity (tensile strength ratio), stability, flow and voids in the bituminous mix.
   2. Before changing mix design, submit new design to Engineer 10-days prior to placing pavement for review and evaluation of changes.
   3. Type and number of compaction and finish rollers.

C. At Delivery: Supply a batch ticket identifying:
   1. Serial Number of ticket.
   2. Date and truck number.
   3. Job name, location and mix identification.
   4. Type, grade and weight of asphalt.
   5. Type, grade and weight of aggregate.
   6. Mix design method.

D. Trial Batch: Before placing any paving material, a testing laboratory acceptable to the Engineer shall prepare a trial batch of asphalt concrete for each job-mix formula to be used by the Contractor for the work. The trial batch shall be prepared using the aggregates and asphalt cement proposed by the Contractor, and approved by the Engineer. The compacted trial batch shall provide a basis for computing the voids ratio, provide an indication of the optimum asphalt content, and establish a basis for controlling compaction during construction. The cost of not more than two laboratory trial batch tests will be paid by the Owner but the Contractor shall furnish the materials at no cost to the Owner. Any additional trial batch testing required shall be performed at the expense of the Contractor.

1.4 QUALITY ASSURANCE

A. Use a laboratory that follows and complies with ASTM D 3666.

B. Do not change aggregate source, asphalt source or mix design without Engineer's prior written approval.

C. Reject product and work that does not meet the requirements of this Section.

D. Remove product that is found to be defective after installation and install acceptable product at no additional cost to the Owner.

E. Foreman of paving crew shall have completed at least five projects of similar size and nature.

1.5 WEATHER

A. Do not pave until air temperature is 45 degrees F and rising.

B. Cease paving if air temperature falls below 50 degrees F.

C. Do not pave is surface is wet or if rain, snow or other precipitation is expected.

D. Do not pave if wind or ground cools the mix material before compaction.

1.6 ACCEPETANCE

A. General: Acceptance is by lot.

B. Materials:
   1. Lot is one day's production.
   2. At the source:
      a. Aggregate: Verify gradation. Collect sample form the conveyor belt or stockpile if belt is not accessible.
      b. Paving Asphalt: Asphalt shall meet the requirements of this section and shall satisfy the limits identified in the Utah Department of Transportation's "Manual of Instructions – Part 8 Materials"
      c. Mix Temperature shall not exceed 325 degrees F in the transport vehicle.
   3. At the Site:
      a. A sub-lot is 500 tons.
      b. Obtain one random sample per sub-lot behind the paver before compaction or at locations exhibiting non-uniform appearance.
   4. At the Laboratory:
      a. Air voids shall be evaluated on the basis of laboratory compacted samples.
      b. Dust to asphalt ratio.
      c. Asphalt content and aggregate gradation.
   5. If material does not meet any requirement of the specification, the Engineer may direct that the sub-lot be removed and replace with a material meeting the specification requirements at no additional cost to the Owner.

C. Installation:
   1. Observation of Contractor's field quality control testing does not constitute acceptance.
   2. Opening a paved surface to traffic does not constitute acceptance:
   3. Reject any mixes exceeding 325 degree F in transport vehicle.
      a. Dispose of cold mix in paver hopper as thin spread underlay.
   4. Grade, Cross Slope: Verify that tolerance is not exceeded.
   5. Compaction:
      a. For compaction a lot is 1,000 square yards or any part thereof.
      b. Core Density: A lot is acceptable if the average core density does relative to ASTM D 2041 is 93 percent, with no individual test less than 89 percent.
      c. At least two test locations shall be sampled per ASTM D 3665 and three core samples shall be collected per each test location per ASTM D 5361. Core samples shall be full depth.

d. Cores shall be tested per ASTM D 2725 for core density and ASTM D 2041 (Rice) for maximum theoretical density.
e. Other non-destructive testing methods may be used during placement to aid in establishing a rolling pattern and determining the required compaction effort. However, density acceptance will be by core densities.

6. Thickness:
   a. For thickness a lot is 1,000 square yards or any part thereof.
   b. Core Thickness: A lot is acceptable if the average core thickness is not less than 0.25 inches less than the specified thickness.
   c. At least two test locations shall be sampled per ASTM D 3665 and three core samples shall be collected per each test location per ASTM D 5361. Core samples shall be full depth.
   d. Cores shall be tested per ASTM D 3549 for thickness.
7. Lots that are not acceptable may be rejected and the Engineer may direct that the lot be removed and replaced at no additional cost to the Owner.

PART 2 - PART 2 – PRODUCTS

2.1 UNTREATED BASE COURSE

A. The untreated base course shall consist of select material, either natural or crushed and shall be graded as follows:

Sieve Size	Gradation Ideal Gradation
3/4 inch	100
3/8-inch	75-95
No. 4 sieve	55-70
No. 16 sieve	30-40
No. 200 sieve	2-10

2.2 TACK COAT

A. Tack coat shall be emulsified asphalt Grade SS-1 or SS-1h, CSS-1 or CSS-1h diluted with one part water to one part emulsified asphalt, undiluted asphalt Grade RS-1 or CRS-1, or paving asphalt Grade AR-1000. Emulsified asphalt shall comply with the requirements of AASHTO M 140 (ASTM D 977) or M 208 (ASTM D 2397); paving asphalt shall comply with the requirements of AASHTO M 226 (ASTM D 3381).

2.3 ASPHALT CEMENT (AC)

A. Petroleum Asphalt that complies with table 2 of ASTM D 3381 except as follows:
   1. Replace ductility at 77 deg F. with ductility at 39.2 deg. F. Use the following values:
      a. AC - 10: greater than 15
      b. AC - 20: greater than 5
   2. Delete the loss on heating requirement on the residue from the “Thin-Film Oven Test”.

B. Substitute Performance Graded Asphalt Binder (PGAB)
   1. PGAB asphalt meeting the requirements of ASTM D 6373 may be substituted for AC asphalt cement as follows:

a. AC - 10 – PGAB 58-22 or PGAB 58-28
b. AC - 20 – PGAB 64-22

2.4 AGGREGATE

A. Aggregate shall be clean, hard, durable, angular and sound consisting of crushed stone, crushed slag, crushed gravel, sand, or a combination of two or more of these materials.

B. Source Suitability: Use the following requirements to determine the suitability of the aggregate source and not for project control.
1. Coarse Aggregates:
a. Angularity (fractured faces), ASTM D 5281: 50 percent maximum by weight of particles with at least 2 fractured faces.
b. Hardness (toughness), ASTM C 131: 40 percent minimum wear of aggregate retained above the No. 4 sieve unless specific aggregates having higher values are known to be satisfactory.
c. Flat or elongated particles, ASTM D 4791: 20 percent maximum retained above the 3/8 inch sieve has a 3:1 length to width ratio.
2. Fine Aggregates:
a. Friable Particles, ASTM C 142: 2 percent maximum passing the No. 4 sieve.
b. Plasticity, ASTM D 4318: Aggregate passing the no. 40 sieve shall be non-plastic even when filler material is added to the aggregate.
1) Liquid Limit: Less than 25
2) Plastic Limit: Less than 6

C. Combinations of aggregates having a history of polishing shall not be used in surface courses.

2.5 ADMIXTURES

A. Mineral filler shall comply with ASTM D 242.

B. Antistrip shall be heat stable cement slurry of lime slurry.

2.6 MIX DESIGN

A. Material Designation:
1. Asphalt Cement shall be (See Drawings).
2. Aggregate gradation shall be (See Drawings).
3. Traffic Classification shall be medium.

B. Design Aggregate Gradation: The job-mix formula for the asphalt-aggregate surface course mixture shall be within the following gradation limits as percent passing by weight, ASTM C 136:

Aggregate Gradations				
Sieve Size	DM-1	DM-3/4N	DM-3/4	DM-1/2
1 inch	100			
3/4 inch		100	100	
1/2 inch	75-91	74-99		100
3/8 inch		69-91	75-91	

No. 4	47-61	49-65	46-62	60-80
No. 8		33-47		
No. 16	23-33	21-35	22-34	28-42
No. 50	12-22	6-18	11-23	11-23
No. 200	3-7	2-6	3-7	3-7

1. Dry-rodded Unit weight per ASTM C 29 shall be a minimum of 75 pounds per cubic foot.
2. Weight Loss or soundness per ASTM C 88 shall be a maximum of 16 percent using sodium sulfate.
3. Clay Content or cleanliness per ASTM D 2419shall be determined by the sand equivalent value after passing through the dryer or prior to the drum mixer at the following levels:
   a. 45 percent minimum for Medium Traffic Classification
   b. 60 percent minimum for Heavy Traffic Classification.

C. Design Mixture Test Criteria: Use the Marshall volumetric mix design, AI MS-2: price and payment procedures

Mix Design Criteria			
Criteria	Traffic Classification		
	Light	Medium	Heavy
Number of Compaction Blows	35	50	75
Stability, lbs. (minimum), ASTM D 5581	750	1200	1800
Flow, in 0.01 inch units, ASTM D 5581	10-18		
Voids in Mineral Aggregate (VMA), percent min., ASTM D 3203 Nominal Maximum Particle Size 1” 3/4” 1/2” 3/8”	 13 14 15 16.5		
Voids in Bituminous Mix (percent)	3-5		
Dust to Asphalt Ratio	0.8 – 1.6		
Moisture Sensitivity, ASTM D 4867	>0.8 with freeze thaw conditioning and test specimen compacted at 6-8 percent air voids		

Notes
Traffic Classifications:
Light – Parking lots, driveways, light traffic residential streets, light traffic farm roads. (ESAL $<10^4$ per year)
Medium – Residential streets, rural farm and residential roads (Class II); Urban minor collector streets, rural minor collector roads (Class III). (10^4<ESAL<10^6 per year)
Heavy – Urban Minor arterial and light industrial streets, rural major collector and minor arterial highways (Class IV); Urban major arterial and heavy industrial streets, freeways, expressways, arterial highways, rural interstate, and other principal arterial highways (Class V). (ESAL > 10^6 per year)

2.7 SOURCE QUALITY CONTROL

A. General: Supplier shall randomly collect samples per ASTM D 3665. The same sample point shall be used for all samples of a particular material.
   1. Aggregate sampling shall be per ASTM D 75.
   2. Asphalt Cement sampling shall be per ASTM D 140.

B. Asphalt-aggregate mix shall be sampled per ASTM D 979 and test for:
   1. Air Voids per ASTM D 3203.
   2. Paving Asphalt Content per ASTM D 6307.
   3. Aggregate Gradation per ASTOM D 5444
   4. Tensile strength of bitumen-aggregate mixtures per ASTM D 4867.

C. Mixing plant shall meet the requirements of ASTM D 3515.

2.8 PAVEMENT MARKING PAINT

A. Pavement marking paint shall be a product specifically formulated for use on asphalt concrete pavement and shall have a proven record of performance and durability. The paint striping materials shall conform with the State of Utah Standard Specifications for Road and Bridge Construction and its addenda.

PART 3 - EXECUTION

3.1 SUBGRADE PREPARATION

A. The subgrade shall be prepared in accordance with Section 31 23 00 – Earthwork as applicable to roadways and embankments. The surface of the subgrade after compaction shall be hard, uniform, smooth and true to grade and cross-section. Subgrade for pavement shall not vary more than 0.02-foot from the indicated grade and cross section. Subgrade for base material shall not vary more than 0.04-foot from the specified grade and cross section.

3.2 UNTREATED BASE COURSE

A. Untreated base course shall be provided where shown and to the thickness indicated. Imported untreated base course shall be delivered to the job site as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free of pockets of coarse or fine material. Where the required thickness is 6 inches or less, the base materials may be spread and compacted in one layer. Where the required thickness is more than 6 inches; the base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6 inches. The relative compaction of each layer of aggregate base shall be not less than 96 percent of maximum density when measured in accordance with ASTM D 1557 with no test below 92 percent of maximum density. The compacted surface of the finished aggregate shall be hard, uniform, smooth and at any point shall not vary more than 0.02 foot from the specified grade or cross-section.

3.3 TACK COAT

A. A tack coat shall be applied to existing paved surfaces where new asphalt concrete is to be placed on existing pavement. It shall also be applied to the contact surfaces of all cold pavement joints, curbs, gutters, manholes and the like immediately before the adjoining asphalt pavement is placed. Care shall be taken to prevent the application of tack coat material to surfaces that will not be in contact with the new asphalt concrete pavement. Diluted emulsified asphalt shall be applied at the rate of 0.05 to 0.15 gal/sq yd. Undiluted emulsified asphalt shall be applied at the rate of 0.025 to 0.075 gal/sq yd. Paving asphalt shall be applied at the rate of approximately 0.05 gal/sq yd.

3.4 CONSTRUCTION EQUIPMENT

A. Lay Down Machine shall have tracks when operating on fabrics, geogrids or pavement mats hotter than 180 degrees F.

B. Compactors shall be static or vibratory, steel wheel rollers. Pneumatic tire rollers may be used for intermediate rolling only.

3.5 ASPHALT CONCRETE

A. At the time of delivery to the work site, the temperature of mixture shall not be higher than 320 degrees F, and shall not be less than indicated below:

Minimum Asphalt Concrete Temperature, degrees F						
Air	Compacted Mat Thickness					
Temperature	3/4 inch	1 inch	1-1/2 inch	2 inch	3 inch	4 inch +
45-50	-	-	-	-	280	265
50-59	-	-	-	280	270	255
60-69	-	-	285	275	265	250
70-79	285	285	280	270	265	250
80-89	280	275	270	265	260	250
90+	275	270	265	260	250	250

B. The asphalt concrete shall be evenly spread upon the subgrade or base to such a depth that, after rolling, it will be of the required cross section and grade of the course being constructed.

C. The depositing, distributing, and spreading of the asphalt concrete shall be accomplished in a single, continuous operation by means of a self-propelled mechanical spreading and finishing machine designed especially for that purpose. The machine shall be equipped with a screed or strike-off assembly capable of being accurately regulated and adjusted to distribute a layer of the material to a definite pre-determined thickness. When paving is of a size or in a location that use of a self-propelled machine is impractical, the Engineer may waive the self-propelled requirement.

D. Spreading, once commenced, shall be continued without interruption.

E. The mix shall be compacted immediately after placing. If needed, intermediate rolling with a pneumatic-tired roller shall be done immediately behind the initial rolling. Final rolling shall

eliminate marks from previous rolling. In areas too small for the roller, a vibrating plate compactor or a hand tamper shall be used to achieve thorough compaction.

F. Compaction shall be completed before temperature drop to 180 degrees F.

G. Do not leave unsafe butt joints if paving operations stop.

H. Barricade or eliminate fall off edges.

I. Joints
   1. Construct joints to have the same texture, density and smoothness as other section of the new pavement course.
   2. Clean contact surfaces and apply tack coat. Ensure continuous bond between old and new pavement or between successive day's work.
   3. Offset longitudinally joints a minimum of 12 inches in succeeding courses and offset transverse joints a minimum of 6 feet to avoid a vertical joint through more than one course. In the tops course restrict longitudinal joints to either side of the lane lines.
   4. Prevent traffic, including construction traffic, from crossing vertical edges. Apply tack coat to vertical edges prior to making another pass with the paver if the mix has cooled to 90 degrees F.

3.6 TOLERANCES

A. Lift thickness shall not be less than 2 times the maximum aggregate size nor more than 3 inches (compacted thickness) or the limits established by the pneumatic or vibratory compactor equipment manufacturer, whichever is less.

B. Upon completion the pavement shall be true to grade and cross-section. When a 10-ft straightedge is laid on the finished surface parallel to the center of the roadway, the surface shall not vary from the edge of the straightedge more than 1/8-in except at intersections or changes of grade. In the transverse direction, the surface shall not vary from the edge of the straightedge more than 1/4-in.

3.7 BITUMINOUS SURFACE PATCHING

A. Where pits are excavated through bituminous surfaced roads, driveways, parking areas, etc., the surface shall be restored and maintained as follows:
   1. A temporary gravel surface shall be placed and maintained after the required backfill and compaction of the trench has been accomplished.
   2. The gravel shall be placed to such depth as to provide six inches below the pavement and shall be brought flush with the paved surface.
   3. The area over trenches to be resurfaced shall be graded and rolled with a roller weighing not less than twelve tons, or with the rear wheels of a five-yard truck loaded to capacity, until the subgrade is firm and unyielding. Mud or other soft or spongy material shall be removed and the void filled with gravel and rolled and tamped thoroughly in layers not exceeding six inches in thickness. The edges of trenches which are broken down during the making of subgrade shall be removed and trimmed neatly before resurfacing.

4. Before any permanent resurfacing is placed, the Contractor shall trim the existing paving to clean, straight lines as nearly parallel to the centerline of the trench as practicable.
5. Existing bituminous paving shall be cut back a minimum of six inches beyond the limits of any excavation of cave-in along the trench so that the edges of the new paving will rest on at least six inches of undisturbed soil.
6. As soon as is practical, weather permitting, the bituminous surface shall be restored by standard paving practices to the thickness specified herein.
7. Pavement restoration shall include tacking of pavement of edges and subbase with MC 70-250 bituminous material and placing rolling plant hot mix bituminous material to the level of the adjacent pavement surfaces.

3.8 PROTECTION AND REPAIR

A. General: All work is at no additional expense to the Owner.

B. Protection:
1. Protect all structures, including curb, gutter, sidewalks, street fixtures, delineators, signs, guard rails and guide posts.
2. Remove all spatter, over-coat or mar.
3. Do not discharge bituminous materials into borrow pits, roadside ditches, gutters or other areas.
4. Protect hot pavement from traffic until mixture has cooled enough not to become marked.
5. Protect neighborhood, storm drains and downstream wetland and fish habitats.

C. Repair
1. When thickness is deficient, place additional material over deficient areas. Do not skin patch. If necessary, mill for inlay.
2. Repair defective seams, edges and joints.
3. Remove and replace unacceptable paving.

3.9 PAVEMENT MARKING

A. Pavement marking paint shall be applied where indicated only when the pavement surface is dry and clean, and when the air temperature is above 40 degrees F. Pavement marking shall commence no sooner than 21 days after completion of pavement installation. All equipment used in the application of pavement marking shall produce stripes and markings of uniform quality with clean and well-defined edges that conform to the details and dimensions shown. Drips, overspray, improper markings, and paint material tracked by traffic shall be immediately removed from the pavement surface by methods previously reviewed by the Engineer.

END OF SECTION

SECTION 32 13 73
PAVEMENT JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes joint sealants for exterior site concrete pavement work including parking lots, ,driveways, sidewalks, curbs, curb and gutters, waterways, etc:
   1. Joint Void-former
   2. Cold-applied joint sealants.
   3. Hot-applied joint sealants.

B. Related Sections:
   1. Section 32 12 16 - "Asphalt Cement Pavement and Base" for constructing joints between concrete and asphalt pavement.

1.3 SUBMITTALS

A. Product Data: Provide Manufactures product data and sample for each joint-sealant product indicated.

B. Product Certificates: For each type of joint sealant and accessory, from manufacturer.

C. Manufacturer's instructions for joint preparation, type of cleaning and installation for each type of joint sealant.

1.4 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
   2. When joint substrates are wet.
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.5 SYSTEM PERFORMANCE

A. Pavement joints include longitudinal and transverse expansion joints, isolation joints, contraction joints, and crack control joints.

B. Provide joint sealants that maintain watertight and airtight continuous seals.

1.6 QUALITY ASSURANCE

A. Installation of joint systems shall follow manufacturer's published instructions.

B. For cold applied joint sealant installation, use installers that are approved by the joint sealant supplier. Provide written proof on sealant supplier's approval.

C. Obtain joint sealing materials from a single manufacturer for each different product required.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site in original, unopened containers or bundles with labels identifying manufacturer, product name and designation, color, expiration period for use, pot life, cure time, and mixing instructions for multi-component materials.

B. Store and handle materials in compliance with manufacturer's recommendations to prevent deterioration; or damage due to moisture, high or low temperatures, contaminants or other causes.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

2.2 JOINT VOID-FORMER

A. Plastic, with a water stop.

B. ¼ depth of concrete slab thickness.

2.3 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Crafco Inc., an ERGON company; RoadSaver Silicone.
      b. Dow Corning Corporation; 888.
      c. Pecora Corporation; 301 NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Crafco Inc., an ERGON company; RoadSaver Silicone SL.
      b. Dow Corning Corporation; 890-SL.
      c. Pecora Corporation; 300 SL.

C. Single-Component, Self-Leveling, Polyurethane Joint Sealant for Concrete: ASTM D 5893, Type SL.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Sikaflex – 1C SL - Polyurethane SL.

D. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Pecora Corporation; Urexpan NR-200.

2.4 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant for Concrete: ASTM D 3406.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Crafco Inc., an ERGON company; Superseal 444/777.

B. Hot-Applied, Single-Component Joint Sealant for Concrete and Asphalt: ASTM D 6690, Types I, II, and III.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Meadows, W. R., Inc.; Sealtight 3405.
      b. Right Pointe; D-3405 Hot Applied Sealant.

2.5 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.6 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Immediately after sawcutting control joints, wash freshly sawed joints with a high pressure wash to remove saw slurry from the joint faces.

C. Immediately prior to installing joint sealant, remove oil, grease, wax, form-release agents, curing compounds, bitumens, laitance and old chalking material by sandblast, as recommended by manufacturer of sealant. Maximum sand blast angle, 25 degrees plus or minus 5 degrees. Complete two full passes for each joint to be sealed, one blast for each face.

D. Clean and dry with air blast. Do not contaminate air blast with oils or lubricants.

E. Remove frost and moisture in concrete joint substrates before commencing sealing.

F. Install bond breaker tape where needed or required by manufacturer’s recommendations to ensure that elastomeric sealants will perform properly.

G. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Depths: Saw cut joints if necessary to provide the required sealant thicknesses and depth. Install sealant to the depths indicated or, if not indicated, as recommended by the sealant manufacturer, but within the following general limitations measured at center (thin) section of bead:

1. For sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth

equal to 75 percent of joint width, but not more than 5/8 inch deep nor less than 3/8 inch deep.

2. For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than ½ inch deep nor less than ¼ inch deep.
3. For joints sealed with non-elastomeric sealants and caulking compounds, fill joints full depth.

D. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
1. Do not leave gaps between ends of joint-sealant backings.
2. Do not stretch, twist, puncture, or tear joint-sealant backings.
3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
1. Place joint sealants so they directly contact and fully wet joint substrates.
2. Install joint sealants in uniform, continuous ribbons without gaps or air pockets, with complete bonding of joint surfaces on opposite sides.
3. Completely fill recesses in each joint configuration, unless otherwise indicated.
4. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
5. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove so that joint will not trap moisture and dirt.

F. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

G. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

H. Spillage: Do not allow poured sealant compound to overflow or spill onto adjoining surfaces or to migrate into voids of adjoining surfaces. Clean adjoining surfaces to eliminate evidence of spillage.

I. Heating: Do not use overheated hot-applied sealants.

J. Edges: Unless indicated otherwise, recess exposed edges of gasket and exposed joint filler slightly behind adjoining surfaces so compressed units will not protrude from joints.

3.4 CURING AND CLEANING

A. Cure joint sealant compounds per manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength, and surface durability.

B. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.6 PAVEMENT-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within cement concrete pavement.
   1. Joint Location:
      a. Expansion and isolation joints in cast-in-place concrete pavement.
      b. Contraction joints in cast-in-place concrete slabs.
      c. Other joints as indicated.
   2. Silicone Joint Sealant for Concrete: Single component, nonsag or Single component, self-leveling.
   3. Urethane Joint Sealant for Concrete: Multicomponent, pourable, traffic-grade.
   4. Hot-Applied Joint Sealant for Concrete: Single component.
   5. Joint-Sealant Color: Color shall match the color of adjacent concrete surfaces

B. Joint-Sealant Application: Joints between cement concrete and asphalt pavement.
   1. Joint Location:
      a. Joints between concrete and asphalt pavement.
      b. Joints between concrete curbs and asphalt pavement.
      c. Other joints as indicated.
   2. Hot-Applied Joint Sealant for Concrete and Asphalt: Single component.

END OF SECTION

SECTION 32 16 00
DRIVEWAYS, SIDEWALKS, CURBS, GUTTERS, AND OTHER CONCRETE FLATWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes exterior cement concrete flatwork such as but not limited to the following:
   1. Driveways.
   2. Curbs ,gutters and waterways
   3. Sidewalks and Walkways.
   4. Other exterior site concrete flatwork

B. Related Sections include the following:
   1. Section 31 23 00 – Earthwork for subgrade preparation, grading, and base course.
   2. Section 32 13 73 – Pavement Joint Sealants for joint sealants of joints in concrete flatwork and at isolation joints of concrete flatwork with adjacent construction.

1.3 REFERENCES

AASHTO M 6	Standard Specification for Fine Aggregate for Portland Cement Concrete
AASHTO M 154	Standard Specification for Air-Entraining Admixtures for Concrete
AASHTO M 80	Standard Specification for Coarse Aggregate for Portland cement Concrete
AASHTO M 182	Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats
ACI 117	Standard Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete for Buildings; American Concrete Institute International; 1996.
ACI 305 R	Hot Weather Concreting; American Concrete Institute International; 1991.
ACI 306 R	Cold Weather Concreting; American Concrete Institute International; 1988.

ACI CP-1(08)	Technical Workbook for ACI Certification of Concrete Field Testing Technician-Grade
ASTM A 307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
ASTM A 615/A 615M	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 1996a.
ASTM C 31/C31 M	Standard Practice for Making and Curing Concrete Test Specimens in the Field.
ASTM C 33	Standard Specification for Concrete Aggregates; 1993.
ASTM C 39/C39 M	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 1996.
ASTM C 94/C94M	Standard Specification for Ready-Mixed Concrete; 1996.
ASTM C 143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C 150	Standard Specification for Portland Cement; 1996.
ASTM C 171	Standard Specification for Sheet Materials for Curing Concrete; 1997.
ASTM C 172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method; 1994a.
ASTM C 260	Standard Specification for Air-Entraining Admixtures for Concrete; 1995.
ASTM C 494	Standard Specification for Chemical Admixtures for Concrete.
ASTM C 618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete; 1996a.
ASTM C 881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 1990.
ASTM C 1017/C 1017M	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1059/C1059 M	Standard Specification for Latex Agents for Bonding Fresh To Hardened Concrete

ASTM C 1064	Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete.
ASTM C 1077	Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM D 1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types); 1983 (reapproved 1991).
ASTM D 1752	Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM E 329	Standard Specification for Agencies Engaged in Construction Inspection and/or Testing
FS TT-P-1952	Pavement Markings

1.4 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with fly ash.

1.5 SUBMITTALS

A. Design Mixtures: For each concrete flatwork mixture satisfying the requirements of this section and Section 03 30 00 Cast-in-place Concrete. Include alternate mixture designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments
   1. Mix designs will be approved based on results of trial batches or on past history of mix design successes from project(s) within the last year.
   2. Use the same components in the trial batches that are to be used in the project. The Contractor assumes responsibility for the compatibility of all admixtures with the mix design and their potential effects on concrete properties.
   3. Personnel performing and witnessing trial batches, and performing compressive and flexural strength testing, must be performed by an AASHTO accredited laboratory paid for by Contractor.
   4. The Owner or Engineer may witness trial batch preparation and testing.

B. Product Data: For each type of manufactured material and product indicated.

C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:
   1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
   2. For any proposed mix design, provide test results for potential reactivity of coarse and fine aggregates in accordance with the requirements of this section.

3. When using potentially reactive aggregates in a mix design, provide results from appropriate testing to determine the ability of the combinations of cementitious materials and aggregates to control the reactivity

D. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
   1. Cementitious materials.
   2. Steel reinforcement and reinforcement accessories.
   3. Fiber reinforcement.
   4. Admixtures.
   5. Curing compounds.
   6. Applied finish materials.
   7. Bonding agent or epoxy adhesive.
   8. Joint fillers.

E. Joint Layout Plan: Submit plan showing location and type of each joint to be placed in the concrete flatwork.

F. Proof of finishers' ACI Certifications

G. Manufactures recommended installation procedures for joint sealing material which, when accepted by Engineer, will become the basis for accepting or rejecting the actual installation procedures used in the Work.

H. Delivery tickets per Section 03 30 00 – Cast-in-place Concrete

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1(08) or an equivalent certification program.

C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

D. Concrete Testing Service: All concrete testing will be done by a testing laboratory of the Owner's choice at the Owner's expense.

E. Do not change concrete Supplier until Engineer accepts new source and new mix design.

F. Remove product found defective after installation and install acceptable product at no additional cost to Owner.

G. Foreman of paving crew shall have completed at least three (3) projects of similar size and nature.

1.7 1ACCEPTANCE

A. General: Acceptance is by lot. Lot size is specified below for each component.

B. Concrete Mix:
   1. Lot size is 50 cu. yd. or fraction thereof of each concrete mix placed each day.
   2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
   3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
   4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each omposite sample.
   5. For slump, air and temperature reject non-complying batches until 2 consecutive batches are compliant then continue in random batch testing for acceptance.

C. Strength
   1. Lot size is 50 cu. yd. or fraction thereof of each concrete mix placed each day.
      a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   2. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of five standard cylinder specimens for each composite sample.
   3. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.
   4. Strength of each lot will be satisfactory if the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
   5. Remaining cylinders shall be held to verify test results, if required.

D. Installation:
   1. Grades, finishes, cross-slopes and dimensions of completed pavement shall be checked for compliance with plan requirements. Standing water in curb and gutter or “bird baths” in flatwork are not permitted and shall be immediately corrected by removal of failed areas and replacement per these specifications and directions of the Engineer at no additional cost to the owner.

E. Test Results: Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

G. Additional Tests: Engineer may direct testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met.

H. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

I. Additional testing and inspecting, at Contractor's expense will be performed to determine compliance of replaced or additional work with specified requirements.

1.8 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Weather: Concrete placement shall conform to the requirements of ACI 305 R and ACI 306 R for hot and cold weather, respectively in addition to the requirements of Section 03 30 00 – Cast-in-place Concrete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
   2. Products: Subject to compliance with requirements, provide one of the products specified.
   3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
   1. Use flexible or curved forms for curves with a radius 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed, epoxy coated

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:
   1. Portland Cement: ASTM C 150, Type II.
   2. Do not use cement that contains lumps or is partially set.
   3. Do not mix cements originating from different sources.
   4. Do not use air-entrained cement.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar concrete flatwork applications and service conditions using similar aggregates and cementitious materials.
   1. Maximum Coarse-Aggregate Size: 3/4 inch nominal
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Mixing Water:
   1. For standard Type II Cement: ASTM C 94/C 94M

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
   1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   2. Retarding Admixture: ASTM C 494/C 494M, Type B.
   3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz. /sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete. Evaporation Retarder shall not be used as a finishing aid.

2.6 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.
   1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:
   1. Compressive Strength (28 Days): 4000 psi.
   2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.44.
   3. Do not exceed water/cementitious ratio.
   4. Calculate the water/cementitious ratio (w/c) according to the following formula:
      a. W = Water
      b. C Cement + Pozzolan
   5. Concrete Slump Limits:
      a. For concrete not containing water reducers, 4 inches, plus or minus 1 inch.
      b. For concrete containing low range water reducers: 1 inch to 5 inches for all classes of concrete.
      c. For concrete containing high range water reducers: 4 inches to 9 inches for all classes of concrete.
   6. Cement Content: 6.5 bags

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete having an air content as follows:
   1. Air Content: 6 percent plus or minus 1.0 percent for 3/4-inch nominal maximum aggregate size at point of placement.
   2. The range listed represents air content at point of placement. Make necessary adjustments for impacts to air content due method of placement.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals:

2.8 POZZOLAN

A. Fly Ash:
   1. Fly ash must conform to ASTM C 618 Class F specifications with the following modifications:
      a. Loss on Ignition (LOI): not to exceed 3 percent.
      b. Maximum allowable CaO content: not to exceed 15 percent.
      c. Label the storage silo for fly ash to distinguish it from cement.
      d. Use different size unloading hoses and fittings for cement and fly ash.
      e. When used as partial portland cement replacement, the fly ash may replace 20% of the cement by weight.

2. Fly ash may be sampled and tested for compliance at any time.

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.
   1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. When automatic machine placement is used for placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce sidewalks, curbs, curbs and gutters, and other flatwork to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.
   1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

3.2 EXAMINATION

A. Examine exposed subgrades and base surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proceed with concrete flatwork operations only after nonconforming conditions have been corrected and subgrade and base is ready to receive flatwork.

3.3 PREPARATION

A. Assure the subgrade or base for the concrete has a firm even surface and is compacted meeting the requirements of Section 31 23 00 – Earthwork.

B. Remove loose material from compacted base surface immediately before placing concrete.

C. Remove sand, leaves, trash, rubbish, topsoil, and other objectionable materials prior to placing concrete.

D. Coat the surface of street fixtures with oil to prevent bond with concrete flatwork.

E. Notify Engineer a minimum of 48 hours prior to commencing laying operations.

3.4 LAYOUT

A. Curb, Gutter, Curb and Gutter, Waterways: Set lines, forms, screeds, etc to meet the following requirements:

1. Line: Less than ½ inch variance in 10 feet and not more than 1 inch from true line at any location.
2. Grade: Not more than ¼ inch variance in 10 feet. Flood curb and gutter and waterway with water after final cure has been reached. Remove and replace any area where ponding is found.

B. Sidewalk and Walkways: Set forms, screeds, etc to meet the following requirements:
1. Cross-slope shall not be less than 1.5% nor more than 2%.
2. Landings and doorway aprons shall not slope more than 2% in any direction.

C. Layout shall meet the requirements as given in the construction plans.

3.5 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for flatwork to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Check formwork for grade and alignment variance from the following tolerances:
1. Top of forms shall not be more than ¼ inch from design grade
2. Vertical face on longitudinal axis shall not be more than ¼-inch from true line.

C. Place joint filler in vertical position, in straight lines and secure to formwork during concrete placement.

D. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, grade lines, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work. Inspect formwork for line and grade and make corrections as required.

B. Remove snow, ice, or frost from base surface before placing concrete. Do not place concrete on frozen surfaces.

C. Obtain Engineer's review of base, forms, lines, etc. before placing concrete. Engineer's review does not relieve the Contractor's responsibility to ensure all Work is in compliance with the contract documents and these requirements and correct defective Work as required.

D. At the beginning of concrete placement, test slump, temperature and air entrainment. If corrections are necessary, placement may proceed after 2 subsequent and consecutive batches pass testing.

E. Moisten base to provide a uniform dampened condition, without standing water, at time concrete is placed.

F. Do not place concrete around manholes or other structures until they are at required finish elevation, cross-slope and alignment.

G. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

H. Do not add water to concrete during delivery to the Project site.

I. Water may not be added to the delivery truck at the project site prior to discharge unless approved by the Engineer. If water is added at the project site, record quantity of water added on delivery ticket.

J. Site-added air-entrainment. (Meet AASHTO M 154)
   1. Limit the use of site-added air-entraining agents to one addition (regardless of quantity) per load
   2. Use pre-measured admixtures.
   3. Record amount used on batch ticket.
   4. Rotate the drum at least 30 revolutions at the mixing speed recommended by the manufacturer.

K. Do not add water to fresh concrete after testing.

L. Deposit and spread concrete in a continuous operation. Prevent segregation of concrete mix. If placement operations are interrupted for more than 30 minutes, place a construction joint.

M. Place concrete so time between end of placement and beginning of finishing is less than 15 minutes.

N. Consolidate concrete with vibrator or other acceptable method. Do not use mechanical vibrators. Prevent dislocation of inserts.

O. Cold-Weather Placement: Comply with ACI 306.R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
   2. Do not use frozen materials or materials containing ice or snow.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.

P. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
   1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 JOINTS

A. General:
   1. Review joint layout plan with Engineer.

B. Isolation/Expansion Joints:
   1. Geometrics: ½ inch wide full depth filler that is flush with concrete surface. Do not place seal over top of filler.
   2. Sidewalks, Walkways, Sidewalk Ramps:
      a. Place isolation joints to separate sidewalk from utility poles, hydrants, manhole frames, buildings, abutting sidewalks and other street fixtures or structures.
      b. Place isolation joints between the sidewalk and the back of curb returns and between the sidewalk and sidewalk ramps.
      c. Do not place isolation joints in sidewalk ramp surfaces.
   3. Curb, Gutter, Curb and Gutter, Waterway:
      a. Do not place longitudinal joints in gutter flow-lines.
      b. Where gutter transitions extend beyond the curb return, place expansion joints at the ends of the gutters transition.
      c. Place isolation joints at beginning of curb radius and end of curb radius.
   4. Slip Form Work: Expansion joints are not required except at beginning of curb radius, end of curb radius, structures, street fixtures, inserts, foundations and other structures.
   5. Driveway approach: Do not place isolation joints in curb returns.

C. Contraction Joints: Contraction joints (crack control joints) are scorelines made to force crack joint location in concrete. Form weakened-plane contraction joints, sectioning concrete into areas as indicated.
   1. Geometrics:
      a. Tooled Joints (score lines)
      b. Construct contraction joints to a depth equal to at least one-fourth ($1/4^{th}$) of the concrete thickness
      c. Top radius of joints shall be ½ inch.
      d. Saw Cut Joints: Saw joints before uncontrolled shrinkage cracking occurs. Do not tear or ravel concrete during sawing.
      e. Template Joints: 1/8 to 3/16 inch wide, ¼ depth of concrete.
   2. Sidewalks.
      a. Place contraction joints at intervals equal to the width of the sidewalk and transverse to the direction of travel.
      b. Place radial contraction joints curves and curb returns.
      c. Place longitudinal contraction joints in walks when width of walk in feet is greater the 2 times the walk thickness in inches. (e.g. maximum width of a 4 inch thick walk before placement of a longitudinal contraction joint is 8 feet.) Make longitudinal joints parallel to, or concentric with, the lines of the walk.

d. In walk returns make one joint radially midway between the beginning of curb return and end of curb return. Match the longitudinal and transverse joints with adjacent walks.

3. Curb, Gutter, Curb and Gutter, Waterway.
   a. Place joints at intervals not exceeding 12 feet.
   b. At curb radius and walk return make the joints radial.
   c. Where integral curb and gutter is adjacent to concrete pavement, align the joints with the pavement joints, where practical.
4. Other Flatwork:
   a. Joint Spacing, in feet, shall be twice the slab thickness measured in inches, unless otherwise indicated. (i.e. Slab thickness is 6-inches, joint spacing shall be 12-feet.) Joint spacing shall not exceed 15 feet.
   b. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
   c. Keep a minimum of three (3) working power saws on site when concrete operations are underway.
   d. Longitudinal joint spacing shall match the transverse joint spacing.
   e. Transverse joints shall extend across the width of the pavement and meet the joints of the adjoining concrete surfaces (i.e. sidewalk, curb and gutter, etc.).

D. Volunteer Crack Joints: If a volunteer crack joint occurs within any flatwork of this section, sawcut and remove cracked section at nearest contraction joints and replace the section at no additional cost to the owner.

3.8 FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/2-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

C. Apply broom finish longitudinal to curb, gutter, curb and gutter, and waterway flowline.

D. Apply broom finish transverse to sidewalk, walkway and other flatwork centerline as follows:
   1. Fine hair finish where grades are less than 6 percent.
   2. Rough hair finish where grades exceed 6 percent.

E. Remove form marks, tool marks, and other irregularities from finish surfaces.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306 R for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
   1. Curing Compound: Use a Type ID, Class A (clear with fugitive dye) membrane forming compound. Apply total coverage in 2 directions after texturing. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
   2. Eliminate thermal shock of concrete by keeping cure temperatures even throughout extent and depth on concrete slab.

3.10 REPAIRS AND PROTECTION

A. Protect concrete in compliance with requirements of Section 03 30 00 – Structural Concrete. Remove and replace concrete flatwork that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Protect concrete from damage. Do not allow steel wheel rollers or steel wheel vehicles on the concrete flatwork.

C. Exclude traffic from concrete flatwork for at least 14 days after placement or until 100 percent of the design strength has been achieved as demonstrated by concrete cylinder compression tests.

D. If construction traffic is permitted, maintain concrete flatwork as clean as possible by removing surface stains and spillage of materials as they occur.

E. Protect fresh concrete from vandals, damage, pedestrian traffic, etc. Repair damaged section immediately to the satisfaction of the Engineer.

F. Remove saw-cut dust immediately. Do not allow saw-cut dust to be flushed down storm drains or into adjacent wetlands or landscaping areas.

G. Maintain concrete flatwork free of stains, discoloration, dirt, and other foreign material. Sweep concrete flatwork not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

DIVISION 33
UTILITIES

THIS PAGE INTENTIONALLY BLANK

SECTION 33 01 30.16
TV INSPECTION OF SEWER PIPELINES

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work covered by this Section includes furnishing all labor, competent certified technicians, equipment, tools, accessories, and materials required to perform Pre- and Post-Installation CCTV inspection as required to complete the work.

B. CCTV inspection of sanitary sewers shall use the NASSCO industry standard Pipeline Assessment and Certification Program (PACP) forms and coding.

C. Digital videos, NASSCO PACP data, logs, and photos shall be submitted to the Engineer on a portable hard drive.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 33 01 30.51 – Sewer Cleaning

B. Section 33 01 30.72 – Cured-in-Place Pipe Lining

1.3 REFERENCE STANDARDS

A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
   1. NASSCO Pipeline Assessment and Certification Program (PACP)

1.4 SUBMITTALS

A. Submit a thumb drive or cloud link with sample CCTV inspection video file to ensure the video quality and clarity meets the requirements and expectations.

B. Submit portal hard drive and Inspection logs to the Engineer for review.
   1. Provide a portal hard drive of a quality sufficient for the Engineer to evaluate the condition of the sewer, locate the sewer service connections, and verify cleaning. If the Engineer determines that the quality is not sufficient, Contractor shall re-televise the sewer segment and provide a portal hard drives and report at no additional cost to the Owner. Camera distortions, inadequate lighting, dirty lens, or blurred/hazy picture will be cause for rejection of a video and rejection of the associated line segment. Payment for televised inspection will not be made until Engineer approves the quality of the portal hard drives and reports.
   2. List of portal hard drives submitted become the property of the Owner.
   3. Contractor shall maintain a master copy of all portal hard drives and Inspection Reports submitted.
   4. The Pre-and Post-Installation TV Inspection portal hard drives shall not be edited.

PART 2 - PRODUCTS

2.1 TELEVISION INSPECTION EQUIPMENT

A. Contractor shall provide CCTV equipment capable of operating in pipes that are at least 8-inches in diameter.

B. CCTV equipment, data collection device, and power for operation must be self-contained.

C. Equipment shall be capable of moving through the pipeline in either direction at a uniform rate to ensure proper documentation of the sewer pipeline condition but in no case shall the television camera traverse at a speed greater than two feet per second (2 fps or 30 fpm).

D. Equipment shall be capable of viewing defects to thoroughly evaluate the pipes condition.

E. Equipment shall be capable of producing a continuously monitored picture with the resolution capability to discern small cracks and other minor/major defects in the sewer pipeline.

F. Equipment shall be equipped with a non-powered high strength tether for equipment retrieval.

G. Operation of CCTV equipment shall be capable of being operated by no more than one (1) operator.

H. Contractor shall provide a mobile vehicle with video monitoring equipment specifically compatible with the camera equipment being used. The vehicle shall be large enough to accommodate at least three people at any time for viewing of the monitor. Owner and Engineer shall have unrestricted access to observe the television screen and all other operations at all times.

I. The television camera used for the inspection shall be specifically designed and constructed for such inspection. Adjustable light source to allow an even distribution of lighting for the camera shall be suitable to allow a clear color picture of the entire periphery of the pipe. The camera shall be capable of panning 360 degrees and tilting 270 degrees to facilitate the inspection of all defects, with optimum picture quality provided by focus and iris adjustment. The camera, television monitor, and other components of the video system shall be capable of producing a minimum 600 line resolution picture. Backup camera shall be available on the Project site. The camera shall be operative in 100 percent humidity conditions and in a hazardous and corrosive environment. The camera shall be capable of zooming at least 10:1 for looking further down the pipe.

J. The camera, television monitor, and other components of the video system shall be capable of producing picture quality to the satisfaction of Engineer and/or Owner. The same quality provided in the pre-construction submittal is expected.

PART 3 - EXECUTION

3.1 TELEVISING

A. Pre-installation TV Inspection shall be performed under bypass pumping. Pre-Installation TV Inspection shall be performed immediately after line cleaning and before line rehabilitation work. Verify that the line is clean and ready to accept the line rehabilitation material. Maintain copies of video files and logs for reference by the Engineer for the duration of the Project. Inspection files shall be submitted for permanent record, but Engineer/Owner may approve the pre-Installation CCTV from the TV truck.

B. Perform Post-Installation TV Inspection while the pipe is still under bypass pumping to confirm completion of rehabilitation work. Verify that the rehabilitation work conforms to the requirements of the Specifications. Provide a color video file showing the completed Work. Prepare and submit a log providing location of any discrepancies.

C. Perform TV inspection of the sewer as follows:
   1. Move the camera through the line in either direction at a uniform rate, stopping when necessary to ensure proper documentation of the sewer's condition.
   2. Use manual winches, power winches, TV cable and powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the sewer conditions to move the camera through the sewer line.
   3. Quantify visible leakage of extraneous flow into the sewer and record on electronic log and audio video files. The video recording may be paused during observation. Record results of the flow observed on video files and inspection logs.

D. Camera shall pan beginning and ending manholes to demonstrate that all debris has been removed. Camera operator shall slowly pan clamped joints, and when pipe material transitions from one material to another. A log shall be completed for every segment that is submitted to the Engineer.

E. Whenever non-remote powered and controlled winches are used to pull the television camera through the line, telephones, radios, or other suitable means of communication shall be set up between the operators positioned at the two manholes of the sewer line being inspected to ensure that good communications exist between members of the crew.

F. Naming Convention: CCTV footage files and inspection logs shall be named based on the upstream and downstream manholes and type of inspections. For example, the CCTV and inspection logs for the pipe segment between manholes MH31864 and MH3047 shall be named:
   1. MH31864_MH3047_Pre-CIPP.pdf
   2. MH31864_MH3047_Pre-CIPP.mpeg
   3. MH31864_MH3047_Post-CIPP.pdf
   4. MH31864_MH3047_Post-CIPP.mpeg

G. The accuracy of the measurements for location of defects and service connections cannot be stressed too strongly. Marking on cable, or the like, which would require interpolation for depth of manhole, will not be allowed. Measurement meters shall be accurate to two-tenths of a foot over the entire length of the sewer line section being inspected. Prior to recording

the location of defects and service connections, slack in the cable of the television inspection camera shall be taken up to assure metering device is designating proper footage. Accuracy of the measurement meters shall be checked daily by use of a walking meter, roll-a-tape, or other suitable device.

3.2 FLOW CONTROL

A. Pre-installation TV Inspection and Post-Installation TV Inspection shall be completed during dry weather low flow conditions.

3.3 PASSAGE OF TV CAMERA

A. Do not pull or propel the television camera through the line at a speed greater than 30 feet per minute for Pre- and Post-Rehabilitation TV Inspection.

B. For Post-Installation TV Inspection, exercise the full capabilities of the camera equipment to document the completion of the rehabilitation work and the conformance of the Work to the Specifications. Provide a full 360-degree view of pipe and joints.

3.4 FIELD QUALITY CONTROL

A. Contractor shall not allow, under any circumstances, sewage or solids removed in the cleaning process to be released onto streets or into ditches, catch basins, storm drains, or storm sewer manholes, or cleanouts.

B. Acceptance of sewer cleaning work is contingent upon the successful completion of the TV inspection. If the TV inspection shows debris, solids, sand, grease, or grit remaining in the line, the cleaning will be considered unsatisfactory. Repeat cleaning, inspection, and televising of the sewer line until cleaning is satisfactory.

END OF SECTION

SECTION 33 01 30.51
SEWER CLEANING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to clean all sewer pipe as directed by the Owner and as specified herein. Cleaning shall include the proper high pressure water jetting, robotic cutters/grinders, and flushing of sewers and manholes. Cleaning shall dislodge, transport, and remove all sludge, protruding lateral pipes, mud, sand, gravel, rocks, bricks, grease, roots, sticks, and all other debris from the interior of the sewer pipe and manholes.

B. The goals of the cleaning are to remove all debris, roots, deposits, and intruding taps, and other blockages for the purpose of CIPP lining. If the pipe condition is such that cleaning may cause a potential collapse, no attempt shall be made to clean the pipe without approval of the Owner/Engineer.

C. Sandbags or filter bags shall be utilized downstream of sewer cleaning to prevent loose concrete, debris, and other sediment from being conveyed downstream to the South Valley Water Reclamation Facility.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 33 01 30.16 – TV Inspection of Sewer Pipelines

B. Section 33 01 30.72– Cured-in-Place Pipe Lining

C. Section 33 01 30.82 – Polymeric Rehabilitation of Buried Concrete Structures

PART 2 - PRODUCTS

2.1 GENERAL

A. The equipment shall be capable of removing roots, dirt, grease, rock, sand, protruding lateral pipes, other materials and obstructions from the sewer lines and manholes.

B. All loose debris and other solid or semisolid material resulting from cleaning operations shall be removed at the downstream manhole. When hydraulic cleaning equipment is used a suitable dam or weir made of sandbags or filter bags shall be placed in the downstream manhole to trap all such material. Filter bags to prevent transport of sediment shall be Danby Bag, or approved equal.

C. No loose debris removed during cleaning operations shall be dumped or spilled into streets, ditches, storm drains, or other sanitary sewers. All material collected during cleaning operations shall be collected by and properly disposed of by the contractor.

D. All necessary precautions shall be taken during cleaning operations to protect the sewer from damage and ensure that no damage is caused to properties adjacent to or served by the sewer or its branches. Any property damage caused as a result of such cleaning operations shall be restored to preexisting conditions by the contractor at no additional cost to the owner.

2.2 MATERIALS

A. Hydraulically propelled Sewer Cleaning Equipment shall have the following:
1. High pressure/velocity of at least 2,500 psi and at least 80 gpm capacity
2. Appropriate nozzle for sewers 12-in to 24-in where aggressive sewer cleaning is needed.
3. A minimum of 550 feet of high-pressure hose
4. Two or more high velocity nozzles capable of producing a scouring action from 15 to 45 degrees in all size lines to be cleaned
5. A high velocity gun for washing and scouring manhole walls and floor
6. Capability of producing flows from a fine spray to a long distance solid stream
7. A water tank, auxiliary engines and pumps, and a hydraulically driven hose reel
8. Equipment operating controls located aboveground

B. Robotic Cutters / Chain Cutters shall be capable of removing protruding concrete lateral pipes in any clock position to within ¼ inch of the pipe wall from the project's 12-in to 30-in concrete trunk sewer pipes without damaging the concrete trunk sewer.

C. Mechanical cleaning equipment shall be either power buckets or power rodders by the Flexible Tool Division of Rockwell Manufacturing Co. or Engineer-approved equal. Mechanical equipment shall only be utilized with prior approval of Owner or Engineer and after structural condition of the pipe has been verified and Contractor has indicated that jetting will not be sufficient to perform the cleaning and mechanical cleaning will not further damage the pipe.
1. Power bucket machines shall:
   a. Be furnished with buckets in pairs and with sufficient dragging power to efficiently perform the work.
   b. Either use V-belts for power transmission or have an overload device. Direct drive machines will <u>not</u> be permitted.
   c. Be equipped with a take-up drum and a minimum of 500 feet of cable.
2. Power rodding machines shall:
   a. Be either sectional or continuous.
   b. Hold a minimum of 750 feet of rod.
   c. Have rods composed of treated steel.
   d. Be fully enclosed and have an automatic safety throw out clutch.

PART 3 - EXECUTION

3.1 PERFORMANCE

A. Cleaning Precautions: All sewer cleaning operations shall be performed under bypass pumping. During sewer cleaning operations, satisfactory precautions shall be taken by the Contractor in the use of cleaning equipment. When hydraulically-propelled cleaning tools,

which depend upon water pressure to provide their cleaning force are used, precautions shall be taken by the Contractor to ensure that the water pressure created does not damage or cause flooding of public or private property being served by the sewer being cleaned. Contractor shall protect existing sewer lines from damage caused by improper use of cleaning equipment.

B. Water for cleaning may be purchased from either West Jordan City, Jordan Valley Water Conservancy District or South Valley Water Reclamation Facility. Coordinating the use of, and fee for bulk water from hydrants or bulk fill stations can be coordinated with:

1. Greg Davenport, 801-569-5077 (West Jordan City)
2. Shane Swenson, 801-565-4300 (Jordan Valley Water Conservancy District)
3. Taigon Worthen, 801-566-7711 (South Valley Water Reclamation Facility)

Water suppliers may require certified backflow preventers. The Contractor shall be responsible for making the needed arrangements, associated fee, and following the supplier's requirements. No fire hydrant shall be obstructed in the event that emergency use is required by the Owner or fire department. Contractor shall protect existing sewer lines from damage caused by improper use of cleaning equipment.

C. Light Sewer Cleaning: A sewer reach will have undergone "Light Cleaning" if it requires three or fewer passes of high-pressure water jetting to sufficiently remove the debris. Costs related to the cleaning of such sewers in three or fewer passes, and material disposal shall be included in Contractor's unit prices bid for CIPP and sectional CIPP liner, depending on pipe diameter. The equipment, as properly selected by the Contractor, shall be capable of removing dirt, grease, rocks, sand, and other deleterious materials and obstructions from the sewer lines and manholes. If cleaning of an entire section of sewer cannot be successfully performed from one manhole, the equipment shall be set up on the other manhole and cleaning shall be attempted again. If successful cleaning cannot be subsequently performed from the other manhole or if the equipment fails to traverse the entire sewer section, it will be assumed that a major blockage exists, and the cleaning effort shall be repeated with other types of equipment. Selection of cleaning equipment shall be based on the conditions of the manholes and sewer lines at the time the work commences based on the CCTV inspection to be performed by the Contractor. Contractor shall exercise special attention in selecting cleaning equipment and precautions during cleaning to ensure complete removal of visible roots from pipe joints. Light Cleaning shall be used for small amounts of debris and/or very light root growth existing within the sewer line. Balls, scooters, high pressure water jetting equipment, brushes, and swabs may be used.

D. Additional Hydraulic Cleaning: If, after three passes of high-pressure water jetting, the sewer is still not clean, the Contractor shall inform the Engineer of the condition and the reason(s) for the failure to fully clear the line. The Engineer may then direct the Contractor to perform Additional Hydraulic Cleaning or Heavy Cleaning of the problem section of sewer. In no case shall the high-pressure water jetting equipment be pulled at a speed greater than 25 feet per minute.

E. Heavy (Hourly) Cleaning: Pipes that contain excessively heavy amounts of accumulated debris, grease, and large stones and bricks and cannot be cleaned by hydraulic methods may be paid on an hourly basis, upon approval by Owner or Engineer. Owner or Engineer may determine if any individual pipe should be cleaned on an hourly basis and what method shall

be used. No method used for heavy cleaning shall put the sewer in serious risk of collapsing. Payment will be made according to the Contractor's price bid for Excessive Heavy Cleaning.

F. Removal of Materials: Contractor shall provide appropriate screening and on-site settling tank to prevent passage of materials into downstream sewers or treatment facilities. All solid and semi-solid materials dislodged during cleaning operations shall be captured and removed from the sewer by Contractor at the downstream manhole of the sewer section being cleaned. These materials shall become the property of the Contractor, shall be removed from the site at the end of each workday by the Contractor, and shall be disposed of in a lawful manner by the Contractor. The passage of dislodged materials from the sewer segment being cleaned to the sewer segment located immediately downstream will not be permitted. In such an event, as observed or detected by the Owner, Engineer, or any third party, Contractor shall be responsible for cleaning the affected downstream sewers in their entirety at no additional cost to Owner or Engineer.

G. Filter bags or sandbags shall be placed in downstream pipe to create a "dam" at least 12 inches high to prevent transport of sediment to the South Valley Water Reclamation Facility. Contractor shall remove all debris, sand, grit, etc. captured by the filter bag.

3.2 SAFETY

A. The Contractor is responsible for providing all traffic safety. Contractor's Traffic Safety Procedures shall conform to the most recent edition of UDOT's Manual of Uniform Traffic Control Devices (Utah MUTCD) and all other applicable federal, state, City, and other local regulations and ordinances. Work during evening or other low traffic hours may be implanted.

B. All open access structures or manholes shall be attended at all times by the Contractor.

C. If a manned entry is to be made for cleaning, Contractor shall be responsible for all public and Contractor safety precautions to minimize hazards to persons and public and private properties. This project includes entry and inspection operations within confined spaces, including permit-required confined spaces. The Contractor shall comply with all federal, state and local safety regulations, including, but not limited to, Federal Occupational Safety and Health Act (OSHA) requirements for entering confined spaces.

END OF SECTION

SECTION 33 01 30.72
CURED-IN-PLACE PIPE LINING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide all labor, materials, accessories, equipment, tools, and incidentals required for the renewal of 48-inch, 54-inch, and 60-inch sewer pipes by the installation of a resin-impregnated flexible tube which is formed to the original pipeline and cured to produce a continuous and tight-fitting Cured-in-Place Pipe (CIPP) lining as shown on the Drawings and as specified herein.

B. Scope of work also includes review of existing provided inspection data, pre-cleaning, pre- and post- CCTV, and the collection of samples for testing CIPP lining.

C. The design intent of the CIPP liner is to provide a 50-year design with a factor of safety or 2.0 as measured by the appropriate ASTM standards and design calculations listed herein. A CIPP liner that is not proven to meet both of these requirements may be accepted at a lower payment as defined in Section 01 20 00 Measurement and Payment.

D. Sewer flows from the South Confluent Structure (C-02) to the North Confluent Structure (C-09) may be diverted to only one of the existing 48-inch or 54-inch trunk lines. Flows from the existing sidelines will still require bypassing. Operation of the confluent structure gates shall only be performed by representatives of SVWRF.

E. The use of standard polyester styrene-based resin is the basis of design and work in this project. The use of Non-Styrene Emitting CIPP lining may be requested by the Owner. All provisions stated in this specification applies to all CIPP work. Any underlined text herein also applies to the Non-Styrene Emitting CIPP work.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 33 01 30.16 – Television Inspection of Sewer Pipelines

B. Section 33 01 30.51 – Sewer Cleaning

C. Section 33 01 30.16 – Television Inspection of Sewer Pipelines

D. Section 33 05 09.13 – Internal Joint Seals

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
   1. ASTM D543 – Evaluating the Resistance of Plastics to Chemical Reagents
   2. ASTM D578 – Standard Specification for Glass Fiber Strands

3. ASTM D790 – Flexural Properties Testing of Unreinforced and Reinforced Plastics
4. ASTM D2290 – Standard Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe
5. ASTM D2412 – Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe
6. ASTM D2990 - Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
7. ASTM D3567 – Determining Dimensions of Glass-Fiber Reinforced Thermosetting Resin (Fiberglass) Pipes and Fittings
8. ASTM D5813 – Cured-In-Place Thermosetting Resin Sewer Piping Systems
9. ASTM F1216 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the inversion and Curing of Resin-Impregnated Tube
10. ASTM F1743 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-In-Place Installation of Cured-In-Place Thermosetting Resin Pipe
11. ASTM F2019 (UV Cure) - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP)
12. NASSCO – Cured-in-Place Pipe Inspector Training and Certification Program (CIPP ITCP) Manual
13. International Organization for Standardization ISO – 9001:2015 Quality Management System

1.4 SUBMITTALS

A. Prior to CIPP installation, the Contractor shall submit the following:
1. Final PWS summarizing the work to be completed. PWS shall include verification of conformance to these Specifications and a detailed description of the work plan including product delivery, installation schedule, cleaning operations, CCTV inspections, field sample collection and labeling, bypass pumping, traffic control, provisions for pipes with sags too large for lining, curing method, cure water cool down plan, repair methods, service reconnections, as-built procedures, warranty, Quality Control Plan (QCP), etc. The QCP shall define the Contractor's, Owner's, Engineer's, and testing labs' role in quality control.
2. CIPP design data listing all parameters used in the CIPP design and thickness calculations. All CIPP liner design calculations shall be signed and sealed by a Professional Engineer in the State of Utah and certified by the manufacturer as to the compliance of his/her materials to the values used in the calculations. Calculations shall be based on actual ovalities and parameters specified in Part 2 herein and shall be based on ASTM F1216 and other approved methods. The buckling analysis shall account for the combination of dead load, live load, hydrostatic pressure, and grout pressure (if any). The liner side support shall be considered as if provided by soil pressure against the liner. Modulus of soil reaction shall be as specified in Part 2 herein.
3. Product data on the following items:
    a. Tube data including fabric or fiberglass, flexible membrane, etc.
    b. Technical data sheets showing the physical and chemical properties of the resins (short and long term).
    c. Third-party tested flexural modulus and flexural strength in accordance with ASTM D790.

d. 10,000 hours testing with five samples of flexural modulus and flexural strength in accordance with ASTM D2990. Average of the five samples shall be extrapolated to estimate the 50-year physical properties
e. Technical data sheets showing the chemical-resistance testing of the resins meeting the requirements of ASTM F1216, Appendix X2.
f. Pre-liner (if used)
g. Infiltration controlling chemicals (if used)
h. Internal joint seal (if used)
i. MSDS sheets for all material
j. Finished cured color of liner
k. Cementitious patching material for manhole benches including manufacturer's installation guidelines
l. Hydrophilic end seal, including chemical and physical properties such as swelling capacity
m. Non-styrene resin data (if used)

4. Detailed installation procedures including:
   a. Lining production schedule and location
   b. Testing procedures and schedule
   c. Quality control procedures
   d. Liner curing procedures including heat-up and cool-down rates
   e. Allowable defection angles within an intermediate manhole
   f. Curing temperature and duration
   g. Internal pressures for inversion (if used)
   h. Light train travel speed (if used)
   i. Shipping and storage requirements, schedule, and procedures
   j. Sample collection and preparation procedure
   k. Liner replacement or patching procedures
   l. Spent cure water discharge plan and necessary equipment
   m. Chemical grouting (if used) installation procedures including volume measurement
   n. Pre-liner and internal joint seal (if used) installation procedures
5. A safety plan showing contractor's qualification and competency to perform the work, including but not limited to confined space entry, OSHA standards, material safety data sheets, and emergency plan.
6. A certified statement from the manufacturer that the Contractor is a certified and/or licensed installer of the CIPP lining.
7. A construction schedule.
8. An odor control plan that will ensure project specific odors will be minimized at the project site and surrounding area.
9. A cure water cooldown plan
10. A repair product such as an internal spot liner or mechanical end seal

B. After installation of the liner, the Contractor shall submit the following in accordance with the requirements set forth in Part 3 herein:
   1. Cure Report, including the following documentation:
      a. Curing log, including temperatures, pressures, and times during the curing process to document that a proper cure has been achieved.
   2. Post-installation CCTV survey documentation that meets the requirements of Specification Section 33 01 30.16.

3. Post-installation CIPP Samples as described in Article 3.9.

1.5 QUALIFICATIONS

A. Liner manufacturing capabilities shall be certified to the ISO 9001:2015 Standard.

B. The Contractor performing the CIPP lining work shall be fully qualified, experienced, and equipped to complete this work expeditiously and in a satisfactory manner and shall be certified and/or licensed as an installer by the CIPP manufacturer. Only commercially proven products and installers with substantial track records will be approved.

C. The Contractor shall have successfully installed a minimum of 50,000 linear feet of CIPP lining in pipelines measuring 15 inches in diameter and smaller using the specified method of installation and curing.

D. The Contractor shall have successfully installed a minimum of 10,000 linear feet of CIPP lining in pipelines measuring above 15 inches in diameter using the specified method of installation and curing.

E. The Contractor's superintendent who will perform the work specified herein shall have at least 3 years of experience and shall have successfully installed at least 5,000 linear feet of the proposed CIPP lining.

F. The Contractor shall be capable of providing crews as needed to complete the work without undue delay.

G. An installation reference list of a minimum of three municipal clients that the Contractor has performed this type of work for, including contact names, phone numbers, pipeline diameter, linear footage of pipeline rehabilitated, and a description of the actual work performed.

H. Inspection of the liner may be made by the Owner and/or Engineer after delivery, prior to, during or after installation. The liner shall be subject to rejection at any time on account of failure to meet any of the requirements specified herein, even though sample liner may have been accepted as satisfactory at the place of manufacture. Liner rejected after delivery shall be marked for identification and shall be immediately removed from the job site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Care shall be taken in shipping, storage, and handling to avoid damaging the liner. Extra care shall be taken during cold weather construction. Any liner damaged in shipment shall be replaced at no cost to the Owner and as directed by the Owner and/or Engineer.

B. All material shall be shipped, stored, and handled in conformance with the manufacturer's requirements and recommendations.

C. Any liner showing a split or tear, or which has otherwise received damage, shall be marked as rejected and immediately removed from the site.

D. The liner shall be maintained at a proper temperature to prevent premature curing prior to installation. Any liner showing evidence of premature curing shall be rejected for use and

shall be immediately removed from the site. Any UV CIPP liner shall be protected from sunlight or ambient light sources prior to installation.

E. Field samples taken by the Contractor after installation shall be temporarily stored in an appropriate environment until collection by the Owner/Engineer, which will be no more than 30 days. Chain-of-custody procedures and identifying marking procedures shall be followed closely.

1.7 WARRANTY

A. The materials used for this Project shall be certified by the manufacturer for the specified purpose. The Contractor shall warrant the liner material and its installation for two (2) years from the date of acceptance. During the warranty period, any defects which affect the integrity, strength, function, and/or operation of the pipe shall be repaired at the Contractor's expense in a manner mutually agreed upon by the Owner, Engineer, and the Contractor. All repairs shall also be warranted by the Contractor for two (2) years from the date of repair acceptance. The Owner or Engineer may conduct an independent television inspection, at the Owner's expense, of the lining work prior to the completion of the one-year guarantee period.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The CIPP liner product shall have a widely accepted history of success in the trenchless industry, shall be intended for domestic gravity wastewater application, and meet the standards of ASTM D5813 and F1216.

B. The same CIPP liner product shall be used throughout the project unless unforeseen circumstances justify a change of materials or use of Bid Alternate materials. Owner/Engineer shall be consulted prior to any using other liner products.

C. If UV cured CIPP is used, CIPP lining shall be Insituform or iPlus Composite by Insituform Technologies (Aegion), Inliner STX by Layne Technologies, Saertex-Liner, Alphaliner by Reline America, BKP Berolina-Liner, iMPREG Liner, or Engineer-approved equal.

D. The sewed tube shall consist of one or more layers of absorbent non-woven felt fabric or one or more layers of fiberglass laminate in accordance with the requirements of ASTM F1216, ASTM F1743, ASTM F2019, and ASTM D5813.

E. The tube shall be constructed to withstand installation pressures, have sufficient strength to bridge breaks and missing sections of the existing pipe, sufficiently reinforce sections of high pipe ovality, stretch to fit irregular pipe sections, and able to stretch to fit irregular pipe sections and negotiate bends of up to 15 degrees. The new jointless pipe-within-a-pipe shall fit tightly against the existing pipe wall.

F. The wet-out tube shall have a uniform thickness that, when compressed at installation pressures, shall meet or exceed the design thickness.

G. The tube shall be sewn to a size that, when installed, shall tightly fit the internal circumference and length of the original pipe with minimal shrinkage, in such a way as to minimize water migration (tracking) between the liner and the host pipe. Allowance shall be made for circumferential stretching during inversion and longitudinal stretching during pull-in. Overlapped layers of felt in longitudinal seams that cause lumps in the final product shall not be acceptable.

H. The minimum tube length shall be that deemed necessary by the Contractor to effectively span the distance between the access points and to facilitate a good seal without water migration. The Contractor shall verify the lengths in the field before cutting liner to length and otherwise preparing it for installation. Likewise, the Contractor shall verify the diameter of the sewer segments in the field prior to ordering materials and installation.

I. The outside layer of the tube (before wet-out) and inner (UV cured liners) shall be coated with an impermeable, flexible membrane that shall contain the resin and facilitate monitoring of resin saturation during the resin impregnation (wet-out) procedure.

J. An interior and exterior material shall be styrene resistant to protect and contain the resin used in the liner.

K. The finished CIPP shall be fabricated from materials which, when cured, shall be meet the chemical-resistance testing on ASTM F1216, Appendix X2.

L. The tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No material shall be included in the tube that may cause delamination in the cured CIPP. No dry or unsaturated layers shall be evident.

M. The wall color of the interior pipe surface of CIPP after installation shall be a light reflective color (whitish) so that a clear detailed examination with CCTV equipment may be made.

N. Seams in the tube shall be stronger than the seamless felt and shall meet the requirements of ASTM D5813.

O. The outside of the tube shall be marked for distance at regular intervals, not exceeding five (5) feet, along its entire length. Such markings shall include the manufacturer's name or identifying symbol. The tubes shall be manufactured in the USA.

P. The resin system shall be a corrosion-resistant polyester, vinyl ester, or epoxy and catalyst system that, when properly cured within the tube composite, meets the requirements of ASTM F1216 or ASTM F2019 and ASTM F1743 or ASTM D5813, the physical properties specified herein, and any additional physical properties that are utilized in the design of the CIPP for this Project. The resin shall produce CIPP which shall comply with the structural and chemical resistance requirements specified herein. If the Owner requests the use of Non-styrene emitting CIPP lining, the use of styrene-free resins is permitted, as well UV curing. Styrene free resins shall not contain any styrene monomers.

Q. Resin shall be impregnated by vacuum application, resin bath, or Engineer-approved equal method. If reinforcing materials (fiberglass, etc.) are used, the reinforcing material shall be fully-encapsulated within the resin to ensure that the reinforcement is not exposed, either to the inside of the pipe or at the interface of the CIPP and the existing pipe.

R. The resin color shall be distinguishable from the liner tube so that resin-impregnated portions can be easily identified.

S. The finished CIPP shall be fabricated from materials which, when cured, shall meet the chemical-resistance testing on ASTM F1216, Appendix X2.

T. The layers of the cured CIPP shall be uniformly-bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers cleanly separate or the probe or knife blade freely moves between the layers. If separation of the layers occurs during testing of field samples, new samples shall be cut from the work. Any reoccurrence of separation shall be cause for rejection of the work. The Owner/Engineer will be sending the field samples to a lab for independent testing. If separation occurs during testing, the Contractor shall collect and provide new samples at no additional cost to the Owner.

U. Any layers of the tube that are not saturated with resin prior to insertion into the existing pipe shall not be included in the structural CIPP wall thickness computation.

V. A cementitious patching material shall be used in the manholes to reconstruct a proper flow channel around the end of the cured liner to allow unobstructed flow and prevent collection of debris. Patching material shall be Hyperform by Quadex or Engineer-approved equal.

W. Chemical seal grout (if used) shall have the following properties:
1. Chemical seal grout shall react quickly to form a permanent watertight seal.
2. Grout shall have controllably reaction times from 10 seconds to 1 hour.
3. Resultant seal shall be flexible and immune to the effects of wet/dry cycles.
4. Chemical seal grout shall be non-biodegradable and immune to the effects of acids, alkalis, and organics in sewage.
5. Extraneous sealant left inside pipe shall be readily removable.
6. Chemical seal grout shall be compatible with the CIPP liner resin system utilized.
7. Sealing grout shall be furnished in liquid form in manufacturer's standard containers. Sealing grout shall be manufactured by De Neef, Avanti, or Engineer-approved equal.

X. Pre-Liner (if used) shall consist of multiple layers of polyethylene with cord reinforcement and capable of greatly reducing the moisture transmission. Pre-liner shall be Griffolyn TX-1200 FR, or Engineer approved equal.

Y. Internal Joint seal (if used) shall meet the requirements of Section 33 05 09.13.

Z. A hydrophilic waterstop end seal gasket shall be installed at both of the manhole interfaces to mitigate infiltration from annular space between host pipe and liner. End seals shall meet the following criteria:
1. Be a seamless molded gasket.
2. Not reduce pipe diameter by more than ¾ inch.
3. Form a full-circle which shall swell to 200% of original size when in contact with water.
4. Be appropriately sized to the host pipe.
5. End seals shall be the Insignia™ by LMK, or Engineer approve equal.

2.2 STRUCTURAL REQUIREMENTS

A. The minimum required structural CIPP wall thickness shall be based on the physical and structural properties described herein and shall be in accordance with the design equations in the Appendices of ASTM F1216 or other approved equations and the below listed design parameters. The thickness shall be increased in 0.5 mm increments, but in no case be less than 6.0 mm or 4.5 mm for UV cure.

Design Safety Factor	2.0
Minimum design life	50 years
Groundwater Depth = Grade Elevation	Refer to Drawings
Soil Depth (above crown) = Grade Elevation	Refer to Drawings
Soil Modulus	1,000 psi
Soil Load	120 pcf
Live Load	One AASHTO H-20 Truck
Enhancement Factor "K"	7
Design Condition	Fully-Deteriorated
Creep Retention (unless otherwise measured by 10,000-hr testing)	50%
Ovality – 3% unless stated otherwise	

B. The Contractor shall have performed 10,000 hours testing in accordance with ASTM D2990 for flexural creep retention of the CIPP material. These testing results shall be used to determine the 50-year, time-dependent flexural modulus to be utilized in the product design. This testing shall include demonstration of performance of the materials (tube and resin) and general workmanship of the installation and curing.

C. If reinforcing materials (fiberglass, etc.) are used, the reinforcing material shall be fully-encapsulated within the resin to ensure that the reinforcement is not exposed, either to the inside of the pipe or at the interface of the CIPP and the existing pipe.

D. A percentage of the instantaneous flexural modulus value (as measured by ASTM D790 testing) shall be used in design calculations for external buckling. The percentage, or the long-term creep retention value, utilized shall be verified by this testing. The materials utilized for this Project shall be of a quality equal to or better than the materials used in the long-term test with respect to the initial flexural modulus used in design.

PART 3 - EXECUTION

3.1 GENERAL

A. The CIPP lining shall begin at MH 31864 (C-01) and shall be completed consecutively, pipe segment by pipe segment downstream toward the South Valley Water Reclamation Facility.

B. All CIPP lining work shall be confined to the easements and limits of disturbances as shown on the Contract Plans.

C. Contractor shall clean the pipeline with a high-pressure water jet and hydraulically-powered equipment, as necessary, to remove all internal debris from the pipeline before installation.

D. Flow control shall be exercised, as required, to ensure that active flow is diverted in a controlled manner around the work, the public health is protected, and no flowing sewage comes into contact with sections of the sewer under repair in accordance with the General Notes.

E. Pipe sizes shown on the plans are nominal only. Internal pipe inspection shows evidence that some of the concrete has corroded leaving an altered internal diameter. Contractor shall measure actual diameters of each sewer segment prior to production a liner.

3.2 PUBLIC INTERACTION

A. In general, the Owner's public relations firm will handle communication with residents, businesses, and the general public nearby the project. The Contractor shall assist the Owner and the Owner's public relations firm with information they may request.

B. The Contractor shall coordinate with Owner's Public Relations Firm on the contents of the "talking points" flyer.

1. Name and contact information for the Owner's Public Relations Firm
   Scott Henriksen
   Jacques & Associates
   www.ja-today.com
   scott@ja-today.com
   (801) 857-1408

3.3 PRE-CIPP INSPECTION AND REPAIR

A. Any protruding pieces of concrete, dropped joints, or broken pipe shall be subjected to repairs so that the pipe is left in a clean, mostly smooth condition in all respects ready for lining, unless otherwise jointly determined by the Engineer/Owner that the defect will not compromise the integrity of the liner.

B. If conditions such as broken pipe and major blockages are found that will prevent proper cleaning, or where additional damage would result if cleaning is attempted or continued, the Contractor, with the advance approval of the Owner and Engineer, shall perform the necessary point repair(s) and then complete the cleaning.

C. The Contractor shall not line through any pipe sag, change in direction, deformation, or other reduction of cross-sectional area of more than 30 percent without written permission from the Engineer.

D. Prior to CIPP liner installation, all active leaks of a magnitude that will compromise the integrity of the liner shall be stopped at least one hour prior to installation of the liner using chemical seal grout or joint seals. This shall include all runners (continuous flow) and gushers (flow under pressure) as defined by National Association of Sewer Service Companies (NASSCO) Pipeline Assessment and Certification Program (PACP). Infiltration shall be stopped through the use of chemical grout or a pre-liner (which shall be paid for separately) at Owner's or Engineer's discretion.

E. The Contractor shall modify their equipment as necessary to seal the leaks. The Contractor's equipment and sealing method shall be approved by the Owner and Engineer prior to use. Extreme caution shall be utilized during leak sealing (pressure) operations in order to avoid damaging the already-weakened sewer pipe. If any damage occurs, it shall be repaired at the Contractor's expense and to the satisfaction of the Owner and Engineer. Excessive pumping of grout which might plug a service lateral shall be avoided. Any service laterals blocked by the grouting operation shall be immediately cleared by the Contractor.

F. In presence of the Engineer/Owner, the Contractor perform, for approval, a pre-lining CCTV inspection immediately prior to CIPP lining to demonstrate that the pipe is clean and free of roots, grease, sand, rocks, sludge, PACP runners or gushers, pockets of water, or structural impediments that would affect long-term viability of the pipe liner. If UV curing is used, a pre-curing video inspection of the inflated liner must be recorded and accepted in the presence of the Owner and/or Engineer.

3.4 LINER INSTALLATION

A. Liner installation shall be in accordance with ASTM F1216, or ASTM F1743 or ASTM F2019, with modifications as listed herein.

B. Curing shall be accomplished by hot water in accordance with the manufacturer's recommended cure schedule. The curing temperatures shall be continuously monitored and logged during the cure cycles along the entire length of CIPP. The manufacturer's recommended cure method and schedule shall be used for each line segment installed, and the liner wall thickness and the existing ground conditions with regard to temperature, moisture level, and thermal conductivity of soil, per applicable ASTM standards, shall be taken into account by the Contractor.

C. If installation of the CIPP will occur at elevated ambient temperature conditions, Contractor shall provide means to maintain liner at temperature during insertion process which prevents premature curing of resin.

D. Initial cure shall be deemed complete when temperature sensors indicate that the temperature is of a magnitude to realize an exothermic reaction. The cure period shall be of a duration recommended by the resin manufacturer and in accordance with the approved work plan. The Contractor shall have a digital thermometer or other means of accurately and quickly checking the temperature of exposed portions and/or intermediate portions of the liner on hand at all times for use by his personnel, the Owner, and/or the Engineer.

E. Resin Impregnation: The quantity of resin used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and the loss of resin through cracks and irregularities in the original pipe wall. A vacuum impregnation, resin bath, or Engineer-approved equal method shall be used. To ensure thorough resin saturation throughout the length of the felt tube, the point of vacuum shall be no further than 25 feet from the point of initial resin introduction. After vacuum in the tube is established, a vacuum point shall be no further than 75 feet from the leading edge of the resin. The leading edge of the resin shall be as near to perpendicular as possible. A roller system shall be used to uniformly distribute the resin throughout the tube. If the installer uses an alternate method of resin impregnation, the method shall produce the same

results. Any alternate resin impregnation method shall be proven and subject to the approval of the Owner and Engineer.

F. If approved by the Owner/Engineer, the Contractor may remove the manhole frame or upper portions of the manhole at the liner insertion or end locations for additional working space. After the liner installation is complete, the manhole and/or frame shall be returned to its existing condition or replaced in-kind in accordance with the applicable details as specified in the Contract Documents.

G. Water for the installation process may be purchased from either West Jordan City, Jordan Valley Water Conservancy District or South Valley Water Reclamation Facility. Coordinating the use of, and fee for bulk water from hydrants or bulk fill stations can be coordinated with:
1. Greg Davenport, 801-569-5077 (West Jordan City)
2. Shane Swenson, 801-565-4300 (Jordan Valley Water Conservancy District)
3. Taigon Worthen, 801-566-7711 (South Valley Water Reclamation Facility)

H. Water suppliers may require certified backflow preventers. The Contractor shall be responsible for making the needed arrangements, associated fee, and following the supplier's requirements. No fire hydrant shall be obstructed in the event that emergency use is required by the Owner or fire department.

I. Prior to the installation of the liner, a fiber optic cable sensing system shall be placed through the entire length of the host pipe at the pipe invert for continuous temperature monitoring for the entire cure cycle.
1. The fiber optic cable system shall be computer controlled and capable of recording temperatures at the interface of the liner and the host pipe continuously throughout the entire pipeline being rehabilitated.
2. The computer shall be controlled by a real-time screen display and can be monitored by any smart device. For quality assurance purposes, the system must have the ability to be remotely viewed "live" by the engineer/owner.
3. The continuous monitoring system will monitor the liner cure incrementally every 18-inches or less to verify that an exotherm reaction has occurred and that a full cure has taken place along the entire length of the liner.
4. Systems that only measure temperature at each end or at wider intervals than every 18-inches are not acceptable.
5. The contractor shall provide the owner and engineer a deliverable in the form of a visual graphic representation of the entire cure process as it relates to time, temperature and footage
6. The data collected shall be provided in both excel spreadsheet and graphical viewer formats at the same time as the post-lining inspection videos.

J. End seals shall be installed at both pipe ends within one foot of the access points. Due to the degraded condition of the concrete pipes, Contractor shall remove loose degraded concrete by means of hand tools (screwdriver, claw hammer, etc.) prior to installation of end seal.

K. Curing shall be performed in accordance with the manufacturer's recommended cure schedule.

L. After the liner is inverted and cured, Contractor shall dispose of the water used by allowing it to cool to **100° F** (maximum) and flow downstream at a controlled rate of no more than **500 gpm**. Contractor shall utilize some method that is measurable and verifiable (e.g., a pump with a known pumping rate) to confirm the discharge rate and temperate.

M. Due to the proximity to the South Valley Water Reclamation Facility (SVWRF) and potential risk to this facility, SVWRF will be collecting cure water samples and performing internal testing for styrene concentrations and temperature. The styrene concentration shall not exceed **0.5 mg/L** as measured at the influent to the SVWRF. The testing performed by SVWRF will be conducted at the following locations:

1. Raw wastewater just upstream of MH 31864 (C-01). This shall establish a baseline temperature and styrene concentration just beyond the scope of this project.
2. Raw wastewater at the SVWRF or from the North Confluent Structure (C-09). This location is what will be used to determine if the styrene concentration is within the specified threshold.
3. Spent cure water as it is being discharged into trunk sewer. This will be used to determine a styrene and temperate dissipation rate as it is mixed with the raw wastewater.

N. Coordination with Owner: Contractor shall frequently communicate with the SVWRF to determine if any adjustments need to be made to their lining process due to negative effects on the WRF. At the SVWRF's discretion, the Contractor may be asked to utilize the Non-styrene emitting CIPP lining process.

O. Finish: The finished product shall be continuous over the length of pipe reconstructed and shall be free from dry spots, delamination, and lifts. Visible leaks shall not be present, and the Contractor shall perform grouting to remove leaks or fill voids between the host pipe and the liner. Pipe entries and exits shall be smooth, free of irregularities, and watertight. Visible leaks shall not be present, and the Contractor shall perform grouting to remove leaks or fill voids between the host pipe and the liner. During the warranty period, any defects which will affect the integrity or strength of the product shall be repaired at the Contractor's expense, in a manner mutually agreed upon by the Owner, Engineer, and the Contractor.

P. Manhole Interface: The fully cured CIPP liner shall be cut off to protrude slightly into the manhole. Liner transitions into manholes shall be smooth, free of irregularities, and watertight. Contractor may cut the CIPP liner while it is still in the cooldown phase, but the final flush cut shall not occur until the liner has completely cooled and will no longer retract. Under no circumstances shall the cured liner retract into the pipe beyond the mouth of the host pipe. In cases where the liner retracts leaving a portion of the host pipe unlined, Contractor shall remedy with a solution acceptable to the Owner at no cost to the Owner.

Q. Chamfered Ends: The liners shall be cut square and smooth, and the bottom half of the liners (the springline and under) shall be chamfered to an appropriately 30^0 bevel. Chamfered ends are required to allow for easier CCTV camera entry and to avoid rags/debris from being caught on the liner.

R. Infiltration control devices: Internal joint seal, pre-liners, and chemical grouting shall be installed in accordance with the manufacturer's recommendations.

S. Reinstatement of Services: Not used

3.5 WET-OUT AND CURE REPORT

A. The Contractor shall submit wet-out and cure reports (birth certificates) documenting the specific details of the liner's vacuum impregnation and saturation with resin and the CIPP installation of the liner. A report shall be generated for each liner installation. Copies of all wet-out and cure records shall be made available onsite prior to each liner's installation for review by the District Inspector and submitted to the Owner and Engineer prior to submitting an Application for Payment on which payment for the specific liner(s) included in the wet-out and cure records is requested. If the wet-out and cure reports are not made available onsite prior to each liner's installation for review by the District Inspector, the respective liner shall not be installed. If the wet-out and cure reports are not submitted prior to the associated Application for Payment, payment for the work will not be made and the Application for Payment will be rejected. At a minimum, the report shall include:

1. Contractor name
2. Owner's Contract number
3. Line identification and location
4. Date of wet-out
5. Identification of sample(s) and name of technician(s)
6. Date of installation in sewer
7. Inside diameter of host sewer pipe
8. Liner thickness
9. Liner length
10. Liner and resin batch numbers
11. Resin type
12. Wet-out length
13. Roller spacing
14. Vacuum setting
15. Quantity of resin and catalyst utilized
16. Name of wet-out technician(s)
17. Time wet-out started and completed
18. Applicable remarks
19. Pressure and temperature versus time log or light train speed during cure period
20. Cool down report

3.6 SITE RESTORATION

A. After the liner installation has been completed and accepted by the Owner, the Contractor shall restore the entire Project area and shall return the ground cover, roads, curbs, sidewalks, etc. to their original or better condition. All excess material and debris not incorporated into the permanent installation shall be disposed of by the Contractor.

3.7 TELEVISION SURVEY

A. Prior to installation of the liner and again after the CIPP installation, a television survey of each CIPP-lined pipeline shall be performed in accordance with Section 33 01 30.11. This shall be included in the amount bid for the applicable Bid Item for CIPP lining, and no separate payment shall be made.

3.8 FIELD QUALITY CONTROL

A. The Contractor shall prepare physical samples for all pipes being CIPP lined and provide them to the Engineer/Owner for testing in accordance with Article 3.9 herein. Plate samples may be used.

B. All coordination required for testing of physical samples will be handled by Owner/Engineer. This will include selection of and shipment of samples to be tested, and receipt and interpretation of results. Cost for sample collection shall be included in the amount bid for the applicable Bid Item for CIPP lining, and no separate payment shall be made. The Owner will be coordinating and paying for all lab testing.

C. Test specimens shall be clearly marked in indelible ink to identify the name of the Project Name, Pipe Asset ID, manhole asset ID which sample was taken from, date of lining, and orientation to the top of the pipe (direction of up) so the results can be correlated to the work performed. All test results shall use this designated labeling as a reference.

D. The extraction and labeling of test specimens shall be performed by the Contractor in the presence of the Owner and/or Engineer. The Owner, Engineer, and Contractor shall, upon completion of sample extraction and labeling, all sign a chain-of-custody form that shall subsequently accompany the sample at all times and shall ultimately be received and signed at the testing laboratory. Test reports shall include a copy of the chain-of-custody form with all signatures to ensure that reported test results are for the correct sample. Laboratory testing will be organized by the Owner. Chain-of-custody forms will be distributed at the pre-construction meeting.

E. Each sample shall be large enough to provide at least five total specimens for testing. One test for thickness, flexural strength, and flexural modulus shall be conducted in accordance with ASTM F1216 or ASTM F2019, ASTM D790, and ASTM D2290 for each run of lines. The material shall meet the initial strength requirements of the final engineer stamped calculations.

3.9 TESTING REQUIREMENTS

A. The Contractor shall submit a method to the Owner and Engineer for review and approval for obtaining representative samples from all of the installed liners in accordance with Article 3.8 herein. These samples will be tested by an ASTM-certified testing laboratory to verify compliance with the specifications. Samples will be stored by the Owner for the duration of and after construction.

B. When post-installation thickness measurements and/or physical property testing is performed, installed liners which do not pass these material tests may, at the Owner's discretion, be accepted at reduced payment or rejected as specified in Section 01 20 00 Measurement and Payment.

3.10 ACCEPTANCE

A. Preliminary field acceptance of the liner shall be based on the Owner's and/or Engineer's evaluation of the installation and curing data, results of air testing where required, and review of the digital CCTV recordings. The finished liner shall be continuous over the entire

length of the installation. The liner shall be free from visual defects, leaking, damage, deflection, holes, delamination, uncured resin, etc. and meet widely-accepted industry standards such as NASSCO ITCP and ASTM F1216.

1. There shall be no evidence of splits, cracks, breaks, lifts, soft or dry spots, kinks, or delamination in the liner. If any defective liner is discovered after it has been installed, it shall be removed and replaced, repaired with a spot liner, or full-length liner at no additional cost to the Owner. Repair methods must be approved, in advance by the Owner/Engineer.
2. Defects such as wrinkles, fins, blistering, pinholes, and discoloration shall be identified for the Owner's and/or Engineer review. If the defects are beyond the industry standard's acceptable level, the Contractor may be required to perform additional testing or a repair. Additional testing and/or repairs will be at the full discretion of the owner and at no additional cost to the Owner.
3. The liner shall fully extend into the connecting manholes. If the liner stops short and leaves any portion of the pipe or manhole penetration exposed, it shall be repaired with a spot liner at no additional cost to the Owner. The repair method and plan must be approved in advance by the Owner/Engineer.
4. If excessive groundwater is observed tracking between host pipe and CIPP liner into the manholes, Contractor shall perform chemical grouting, apply non-shrink grout, install mechanical end sleeve until tracking water has seized at no cost to the Owner.

B. Following installation of the liner, the Contractor shall conduct one final digitally-recorded color CCTV inspections of the completed work in accordance with Section 33 01 30.16. Copies of these post-installation digital recordings and the digital recordings made prior to the liner installation shall be submitted to the Engineer for approval. Payment will not be made for any CIPP lining until the Engineer has reviewed and approved these digital recordings. The Contractor shall submit a portable storage device containing the inspection that meets the requirements of Section 33 01 30.16, a minimum of two weeks in advance of submitting an Application for Payment on which payment for the CIPP lining shown is requested.

C. Defective lining shall be evaluated and remedied at no additional cost to the Owner. If liner removal is necessary and the host pipe is damaged during the removal process, Contractor shall perform a point repair at Contractor's expense. Any spot liner or full-length liner repairs shall be designed under the same conditions as the original liner, unless otherwise directed by the Owner/Engineer.

D. Final acceptance of the liner shall be based on the preliminary field acceptance of the liner by the Owner and/or Engineer as previously listed and on the results of the certified laboratory tests on the liner specimens as previously listed. Liners meeting or exceeding the certified thicknesses and specified strengths, as evidenced by the certified laboratory testing results, shall be paid for per Article 3.9 herein.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

SECTION 33 01 30.82
POLYMERIC REHABILITATION OF BURIED CONCRETE STRUCTURES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The work covered by this Section includes furnishing all labor, competent certified technicians, equipment, tools, accessories, and materials required for the application of a 250-mil polymer liner rehabilitation product to the concrete manholes, junction structures, and 90-inch influent pipe as shown on the Contract Drawings.

B. In general, the manholes are 60-inch precast concrete with varying degrees of infiltration, surface defects and corrosion from sewer gases. The manholes also have varying configurations and are classified as Type A, Type B, or Type C as shown on the Contract Drawings. The North and South Junction structures and the 90-inch influent pipe have varying dimensions and surface defects as shown on the Contract Drawings.

C. Contractor may refer to Appendix A for videos and photos of existing concrete structures.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 33 01 30.51 – Sewer Cleaning

B. Section 03 01 30 – Concrete Repairs

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ASTM C273: Standard Test Method of Shear Properties of Sandwich Core Materials
2. ASTM C297: Flatwise Tensile Strength of Sandwich Constructions.
3. ASTM D2240: Durometer Hardness, Type D.
4. ASTM D2584: Volatile Matter Content.
5. ASTM D4414: Wet Film Thickness by Notched Gages.
6. ASTM D4541: Pull-off Strength of Coatings Using a Portable Adhesion Tester for Metal Substrates.
7. ASTM D4787: Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates.
8. ASTM D543: Resistance of Plastics to Chemical Reagents.
9. ASTM D638: Test Method for Tensile Properties of Plastics.
10. ASTM D695: Compressive Properties of Rigid Plastics.
11. ASTM D790: Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
12. ASTM D7234: Method for Pull-off Strength of Coatings Using Portable Adhesion Testers for Concrete Substrates.
13. ASTM E337: Test Method for Measuring Humidity with a Psychrometer.

14. ASTM F2414: Standard Practice for Sealing Sewer Manholes Using Chemical Grouting.
15. Society of Protective Coatings (SSPC)
    1. SSPC SP-7: Surface Preparation Specification, Brush-off Blast Cleaning
    2. SSPC TU-13: Surface Preparation of Concrete.

16. National Association of Corrosion Engineers (NACE)
    1. NACE No. 6: Surface Preparation of Concrete.
    2. NACE SP0188: Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

1.4 SUBMITTALS

A. Submittals shall be provided in accordance with 01 33 20.

B. Shop Drawings:
1. Product data (including MSDSs) covering all materials of construction.
2. Physical and chemical properties.
3. Compliance with ASTM standards.
4. Description of lining manufacturer's installation procedure including surface preparation, repairs, recoat window, temperature range, and equipment proposed for use.
5. Polymer liner's installation procedures shall include the recommended elapsed time between the installation of polymer liner any cementitious patching material.

C. Certification: The Contractor shall be certified by the manufacturer to install the rehabilitation products. This shall include documentation that the Applicator of the coating has been trained and certified by the Manufacturer and meets the experience requirements of these specifications.

D. Material Manufacturer's and Equipment Manufacturer's written certification of Approved Contractor, Contractor's qualifications, and list of project references.

E. If submitted material is not a listed product, submit complete test results from independent lab (third party) for all tests listed in accordance with requirements for Substitutions.

F. Warranty information

G. Applicator's procedures for preparing the surface of the structure and installing the coating system.

H. Cementitious material for manhole benches including Manufacturer's installation guidelines.

I. Infiltration controlling chemicals and chemical grouting installation procedures including volume measurement.

J. Quality Control Plan

K. Traffic Control Plan

L. Sewer Bypass Plan

M. Confined Space Entry Plan including training certificates of proposed entry personnel, Supervisor's certificate, and emergency response plan.

1.5 QUALITY ASSURANCE

A. Single Source Responsibility:
   1. Provide primers and undercoat materials produced by the same Manufacturer, or recommended by Manufacturer, for each type of Lining System specified to ensure compatibility, and proper chemical and mechanical bond.

   2. The Manufacturer of the specified products shall have in existence, for a minimum of five (5) years, a program of training, certifying and technically supporting a nationally organized Approved Contractor Program with annual recertification of its participants. Manufacturer must provide five (5) project histories with names, dates, addresses, and phone numbers of contact persons for projects of similar scope, one (1) of which have been completed at least one (1) or more years ago.

B. Applicator Qualifications:
   1. Engage only factory trained and qualified applicator that has successfully completed applications using specified materials on projects of similar size and scope that are at least one (1) year old.

   2. At least one (1) onsite foreman or supervisor employed by the Contractor shall have completed a forty (40) hour certification program in the use of heated plural component equipment and the specified material. Provide written certification from the equipment Manufacturer and material Manufacturer. Contractor must own and maintain his own plural component equipment.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver product in the Manufacturer's original, new, unopened packages and containers, clearly marked with Manufacturer's identification, printed instructions, lot numbers and shelf-life expiration date for each component.

B. Store materials not in use in tightly covered containers in dry, well-ventilated areas at an ambient temperature between 60°- 80° F (or as recommended by the manufacturer), away from hazards.

1.7 WARRANTY

A. The Contractor shall provide the Owner with a warranty against failure of the concrete structure lining for a period of one (1) year from the date of application or from the date of acceptance by the Owner. Failure will have occurred if the liner fails to prevent deterioration or corrosion of the structure or fails to prevent groundwater infiltration to the structure. Warranty shall require the repair of failed liner.

1.8 MISCELLANEOUS

A. Water may be purchased from either West Jordan City, Jordan Valley Water Conservancy District or South Valley Water Reclamation Facility. Coordinating the use of, and fee for bulk water from hydrants or bulk fill stations can be coordinated with:
   1. Greg Davenport, 801-569-5077 (West Jordan City)
   2. Shane Swenson, 801-565-4300 (Jordan Valley Water Conservancy District)
   3. Taigon Worthen, 801-566-7711 (South Valley Water Reclamation Facility)

   Water suppliers may require certified backflow preventers. The Contractor shall be responsible for making the needed arrangements, associated fee, and following the supplier's requirements. No fire hydrant shall be obstructed in the event that emergency use is required by the Owner or fire department. Contractor shall protect existing sewer lines from damage caused by improper use of cleaning equipment.

PART 2 - PRODUCTS

2.1 REPAIR AND RESURFACING PRODUCTS

A. Repair products shall be used to fill voids, bug holes, and/or smooth transitions between components prior to the installation of the polymer liner. Repair materials must be properly cured and must be compatible with the polymer liner and shall be used and applied in accordance with the manufacturer's recommended requirements.

B. Resurfacing products shall be used to fill large voids or to smooth deteriorated surfaces and to rebuild severely deteriorated structures.

C. The following products may be accepted and approved as compatible repair and resurfacing products for use:
   1. 100% solids, solvent-free polymer grout specifically formulated for epoxy polymer top coating compatibility.
   2. Factory blended, rapid setting, high early strength, fiber reinforced, non-shrink repair mortar that can be troweled or pneumatically spray applied maybe approved if specifically formulated to be suitable for polymer top coating with the specified polymer product. The length of resurfacing material cure required before polymer top-coating, shall be as recommended by the manufacturer.
   3. All repair and resurfacing materials should be properly cured and prepared for surface top-coat application.

2.2 POLYMER LINER PRODUCT

A. The liner shall be a 100% solid, VOC free, polymeric system that provides corrosion resistance and restores the interior of the structure.

B. Liner system shall be specifically designed to withstand the corrosive gases of domestic wastewater (especially hydrogen sulfide), withstand constant and direct contact with flowing wastewater, eliminate the infiltration of groundwater through the structure walls and mortar joints, and be structurally capable of withstanding the pressure of groundwater based on the depth of the specific structure being lined.

C. Internal liner shall meet the following requirements at a minimum:
   1. Adhesion: Concrete Failure (per ASTM D7234)
   2. Flexural Modulus 500,000 psi (per ASTM D790)
   3. Flexural Strength: 8,000 psi (per ASTM D790)
   4. Tensile Strength: 4,000 psi (per ASTM D638)
   5. Shore D Hardness: 85 (per ASTM D2240)
   6. Resistance to Chemicals listed in Table X2.1 in ASTM F1216: Pass (per ASTM D543)
   7. Internal liner shall be:
      a. Structure Guard by Quadex (Vortex)
      b. Raven 405,
      c. Saueresian SewerGard 210 XHB,
      d. Warren Environmental S-301,
      e. SprayRoq by Spraywall,
      f. or Engineer-approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. All manhole and structure rehabilitation work shall be performed while under sewer bypass (see project drawings for details and requirements).

B. All manhole lining rehabilitation shall not be completed until after the pipe lining is complete and the manhole is reconstructed. See Contract Drawings for manhole reconstruction specifications and details.

C. Provide 48 hours of notice to the Owner prior to start of work

D. Polymer liner shall cover the entire trough, channel, shelves (bench), wall, cones (manholes), and ceilings (confluence structures). The liner shall extend to top of cone and ceiling, chimney, and a minimum of 2" onto the metal castings.

3.2 SITE INSPECTION AND TESTING

A. Inspect surfaces for contamination and other critical factors at time of installation. Surfaces to receive coatings must be structurally sound, surface dry, and concrete fully cured before coating is applied. Report in writing to Owner, with copy to Manufacturer, of deficiencies that could impair work. Do not proceed with coating application until unsatisfactory conditions have been corrected.

B. Contractor shall accurately field-measure and size the rehabilitation products for each individual structure. Each existing sewer structure to be rehabilitated may have a different configuration and varying field dimensions. All field measurements shall conform to the requirements of the manufacturers of the rehabilitation products.

C. Ensure that environmental and site conditions are suitable for application and curing. Temperature of surface to be coated must be at least 5° F above the dew point temperature of the air. Check dew point in accordance with ASTM E-337 or by using approved digital instrument.

D. Polymer Lining System will follow the contours of the substrate. Notification that the substrate is ready to be coated indicates the Owner's acceptance of the substrate.

E. Complete daily log, which details all job conditions.

F. Spray one free film sample for every 5000 ft^2 for physical property testing. Test results to show elongation, tensile, and tear strength.

3.3 SAFETY

A. Applicator shall perform his work in a manner to protect the health and safety of all workmen and the public.

B. All work shall be in accordance with standard industry safety practices.

C. All work, including entry into confined spaces shall be performed in strict compliance with current OSHA regulations.

3.4 SURFACE PREPARATION

A. All concrete that is not sound or has been damaged by chemical exposure shall be restored to a sound concrete surface as noted in the Section 03 10 30. All contaminants including all oils, grease, roots, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants shall be removed.

B. All loose and protruding concrete, aggregate roots, and anything else that might prevent proper application of the liner shall be removed prior to application as noted in the Contract Drawings.

C. Manhole steps and protruding pipes shall be removed and ground back 0.5 inches into the manhole wall. Manhole steps and protruding pipe shall not be replaced after installation of the liner.

D. Installation of the polymer liner shall not commence on any surfaces containing concrete repair products until the repair products have properly cured, and in no case less than 48 hours.

E. All active water infiltration (defined as visible and consistent movement of water) found within the manhole shall be stopped to the degree required by the liner manufacturer's installation procedures by the use of hydraulic cement or chemical grouting. Any leak stopping agent shall be compatible and suitable for top coating with the liner.

F. Surfaces to receive polymer liner shall be cleaned to produce a sound concrete surface with adequate profile and porosity to provide a strong bond between the polymer liner and the substrate. Surface preparation methods shall be based upon the conditions of the substrate and the requirements of the polymer liner to be applied, but as a minimum, shall be in accordance with the procedures listed below.

1. Clean all surfaces with high pressure water to remove all loose or contaminated debris. Other equipment and methods may be required to remove all unsound material.

2. When all loose, contaminated, and unsound debris has been removed, the surface shall be etched with a solution of 20% muriatic acid to clean and open the pores of the substrate.
3. The surface shall be washed again, and the wash water shall contain a dilute solution of chlorine to diminish microbiological bacteria growth and to kill any bacteria residing on the surface.
4. The surface shall be tested with litmus paper at various points throughout the structure to ensure that the pH is within acceptable limits (not to exceed 8.5). If the surface does not meet the pH requirements, the above steps shall be repeated until the surface pH is within acceptable limits. All tests results will be retained for review by the Engineer.
5. Concrete surfaces must be clean, sound, and dry prior to application.
6. If pre-installation inspection reveals a collapse in an area of the wall, a bench that needs to be rebuilt/repaired, a necessity for sandblasting (if necessary after surface preparation as described in this Section) or anything that will require more than typical preparation of the structure, the Contractor will advise the Owner's representative. Such extra work shall be approved in writing between the Owner and the Contractor prior to the commencement of the work and shall be considered as a separate pay item.

G. Loose material and debris that has been removed with high-pressure water during surface preparation shall not be allowed to enter the downstream sewer. Contractor shall remove from the manhole and properly dispose of all solids and semi-solids recovered during the cleaning operation.

3.5 INSTALLATION

A. All products must be installed by an Installer that has been trained and certified by the Manufacturer.

B. Apply the polymer liner in a single application in accordance with Manufacturer's instructions and Contract Drawings to the specified thickness. Spray apply only through required equipment. Maintain spray nozzle an even distance from surface providing a uniform application with a 50% overlap from one pass to the next. Incorporate a crisscross pattern to achieve uniform mil thickness.
1. The interior surfacing system shall be applied to the wall, bench, ceiling, manhole chimney, and inverts of all structures and to the specified surfaces of all other structures.
2. The interior surfacing system shall be continuously bonded to all concrete, chemical sealant (grout), pipe and other surfaces inside the manhole according to ASTM C882 testing and therefore shall be designed for hydrostatic loading.
3. The cured surfacing shall be monolithic with proper sealing connections to all un-surfaced areas and shall be placed and cured in conformance with the recommendations of the polymer liner Manufacturer.
4. Fill all bug-holes with the appropriate filler. Press material firmly into all voids.
5. When cured, the system shall form a continuous, tight-fitting, hard, impermeable surfacing that is suitable for sewer system service and chemically resistant to any chemicals, bacteria or vapors normally found in domestic sewage.

6. The system shall effectively seal the interior surfaces of the manhole and prevent any penetration or leakage of groundwater infiltration.
7. The system shall be compatible with the thermal conditions of the existing sewer manhole surfaces.
8. Heated, plural component, specially designed equipment for use in the spray or spin-cast application of the specified system approved for use by the polymer liner Manufacturer.
9. Application procedures shall conform to the recommendations of the interior surfacing system Manufacturer, including material handling, mixing, and environmental controls during application, safety, and equipment.
10. The equipment shall be specially designated to accurately ratio and apply the specified materials and shall be regularly maintained and in proper working order.
11. The walls, bench and invert of the structure shall be lined with the polymer liner to provide a thickness as previously specified based on the condition of the existing structure. The cured surfacing shall be monolithic with proper sealing connections to all un-surfaced areas and shall be placed and cured in accordance with the recommendations of the polymer liner Manufacturer.
12. Specially designed spray, trowel, and/or spin-cast application equipment shall be used to apply each coat of the system.

C. Thickness of Protective Lining System: 250 mils

D. Repairs or recoating after recoat window:
1. Abrade the surface to be repaired and 6 inches beyond the repair area to roughen and dull surface.
2. Scrub in Tack Coat material and allow to dry.
3. Reapply Protective Lining System or other approved material as soon as Tack Coat is dry.
4. Follow Manufacturer's recommendations for all repairs and recoats.

3.6 CLEANING

A. Cleanup: At the end of each workday, remove rubbish, empty containers, rages and other discarded items from the project site.

3.7 QUALITY ASSURANCE

A. Applicator shall initiate and enforce quality control procedures consistent with applicable ASTM standards.

B. Applicator shall use an adequate number of skilled workmen who are thoroughly trained and experienced in the necessary crafts. These workmen shall be completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

C. Applicator shall use approved specialty equipment adequate in size, capacity and number sufficient to accomplish the work of this Section in a timely manner.

3.8 INSPECTION AND TESTING

A. The Owner or Owner's authorized representative may require the services of an independent testing laboratory to test the installed system.
   1. Remove non-compliant systems or components.
   2. Replace system or components
   3. Assume the testing expenses.

B. Minimum requirements of the Protective Lining System are that it be free of the following:
   1. Uncured material
   2. Inadequate thickness
   3. Pinholes
   4. Blisters
   5. Delamination
   6. Foreign matter
   7. Unspecified materials

C. Test Requirements:
   1. Visual Inspection
      a. All structures shall be visually inspected by the Engineer and Applicator. Any leakage into the manhole in areas where system's coating was installed by the Contractor shall be identified. Any deficiencies in the finished system shall be marked and repaired according to the procedures set forth by the Applicator.
      b. The Contractor shall provide samples for testing to the Owner from the actual installed system. Samples shall be provided, at a minimum from one location per every ten (10) system's installed.

   2. Film thickness Measurements
      a. During application a wet film thickness gauge, meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used. Measurements shall be taken, in the presents of the Owner's representative, documented and attested to by Contractor for submission to Owner.

   3. Holiday Detection Test
      a. Holiday detection shall be performed by the Contractor in the presence of the Owner or Engineer. Contractor shall bear the cost of holiday detection including supplying the necessary equipment, confined space entry, and any resulting necessary repair work. This shall be included in the applicable Bid Item for Polymeric Lining, and no separate payment shall be made.
      b. Holiday Detection shall be performed for all coating systems installed in corrosive environments.
      c. After the coating product have set in accordance with Manufacturer instructions, all surfaces shall be inspected for holidays with high-voltage holiday detection equipment. Reference NACE RPO 188-99 for performing holiday detection.
         1) A small (≤ 1/16-inch) hole shall be drilled through the coating in the bench which shall be used to calibrate the spark testing wand. The

voltage shall be adjusted until the wand creates a spark at this drilled hole.

d. All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional coating can be hand applied to the repair area.
e. All touch-up/repair procedures shall follow the coating Manufacturer's recommendations.
f. All verification and testing shall be at no additional cost to the Owner.
g. Documentation on areas tested, results and repairs made shall be provided to the Owner, in writing, by Contractor.

4. Adhesion Testing
   a. Adhesion testing shall be performed by the Contractor in the presence of the Owner or Engineer. Contractor shall bear the cost of adhesion testing including supplying the necessary equipment, confined space entry, and any resulting necessary repair work. This shall be included in the applicable Bid Item for Polymeric Lining, and no separate payment shall be made.
   b. A minimum of 10% of the structures coated shall be tested for adhesion/bond of the coating to the substrate. Testing shall be conducted in accordance with ASTM D4541, ASTM D7234, or NACE SP018. Owner's representative shall select the manholes to be tested.
   c. A minimum of three (3) - 50 mm dollies shall be affixed to the coated surface at the cone area, midsection and at the bottom of the structure or in areas suspect from non-destructive evaluation and testing. The adhesive used to attach the dollies to the coating shall be rapid setting with tensile strengths in excess of the coating product and permitted to cure in accordance with Manufacturer recommendations. The coating and dollies shall be adequately prepared to receive the adhesive.
   d. Failure of the dolly adhesive shall be deemed a non-test and require retesting. Prior to performing the pull test, the coating shall be scored to the substrate by mechanical means without disturbing the dolly or bond within the test area.
   e. Two of the three adhesion pulls shall exceed 300 psi or concrete failure with more than 50% of the subsurface adhered to the coating.
   f. Should a structure fail to achieve two successful pulls as described above, additional testing shall be performed at the discretion of the Owner. Any areas detected to have inadequate bond strength shall be evaluated by the Owner.
   g. Further bond tests may be performed in that area to determine the extent of potentially deficient bonded area and repairs shall be made by Contractor.
   h. The area where the coupon was removed shall be repaired. After abrading and cleaning, additional coating shall be hand-applied to the repair area as needed. All touch-up/repair procedures shall be in accordance with the coating manufacturer's recommendations.

END OF SECTION

SECTION 33 05 09.13
INTERNAL JOINT SEALS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work covered by this Section includes furnishing all labor, competent certified technicians, equipment, tools, accessories, and materials in connection with the repair and rehabilitation of internal pipeline joints utilizing internal joint seals.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 33 01 30.51 – Sewer Cleaning

B. Section 33 01 30.72 – Cured-in-Place Pipe Lining

C. Section 33 01 30.82 – Polymeric Rehabilitation of Buried Concrete Structures

1.3 REFERENCE STANDARDS

A. Materials used in the fabrication, assembly, and installation of internal seals shall comply with the following ASTM (American Society of Testing and Materials) Standards:
   1. D359; Standard Test of Rubber Compression Set
   2. D4212; Standard Test Method for Rubber Properties in Tension
   3. D573; Standard Test Method for Rubber Deterioration in Air Oven
   4. D1171; Standard Test Method for Rubber Deterioration Surface Ozone Cracking Outdoors or Chamber
   5. D2240; Standard Test Method for Rubber Property Durometer Hardness
   6. D3568; Standard Test Method for Rubber Evaluation for EPDM

1.4 SUBMITTALS

A. Material Documentation:
   1. List of equipment to be used.
   2. Technical data for proposed internal joint seal, including applicable instructions, material safety data sheets, and product detail drawings.
   3. Acknowledgement that products submitted meet the requirements of the standards referenced in this specification.

B. Installation Documentation:
   1. List of at least 3 references.
   2. Manufacturer's seal must have a minimum of 100 seals in place and in service for a minimum of three (3) years.
   3. Detailed installation instructions including, if applicable, detailed installation drawings.

C. Installer Safety Qualifications:

1. Installer, if different than the seal manufacturer, shall submit certification that all personnel have been properly trained to install the internal joint seal.
2. Installer shall provide certification that all personnel participating in the installation of internal seals has completed the proper safety training programs required for installation of internal seals.

D. Storage and Handling:
1. Internal seals shall remain in manufacturer's original unopened containers until time to be installed.
2. Labels on containers shall indicate contents, lot #, expiration dates, and shall be visible at all times during storage.
3. Containers containing seals shall not be stacked or stored in such a manner as to damage rubber membranes or steel components.
4. Containers containing rubber membranes shall be stored in a cool dry environment.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Internal joint seals shall be designed to withstand a minimum external head pressure of 30 feet (13 psi).

B. Stainless steel shall be type 316 and shall conform to ASTM A240.

C. All materials such as push tabs, shims, and wedges shall be made compatible with the base metal. Weld wire shall conform to AWS A5.4-92 and alloy 625 shall conform to AWS A5.14-89.

D. Internal joint seals shall consist of EPDM rubber that is at least 7.5" wide. EPDM Rubber shall be manufactured in accordance with ASTM D2000, ASTM D3900, and ASTM D3568 and comply with the following:
1. The stress relaxation shall not exceed 12 percent when tested from a time of 30 minutes to 24 hours.
2. No voids, cracks, or similar defect shall be witnessed during visible inspection.
3. Physical properties:

Hardness Shore A - ASTM D2240	40
Tensile Strength (min) ASTM D412	1,400 psi
Elongation (min) ASTM D412	350%
Ozone Resistance (min) ASTM D1171	85 %

4. The splice in the EPDM rubber seal shall be made using compression molding method with virgin rubber of the same compound which the seal is manufactured. A minimum width of ¼ inch shall be maintained at the interface.

E. Internal joint seals shall be Cretex, Hydratech, Trelleborg, or approved equal.

PART 3 - INSTALLATION

3.1 GENERAL

A. All work associated with the installation and testing of internal seals shall comply with the applicable Federal, State, and local codes and standards.

B. All workers shall be properly trained in the hazards and risk associated with working in confined spaces.

C. Prior to installation, seals should be visually inspected by a qualified installer to assure seal material is free of defects. If quality or condition of material is in doubt, the seals shall not be used.

3.2 SITE PREP WORK

A. Installation work shall be performed with pipelines removed from service and an adequate safety boundary has been established and proved by all parties. All pipelines shall have been dewatered and are maintained at atmospheric pressure throughout the duration of the installation work.

B. All permits, as required by the local and state codes, or by owner of pipeline and as agreed to in the contract shall have been processed and received and shall be available for review.

C. All seals, material, consumables and tools required for completion of work shall be verified as in good working condition. All equipment and tools required for installation and testing shall be calibrated as required.

D. Means of providing continuous forced air ventilation must be provided and maintained to establish a safe level for confined space entry.

3.3 CLEANING

A. Remove all dirt, scale, and other debris from pipe walls in area where seals are to be installed. The extent of the cleaned area should extend a minimum of 1” beyond sealing area. Cleaning operations shall be accomplished by hand brushing and scraping, pneumatic wire brushes, and/or oil-free air jet.

B. All materials removed by the cleaning operation shall be intercepted and removed at the nearest manhole and disposed of at an approved location.

C. All roots in the location of the seal installation or hinder access to the seal location shall be removed by mechanical means.

D. Roots in the seal area shall be removed to a minimum of 1” behind inside face of pipe joint.

E. During cleaning and root removal, protect pipeline from damage. Any damage that may occur during the cleaning process must be repaired at no cost to owner by an acceptable and approved method.

3.4 JOINT PREPARATION

A. Joint preparation shall be performed in accordance with the manufacturer's installation instructions.

3.5 SEAL INSTALLATION

A. Installation of the seal shall be performed in accordance with the manufacturer's installation instructions.

END OF SECTION

SECTION 33 05 09.13
INTERNAL JOINT SEALS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work covered by this Section includes furnishing all labor, competent certified technicians, equipment, tools, accessories, and materials in connection with the repair and rehabilitation of internal pipeline joints utilizing internal joint seals.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 33 01 30.51 – Sewer Cleaning

B. Section 33 01 30.72 – Cured-in-Place Pipe Lining

C. Section 33 01 30.82 – Polymeric Rehabilitation of Buried Concrete Structures

1.3 REFERENCE STANDARDS

A. Materials used in the fabrication, assembly, and installation of internal seals shall comply with the following ASTM (American Society of Testing and Materials) Standards:
   1. D359; Standard Test of Rubber Compression Set
   2. D4212; Standard Test Method for Rubber Properties in Tension
   3. D573; Standard Test Method for Rubber Deterioration in Air Oven
   4. D1171; Standard Test Method for Rubber Deterioration Surface Ozone Cracking Outdoors or Chamber
   5. D2240; Standard Test Method for Rubber Property Durometer Hardness
   6. D3568; Standard Test Method for Rubber Evaluation for EPDM

1.4 SUBMITTALS

A. Material Documentation:
   1. List of equipment to be used.
   2. Technical data for proposed internal joint seal, including applicable instructions, material safety data sheets, and product detail drawings.
   3. Acknowledgement that products submitted meet the requirements of the standards referenced in this specification.

B. Installation Documentation:
   1. List of at least 3 references.
   2. Manufacturer's seal must have a minimum of 100 seals in place and in service for a minimum of three (3) years.
   3. Detailed installation instructions including, if applicable, detailed installation drawings.

C. Installer Safety Qualifications:

1. Installer, if different than the seal manufacturer, shall submit certification that all personnel have been properly trained to install the internal joint seal.
2. Installer shall provide certification that all personnel participating in the installation of internal seals has completed the proper safety training programs required for installation of internal seals.

D. Storage and Handling:
1. Internal seals shall remain in manufacturer's original unopened containers until time to be installed.
2. Labels on containers shall indicate contents, lot #, expiration dates, and shall be visible at all times during storage.
3. Containers containing seals shall not be stacked or stored in such a manner as to damage rubber membranes or steel components.
4. Containers containing rubber membranes shall be stored in a cool dry environment.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Internal joint seals shall be designed to withstand a minimum external head pressure of 30 feet (13 psi).

B. Stainless steel shall be type 316 and shall conform to ASTM A240.

C. All materials such as push tabs, shims, and wedges shall be made compatible with the base metal. Weld wire shall conform to AWS A5.4-92 and alloy 625 shall conform to AWS A5.14-89.

D. Internal joint seals shall consist of EPDM rubber that is at least 7.5" wide. EPDM Rubber shall be manufactured in accordance with ASTM D2000, ASTM D3900, and ASTM D3568 and comply with the following:
1. The stress relaxation shall not exceed 12 percent when tested from a time of 30 minutes to 24 hours.
2. No voids, cracks, or similar defect shall be witnessed during visible inspection.
3. Physical properties:

Hardness Shore A - ASTM D2240	40
Tensile Strength (min) ASTM D412	1,400 psi
Elongation (min) ASTM D412	350%
Ozone Resistance (min) ASTM D1171	85 %

4. The splice in the EPDM rubber seal shall be made using compression molding method with virgin rubber of the same compound which the seal is manufactured. A minimum width of ¼ inch shall be maintained at the interface.

E. Internal joint seals shall be Cretex, Hydratech, Trelleborg, or approved equal.

PART 3 - INSTALLATION

3.1 GENERAL

A. All work associated with the installation and testing of internal seals shall comply with the applicable Federal, State, and local codes and standards.

B. All workers shall be properly trained in the hazards and risk associated with working in confined spaces.

C. Prior to installation, seals should be visually inspected by a qualified installer to assure seal material is free of defects. If quality or condition of material is in doubt, the seals shall not be used.

3.2 SITE PREP WORK

A. Installation work shall be performed with pipelines removed from service and an adequate safety boundary has been established and proved by all parties. All pipelines shall have been dewatered and are maintained at atmospheric pressure throughout the duration of the installation work.

B. All permits, as required by the local and state codes, or by owner of pipeline and as agreed to in the contract shall have been processed and received and shall be available for review.

C. All seals, material, consumables and tools required for completion of work shall be verified as in good working condition. All equipment and tools required for installation and testing shall be calibrated as required.

D. Means of providing continuous forced air ventilation must be provided and maintained to establish a safe level for confined space entry.

3.3 CLEANING

A. Remove all dirt, scale, and other debris from pipe walls in area where seals are to be installed. The extent of the cleaned area should extend a minimum of 1” beyond sealing area. Cleaning operations shall be accomplished by hand brushing and scraping, pneumatic wire brushes, and/or oil-free air jet.

B. All materials removed by the cleaning operation shall be intercepted and removed at the nearest manhole and disposed of at an approved location.

C. All roots in the location of the seal installation or hinder access to the seal location shall be removed by mechanical means.

D. Roots in the seal area shall be removed to a minimum of 1” behind inside face of pipe joint.

E. During cleaning and root removal, protect pipeline from damage. Any damage that may occur during the cleaning process must be repaired at no cost to owner by an acceptable and approved method.

3.4 JOINT PREPARATION

A. Joint preparation shall be performed in accordance with the manufacturer's installation instructions.

3.5 SEAL INSTALLATION

A. Installation of the seal shall be performed in accordance with the manufacturer's installation instructions.

END OF SECTION

SECTION 33 05 20
POLYMER CONCRETE MANHOLES

PART 1 - GENERAL

1.1 SCOPE

A. This specification covers polymer concrete manholes intended for use in sanitary sewers, storm sewers and water lines where corrosion resistance is required.

1.2 REFERENCES

A. ASTM C 478 (most current) Standard Specification for Precast Reinforced Concrete Manhole Sections.

B. ASTM C 579 (most current) Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic, Surfacing, and Polymer Concretes

C. ASTM C 443 (most current) Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets

D. ASTM C 580 (most current) Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

E. ASTM C 857 (most current) Standard Practice for Minimum Structural Design Loading for Underground Utility Structures.

F. ACI 350-06 Code Requirements for Environmental Engineering Concrete Structures & Commentary

G. ACI 440.1R-15 Guide for the Design and Construction of Structural Concrete Reinforced with Fiber-Reinforced Polymer (FRP) Bars

H. ACI 548.6R-96 Polymer Concrete-Structural Applications State-of-the-Art Report

I. ASTM D 648 (most current) Test Method for Deflection Temperature of Plastics Under Flexural Load in Edgewise Position.

J. ASTM D 6783 (most current) Standard Specification for Polymer Concrete Pipe.

K. ASTM D 2584 (most current) Test Method for Ignition Loss of Cured Reinforced Resins.

L. ASTM C 923 (most current) Standard Specifications for Resilient Connectors between Concrete Manholes Structures and Pipe.

M. ASTM C 990 (most current) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections using Preformed Flexible Joint Sealants

N. ASTM C 497 (most current) Test Methods for Concrete Pipe, Manhole Sections, or Tile.

O. California Greenbook Standard Specifications for Public Works Construction Section 211-2

1.3 SUBMITTALS

A. Conform to bid document requirements

B. Submit manufacturer's data and details of following items for approval:
   1. Shop drawings of manhole sections, base units and construction details, jointing methods, materials, and dimensions
   2. Summary of criteria used in manhole design including, as minimum, material properties, loading criteria, and dimensions assumed. Include certification from manufacturer that polymer concrete manhole design meets or exceeds the load and strength requirements of ASTM C 478 and ASTM C 857, reinforced in accordance with ACI 440.1R-15.
   3. Frames, grates, rings, and covers
   4. Materials to be used in fabricating pipe drop connections
   5. Materials to be used for pipe connections
   6. Materials to be used for stubs and stub plugs, if required
   7. Proof of independent chemical resistance testing conducted in accordance with the standard specifications for public works construction (California Greenbook) Section 211-2
   8. Current ISO 9001:2015 Certification
   9. References of 10 previous polymer concrete projects including scope in the last 5 years performed with both owner and contractor for reference and review by owner

C. Submitted sealed drawings by a registered Professional Engineer

PART 2 - PRODUCTS

2.1 POLYMER CONCRETE MANHOLES

A. Provide polymer concrete manhole sections, monolithic base sections and related components referencing to ASTM C 478. ASTM C 478 material and manufacturing is allowed compositional and dimensional differences required by a polymer concrete product

B. Provide base riser section with monolithic floors, unless shown otherwise

C. Provide riser sections joined with bell and spigot / ship-lap design seamed with butyl mastic and or rubber gaskets (ASTM C 990) so that on assembly, manhole base, riser and top section make a continuous and uniform manhole structure

D. Construct riser sections for polymer concrete manholes from standard polymer concrete manhole sections of the diameter indicated on drawings. Use various lengths of polymer concrete manhole sections in combination to provide correct height with the fewest joints

E. Design wall sections for depth and loading conditions with wall thickness as designed by polymer concrete manufacturer

F. Provide tops to support AASHTO HS-20 loading or loads as required and receiving cast iron frame covers or hatches, as indicated on drawings

2.2 DESIGN CRITERIA:

A. Polymer Concrete Manhole risers, cones, flat lids, grade rings and manhole base sections shall be designed by manufacturer to meet the intent of ASTM C 478 with allowable compositional and sizing differences as designed by the polymer concrete manufacturer.
   1. AASHTO HS-20 design or as required loading applied to manhole cover and transition and base slabs
   2. Polymer manholes will be designed based upon live and dead load criteria in ASTM C 857 and ACI 350-06
   3. Unit soil weight of 120 pcf located above portions of manhole, including base slab projections
   4. Internal liquid pressure based on unit weight of 63 pcf
   5. Dead load of manhole sections fully supported by polymer concrete manhole base

2.3 DESIGN:

A. Polymer Concrete Manhole risers, cones, flat lids, grade rings and manhole base sections shall be designed by manufacturer to meet loading requirements of ASTM C 478, ASTM C 857 and ACI 350-06 as modified for polymer concrete manhole design as follows:
   1. Polymer Concrete Mix Design shall consist of thermosetting resin, sand, and aggregate. No Portland cement shall be allowed as part of the mix design matrix. All sand and aggregate shall be inert in an acidic environment
   2. Reinforcement – Shall use acid resistant reinforcement (FRP Bar) in accordance with ACI 440.1R-06 as applicable for polymer concrete design
   3. The wall thickness of polymer concrete structures shall not be less than that prescribed by the manufacturer's design by less than 95% of stated design thickness
   4. Thermosetting Resin - The resin shall have a minimum deflection temperature of 158° F when tested at 264 psi (1.820 mPa) following Test Method D 648. The resin content shall not be less than 7% of the weight of the sample as determined by test method D 2584. Resin selection shall be suitable for applications in the corrosive conditions to which the polymer concrete manhole structures will be exposed
   5. Each polymer concrete manhole component shall be free of all defects, including indentations, cracks, foreign inclusions and resin starved areas that, due to their nature and degree or extent, detrimentally affect the strength and serviceability of the component part. Cosmetic defect shall not be cause for rejection. The nominal internal diameter of manhole components shall not vary more than 2%. Variations in height of two opposite sides of risers and cones shall not be more the 5/8 inch. The under run in height of a riser or cone shall not be more than ¼ in/ft of height with a maximum of ½ inch in any one section
   6. Marking and Identification - Each manhole shall be marked with the following information - Manufacturer's name or trademark, Manufacturer's location and Production Date
   7. Manhole joints shall be assembled with a bell/spigot or shiplap butyl mastic and/or gasketed joint so that on assembly, manhole base, riser and top section make a continuous and uniform manhole. Joint sealing surfaces shall be free of dents, gouges and other surface irregularities that would affect joint integrity

8. Minimum clearance between wall penetrations and joints shall be per manufacturer's design
9. Construct invert channels to provide smooth flow transition with minimal disruption of flow at pipe-manhole connections. Invert slope through manhole is as indicated on drawings. All precast base sections to be cast monolithically. Polymer bench and channel are to be constructed with all polymer concrete material. Extended ballast slab requirements for buoyancy concerns can be addressed with cementitious concrete material
10. Provide resilient connectors conforming to requirements of ASTM C 923 or other options as available. All connectors are to be water tight. Install approved resilient connectors at each pipe entering and exiting manholes in accordance with manufacturer's instructions

2.4 QUALITY CONTROL

A. Facility Quality Control shall be maintained by adhearing to ISO 9001:2015 for manufacturing. All fabricators shall be ISO 9001:2015 Certifiied. All fabrication will take place in an all polymer concrete fabrication facility. At no time will the polymer concrete fabrication facility share the facility with a cementitious precast product production facility. Fabricator is also to provide references of 10 previous projects in the last 5 years performed with both owner and contractor for reference and the scope and review by owner. Polymer concrete shall be cast in a polymer only facility and shall not be manufactured in a cementitious concrete facility

2.5 GROUTING

A. All materials needed for grouting and patching will be a polyester mortar compound provided by the manufacturer or an approved equal by the manufacturer

2.6 MANUFACTURER

1. Armorock LLC, www.armorock.com
   702-824-9702
2. Or Approved Equal

SECTION 33 08 00
GRAVITY PIPING TESTING AND INSPECTION

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall perform all pipeline flushing and testing, complete, for gravity piping systems or other yard piping systems as required in the Contract Drawings, and as specified herein; in accordance with the requirements of the Contract Documents.

B. The Contractor shall be responsible for providing and conveying flushing water to the point of usage and also for disposal, as required, of water used in the flushing operations.

C. For the purpose of this specification, gravity piping, sewer or gravity sewer piping refers to all pipes with flows that are driven by gravity in an open channel flow condition and convey liquids associated with the treatment plant processes and byproducts (e.g. plant drain, raw sewage, etc).

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ASTM F1417	Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
ASTM C924	Standard Practice for Testing Concrete Pipe Sewer Line by Low-Pressure Air Test Method
ASTM C1244	Standard Test Method for Concrete Sewer Manholes by Negative Air Pressure (Vacuum) Test Prior to Backfill
UNI-B-6	Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe

1.3 CONTRACTOR SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MATERIALS REQUIREMENTS

A. Temporary valves, plugs, bulkheads, and other air pressure testing and water control equipment and materials shall be provided by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to pipeline structure and future

function. Air test gages shall be laboratory-calibrated test gages and shall be recalibrated by a certified laboratory at the Contractor's expense prior to the leakage test, if required by the Engineer.

PART 3 - EXECUTION

3.1 GENERAL

A. All testing operations shall be performed in the presence of the Engineer.

B. All water required for cleaning and testing of the sewer pipes shall be furnished by the Contractor.

3.2 CLEANING

A. Do not allow dirt, grease, mud, groundwater, tools, equipment and all other foreign matter to enter the pipe at any point during construction.

B. All pipes shall be completely flushed at a rate with water velocities no less than 4.0 feet per second for pipes up to 12 inches in diameter and 3.0 feet per second for all other pipes. For large diameter pipes, alternate methods, including pigging, or cleaning the pipe may be proposed by the Contractor, subject to the approval of the Engineer, provided proposed method will provide a clean pipe equivalent to flushing as determined by the Engineer.

C. No debris, rubbish, dirt, rocks, or other foreign material shall be permitted to enter downstream sections of the pipeline or system.

D. Furnish, install and permanently remove all cross-connections, piping, valving, ports, etc required to complete the cleaning process. Obtain approval of the Engineer prior to adding any components to the pipeline.

3.3 TESTING OF PIPING

A. General: All gravity sewer pipes and service laterals shall be air tested and mainlines shall be checked for deflection, as specified. All manholes, vaults and boxes directly conveying flows shall be tested for leakage, as specified. Manholes and piping shall be tested following backfill placement. All leakage tests shall be completed and approved prior to the placement of permanent surfacing. When leakage exceeds the amount allowed by the Specifications, the Contractor shall locate the leaks and make the necessary repairs or replacements required to eliminate the leakage. Any individually detectable leaks shall be repaired, regardless of the results of the tests.

B. Leakage Tests: Gravity sewer systems shall be tested for leakage as follows:
   1. Air Pressure Test - Gravity sewers shall be air pressure tested in accordance with UNI-B 6 and/or ASTM F1417 as outlined below.
      a. The Contractor shall furnish all materials, equipment and labor for making an air test. Air test equipment shall be approved by the Engineer.
      b. The Contractor may conduct an initial air test of the sewer main line after densification of the backfill but prior to installation of lateral connection

sewers. Such tests will be considered to be for the Contractor's convenience and need not be performed in the presence of the Engineer.

c. Each section of sewer shall be tested between successive manholes by plugging and bracing all openings in the main sewer line and the upper ends of all lateral connection sewers. Prior to any air pressure testing, all pipe plugs shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released, the leaks eliminated, and the test procedure started over again.

d. Test pressure shall be 4.0 psig, unless groundwater elevation exceeds the invert elevation of the pipe. Where the normal groundwater elevation exceeds the invert elevation of the new pipe, the test pressure shall be adjusted for back pressure created by the groundwater. The new test pressure shall be determined by:

$$P_t = 4.0 + \frac{H}{2.35} \leq 9.0 \text{ psig}$$

e. Where P_t is the new test pressure and H is the difference in feet between the groundwater elevation and the lowest invert elevation of the pipe being tested. In no case shall the test pressure exceed 9.0 psig or the maximum pressure allowed by the pipe manufacturer.

f. After a manhole to manhole reach of pipe has been backfilled and cleaned, and the pneumatic plugs are checked, the plugs shall be placed in the line at each manhole and inflated to manufacturer's recommended inflation pressure. Low pressure air shall be introduced into this sealed line until the internal air pressure reaches test pressure. At least two minutes shall be allowed for the air pressure to stabilize. After the stabilization period minimum pressure (at the beginning of test time shall be test pressure minus 0.5 psig), the air hose from the control panel to the air supply shall be disconnected.

g. For pipe diameters 4"-36", the portion of line being tested shall be termed "Acceptable" if the allocated line pressure decreases less than 1.0 psi in the time shown for the given diameters and lengths in Table 1.

h. For pipe diameters greater than 36", the portion of line being tested shall be termed "Acceptable", if the allocation line pressure decreases less than 0.5 psi in the time shown for the given diameters and lengths in Table 2.

i. Required test times for lines consisting of multiple pipe diameters shall be determined in accordance with UNI-B-6 and or ASTM F1417.

j. If the installation fails to meet these requirements, the Contractor shall determine the source of leakage. He shall perform a leak location test and then repair or replace all defective materials and/or workmanship. This work shall be completed at no additional cost to the Owner.

Table 1
Low Pressure Air Test Times for 1.0 PSig Pressure Drop

Pipe Diameter (in.)	Minimum Time for 1.0 PSIg Pressure Drop (min:sec)	Pipe Length for Minimum Time (ft.)	Test Time for Pipe Length in Excess of Minimum (sec.)
4	03:47	597	.380 L

6	05:40	398	.854 L
8	07:33	298	1.520 L
10	09:27	239	2.374 L
12	11:20	199	3.418 L
15	14:10	159	5.342 L
18	17:00	133	7.692 L
21	19:50	114	10.470 L
24	22:40	99	13.674 L
27	25:30	88	17.306 L
30	28:20	80	21.366 L
33	31:10	72	25.852 L
36	34:00	66	30.768 L

Table 2
Low Pressure Air Test Times for 0.5 PSIg Pressure Drop

Pipe Diameter (in.)	Minimum Time for 0.5 PSIg Pressure Drop (min:sec)	Pipe Length for Minimum Time (ft.)	Test Time for Pipe Length in Excess of Minimum (sec.)
42	19:50	57	20.939 L
48	22:40	50	27.349 L
54	25:30	44	34.614 L
60	28:30	40	42.733 L
66	31:10	36	51.707 L
72	34:00	33	61.535 L
78	36:50	31	72.219 L
84	39:40	28	83.756 L
90	42:30	27	96.149 L
96	45:20	25	

C. Deflection Test: All flexible and semi-rigid main line pipe shall be tested for deflection, joint displacement, or other obstruction by passing a rigid mandrel through the pipe by hand, not less than 30 days after completion of the trench backfill, but prior to permanent surfacing. The mandrel shall be a full circle, solid cylinder, or a rigid, non-adjustable, odd-numbered leg (9 leg minimum) steel cylinder, approved by the Engineer as to design and manufacture. The circular cross section of the mandrel shall have a diameter of at least 95 percent of the specified average inside pipe diameter of the pipe and the minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. Obstructions encountered by the mandrel shall be corrected by the Contractor.

D. Video Inspection: After the sewer pipe has been installed and cleaned; and the trench has been backfilled, the sewer pipe shall be visually inspected by video camera to locate defects in the sewer pipe. Video Inspection shall be performed by an independent testing agency acceptable to the Owner. All sewer pipes shall be video inspected.
   1. Notify the Engineer, 48 hours prior to any televised inspections.
   2. The inspection shall be in digital video format, saved to an electronic media and shall be given to the Engineer for review and final records

3. The Contractor shall ensure safe access to each manhole as required by the testing agency.
4. Video equipment shall include a pipe inspection video camera with the following capabilities: panorama tilt, radial viewing, pans plus and minus 75 degrees, rotates 360 degrees, and has optical zoom from 6 or less inches to infinity. Equipment shall produce a high quality, full color video image.
5. Video equipment shall be equipped with a device that can accurately measure the depth of any ponding encountered in the pipe. Measuring device shall be clearly visible in the video image.
6. The video equipment shall have an accurate footage counter accurate to within 1 foot per 500 foot of pipe. Footage shall be continuously displayed on the video at all times.
7. Pipelines shall be cleaned and flushed immediately prior to video inspection. Pipelines that were cleaned and flushed more than 24 hours prior to video inspection shall be cleaned and flushed again. All dirt/debris, including pipe grease, in the line which could cover a defect shall be removed.
8. Jetting of the lines in conjunction with the video inspection is prohibited.
9. If during the video inspection, foreign material which prohibits an acceptable video inspection is discovered the line shall be cleaned and video inspected again.
10. The video camera shall travel through the pipe at a maximum rate of travel of 30 feet per minute. Video shall be continuous for each pipe segment between manholes or other access points.
11. The video camera shall pause at each tee, lateral or other connection and the camera shall be rotated and tilted to provide an image of the branch for inspection. The image shall remain clear and in focus at all times while zooming to the full extent of the camera. The camera operator shall stop at each fitting and change in pipe type and complete a 360 degree view of the fitting at a rate slow enough to identify any defects.
12. Glare shall be avoided and shall not interfere with viewing the pipe segment.
13. Provide DVDs or CDs with labels indicating project number, segment number, date televised, date submitted, starting manhole number, ending manhole number, pipe diameter, pipe length and street name.
14. Lines to be video inspected shall be flushed within 24 hours prior to beginning of inspection.
15. The video inspection shall be used to identify defective construction such as sags, debris, separated joints, etc. Any Work not conforming to the Specifications or Drawings shall be promptly removed, replaced and retested at no cost to the Owner. The Engineer shall make all final determinations if the severity of the defect constitutes failure and requires subsequent removal or repair of the segment in question.
    a. Conditions identified by the video inspection that require removal and replacement or, but are not limited to:
        1) Alignment (Vertical or Horizontal) is outside the specified limits.
        2) Water ponds in any section with depths equal to or greater than 2 times the grade tolerance specified in the Contract Documents.
        3) Pipe section with visible defects, such as: open joints, pinched gaskets, cracked barrels or bells, leaks, or other defects as determined by the Engineer.

3.4 TESTING OF MANHOLES AND OTHER APPURTENANT STRUCTURES

A. Manholes and other structures

1. Vacuum tests shall be conducted on the newly constructed manholes. Preliminary manhole testing may take place following construction after all connections are made, and before backfilling. Test results derived from this test will allow time for necessary repairs to be completed before further construction proceeds and hinders such repairs. Final tests must be performed after the manhole has been backfilled.

B. Procedures

1. Plug all manhole entrances and exits other than the manhole top access using suitably sized pneumatic or mechanical pipeline plugs and follow all manufacturer's recommendations and warnings for proper and safe installation of such plugs. Plugs should be inserted a minimum of 6 inches beyond manhole wall. Make sure such plugs are properly rated for the pressures required for the test. The standard test of 10 inches Hg. (mercury) is equivalent to approximately 5 PSIG (0.3 bar) backpressure. Unless such plugs are mechanically restrained, it is recommended that the plugs are used with a minimum two times (2x) safety factor or a minimum of 10 PSIG (0.7 bar) backpressure usage rating.
2. Close vacuum inlet/outlet ball valve and monitor vacuum for specified test period (see table). If vacuum does not drop in excess of 1" Hg., manhole is considered acceptable and the manhole passes the test. If manhole fails the test, complete necessary repairs and repeat test procedures until satisfactory results are obtained.

Minimum Test Times for Various Manhole Diameters

Depth, Feet	Diameter, Inches												
	48	54	60	66	72	78	84	90	96	102	108	114	120
	Time, Seconds												
8	20	23	26	29	33	35	38	41	45	48	51	54	57
10	25	29	33	36	41	44	48	52	56	60	63	67	71
12	30	35	39	43	49	53	57	62	67	71	76	81	85
14	35	41	46	51	57	62	67	72	78	83	89	94	100
16	40	46	52	58	67	70	76	83	89	95	101	108	114
18	45	52	59	65	73	79	86	93	100	107	114	121	128
20	50	53	65	72	81	88	95	103	111	119	126	135	142
22	55	64	72	79	89	97	105	114	122	131	139	148	156
24	59	64	78	87	97	106	114	124	133	143	152	161	170
26	64	75	84	94	105	114	124	134	144	155	164	175	185

28	69	81	91	101	113	123	133	145	155	167	177	188	199
30	74	87	98	108	121	132	143	155	166	178	189	202	213

3. (The values listed above are taken from ASTM Specification C1244-93 "Standard Test Method for Concrete Manholes by the Negative Air Pressure (Vacuum) Test.")
4. Repeat the above test procedure after backfilling manhole for final acceptance test.
5. Manholes shall be watertight. All joints, penetrations, etc., shall be sealed watertight prior to acceptance of manhole.

END OF SECTION

THIS PAGE INTENTIONALLY BLANK

SECTION 33 41 02
REINFORCED CONCRETE PIPE (ASTM C 76, MODIFIED)

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall construct all reinforced concrete culvert, storm drain conduits, complete, including connection to existing and new structures, all in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ASTM C76	Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
ASTM C443	Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
ASTM C1479	Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations

1.3 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish certificates to the Engineer guaranteeing that the pipe furnished hereunder is in compliance with the requirements of these Specifications.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture, in accordance with the provisions of the referenced standards, as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

C. Test: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.

D. The Contractor shall perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.

E. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

F. Any concrete pipe which arrives on site with voids, cracked, damaged, or with inadequate concrete cover over reinforcement or exposed reinforcement, or is cracked or damaged during installation shall be cause for rejection. Contractor shall remove precast section(s) from the project site and replace with new undamaged sections at no additional cost to Owner.

1.5 DELIVERY, STORAGE AND HANDLING

A. Handle concrete pipe in positions consistent with their shape and design. Lift and support only from the support points indicated on the shop drawings.

B. Embedded Lifting or Handling Devices capable of supporting pipe in positions anticipated during manufacturing, storage, transportation and installation.

C. Block and brace pipe during storage. Provide lateral bracing which is sufficient to prevent bowing and/or warping and will not inhibit curing of the exposed surfaces.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

A. Reinforced Concrete Pipe: Reinforced concrete pipe shall conform to the requirements of ASTM Designation C 76 meeting the pipe class as shown on the drawings. Bell and spigot joints including rubber gaskets, shall conform to the requirements of the latest revision of ASTM C443. Pipe joints shall be so designed as to provide for self centering and when assembled, to compress the gasket to form a watertight seal. The gasket shall be confined in a groove on the spigot end of pipes larger than 12 inches so that pipe movement or hydrostatic pressure cannot displace the gasket. All pipe shall be manufactured with Type II modified cement. Each pipe section shall be identified by a stamp indicating:

1. Name of Manufacturer
2. Date of Manufacture
3. D-loading in pounds and/or Pipe Class

2.2 CONCRETE END SECTIONS

A. End Sections: Precast reinforced concrete end sections shall have at least one line of reinforcement conforming to the requirements of AASHTO M170 equivalent to the square inches per linear foot for elliptical reinforcement for circular pipe, Class II, Wall B.

2.3 FABRICATION

A. Maintain plant records and quality control program during fabrication of structural precast concrete sections. Make all quality control records available to Engineer upon request.

B. Use molds that are rigid, and constructed of material that will result in uniform finished surfaces.

C. If self-consolidating concrete is not used, thoroughly vibrate concrete to ensure proper consolidation, elimination of cold joints, and to minimize trapped air on at the concrete surface.

D. Fabricate and provide the required lifting devices which are compatible with embedded components.

E. Ensure reinforcing steel, anchors, inserts, plates, angle and other cast-in items are sufficiently embedded, properly secured, and correctly located. Ensure the reinforcing steel is properly supported to prevent movement or shifting during fabrication. Inadequate concrete cover over reinforcing shall be cause for rejection.

F. Chairs or spacers between the reinforcement and forms shall be stainless steel or a nonferrous material.

G. Cure concrete pipe under identical conditions to develop specified concrete quality.

PART 3 - EXECUTION

3.1 GENERAL

A. Laying, jointing, testing for defects and for leakage shall be performed in the presence of the Engineer, and shall be subject to approval before acceptance. Material found to have defects will be rejected and the Contractor shall promptly remove such defective materials from the Site.

B. Installation shall conform to the requirements of ASTM C 1479, instructions furnished by the pipe manufacturer, and to the supplementary requirements herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.2 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of Section 31 23 00 – Earthwork.

3.3 INSTALLATION

A. The pipe shall be installed accurately to the defined line and grade. Variance from established line and grade shall not be greater than one thirty-second (1/32) of an inch per inch of pipe diameter and not to exceed one-half (1/2) inch, provided that such variation does not result in a level or reverse sloping invert; provided also that variation in the invert elevation between adjoining ends of pipe due to non-concentricity of joining surface and pipe interior surfaces does not exceed one sixty-fourth (1/64) inch per inch of pipe diameter or one-half (1/2) inch maximum.

B. All concrete pipe installation shall proceed up grade on a stable foundation with joints closely and accurately fitted. Rubber gaskets shall be fitted properly in place and care shall be taken in joining the pipe units to avoid twisting of gaskets. Joints shall be clean and dry before a joint lubricant, as recommended by the pipe supplier, shall be applied uniformly to the mating jointing surfaces to facilitate easy positive joint closure.

C. Pipe shall be installed with uniform bearing under the full length of the barrel, with suitable excavations being made to receive pipe bells.

D. Place circular concrete pipe that contains elliptical reinforcing so that the reference line designating the top of the pipe is not more than 5 degrees from the vertical plane through the longitudinal axis of the pipe.

E. Pipe zone material shall be compacted around the pipe to firmly bed the pipe in position. If adjustment of position of a pipe length is required after being laid, it shall be removed and rejointed as for a new pipe. When laying is not in progress, the ends of the pipe shall be closed with a tight-fitting stopper to prevent the entrance of foreign material.

F. In addition to the above-mentioned requirements, all pipe installation shall comply with the specific requirements of the pipe manufacturer.

G. During pipe installation, the trench shall be sufficiently dewatered that the joints will be free of water when jointed.

H. Grout all fittings to provide a smooth interior and exterior surface.

3.4 FIELD QUALITY CONTROL:

A. All installations of reinforced concrete pipe shall be subject to the testing, inspection and acceptance requirements of Section 33 08 00 – Gravity Piping Testing and Inspection.

END OF SECTION

SECTION 33 41 04
FRPM OR GRP PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for manufacture of Centrifugally Cast or Filament Wound Fiberglass Reinforced Polymer Mortar (FRPM) piping for installation by Direct Buried Open-Trench (DB) construction methods.

B. Special Fittings: Special fittings for shall be manufactured from pipe material.

1.2 REFERENCES

A. Section 01 33 20 – Submittal Procedures

B. ASTM D2412 – Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel Plate Testing

C. ASTM D477 – Specification for elastomeric seals (gaskets) for joining plastic pipe

D. ASTM C33 – Standard specification for concrete aggregates

E. ASTM C579 – Standard test method for compressive strength of chemical resistant mortars, grouts, monolithic surfacing and polymer concretes

F. ASTM D3262 – Standard specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe

G. ASTM D4161 – Standard specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals

H. ASTM D3681 – Standard Test Method for Chemical Resistance of "Fiber glass" Pipe in a Deflected Condition.

I. ASTM D638 – Test Method for Tensile Properties of Plastics.

1.3 DESIGN CRITERIA

A. Provide a pipe with a wall thickness determined by the manufacturer that meets the requirements of this specification with a minimum pipe stiffness of 46 psi (SN 46) according to ASTM D2412.

B. Provide pipe that is round and smooth.

1.4 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 20.

B. Submit the following:

1. Pipe specification compliance certifications
2. Full dimensional data on the pipe.
3. Shop drawings of the joint details with full dimensions for the pipe, coupling, machined joint, and bell ring including gasket material proposed.
4. Provide gasket resistance chart and composition of gasket material. The gasket material shall not have plasticizer as an ingredient.
5. Strength calculations showing that the pipe will meet the strength requirements of the installed condition per AWWA M45 Design Manual. Review the depth of bury and axial loading from DB operations as shown on the Drawings and provide calculations showing that the strength provided will meet the strength requirement for earth loading, groundwater, with less than 5% diametrical deflection per ASTM D3262/ISO 10467. Provide calculations signed by a Professional Engineer registered in the State of Utah.
6. Provide buoyancy calculations with a factor of safety of 1.5 against floatation at final design conditions and 1.25 during interim construction conditions. Provide calculations signed by a Professional Engineer registered in the State of Utah.
7. Provide details and material specifications for gaskets with a statement that the material is sewage, and grease resistant.
8. Manufacturers Certified Letter stating that their pipe is guaranteed to withstand the cleaning water pressure specified in Paragraph 3.03 herein.
9. Provide manufacturer's written shipping, handling, storage, assembly, installation, and field repair instructions.
10. Provide product warranty.

1.5 QUALITY ASSURANCE

C. Qualifications:

1. Calculations shall be prepared by a Professional Engineer licensed by the State of Utah.

D. Pipe Segments:

1. Field assemble watertight joints in accordance with manufacturer's written procedures.

PART 2 - PRODUCTS

2.1 FIBERGLASS OPEN-CUT PIPE

A. Materials:

1. Wall Resin Systems: Polyester resin system with a proven history of performance for FRPM piping systems.
2. Liner Resin Systems: Flexiblized polyester liner with a nominal 0.040-inch (1 mm) thickness and minimum elongation of 50% when tested in accordance with ASTM D638.
3. Glass Reinforcement: glass fibers of commercial E-glass filaments with binder and sizing compatible with impregnating resins.

4. Silica Sand: minimum 98 percent silica with a maximum moisture content of 0.2 percent.
5. Additives: resin additives including curing agents, pigments, dyes, fillers, thixotropic agents shall not detrimentally affect the performance of the pipe.
6. Elastomeric Gaskets: gaskets shall be EPDM supplied by a qualified gasket manufacturer and shall be oil and grease resistant suitable for sewage service.

B. Dimensions:
1. Outside Diameter: Outside diameter shall be in accordance with ASTM D3262 or ISO 10467.
2. Nominal Inside Diameters (ID): See plans.
3. Length: Pipe for open cut shall be supplied in length meeting the contractor installation methods but not greater than 20 feet in length.
4. Wall Thickness: Provide wall thicknesses sufficient to meet the Pipe Stiffness required for overburden conditions.

C. End Squareness: Square to plus or minus 1/8-inch (3.5 mm) tolerance.

D. Strain Corrosion Testing Data: Not required for this project.

E. Manufacture:
1. Process: Manufactured in accordance with ASTM D3262 and ISO 10467.
2. Joints:
a. Open-cut Pipe Couplings: A double belled coupling manufactured from FRPM. The elastomeric sealing gaskets made of EPDM rubber meeting the requirements of ASTM D4161/ISO 10467 for sanitary sewer service shall be placed in the bell or the spigot of the pipe, where coupling bridges over to provide a complete watertight seal with minimum 25 psi internal pressure.
b. Fittings: Mold or fabricate fittings from pipe joined with glass-fiber-reinforced overlays to meet the fitting requirements.
3. Only manufacturers with 10 years of proven history in supplying FRPM pipes of nominal inside diameters shown in the plans or larger per ASTM D3262/ISO 10467 are acceptable. A certified letter shall be provided by the pipe manufacturer stating that the pipe to be supplied is guaranteed for use as an open-cut pipe and meets the loading requirements for the project.
4. Acceptable manufacturers are
a. Hobas Pipe
b. Flowtite Pipe
c. Or Approved equal

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING BY OPEN-CUT METHODS

A. Install the pipe into the ground by open-cut per manufacturer's published instructions and per the plans. Interior of installed pipe shall be smooth without gouges and free of obstructions.

B. Contractor shall use textile slings, other suitable materials or a forklift, as instructed by the manufacturer. Use of chains or cables is not permitted for lifting pipe.

C. Jointing:
   1. Clean ends of pipe and coupling components.
   2. Apply joint lubricant to pipe ends and elastomeric seals of coupling. Use only lubricants approved by the pipe manufacturer.
   3. Use suitable equipment and end protection to push or pull the pipes together.
   4. Do not exceed forces recommended by the manufacturer for coupling pipe.
   5. Join pipes in straight alignment then deflect to required angle. Do not allow the deflection angle to exceed 50 percent of the maximum permitted deflection permitted by the manufacturer.

3.2 PIPELINE LINING REPAIR

A. During installation of piping, damage to the interior lining sometimes occurs. Repair this damage in accordance with the manufacturer's published instructions.
   1. Pipe Scratches: Scratches that do not penetrate the surface resin coating shall be repaired by cleaning the scratched area, drying the cleaned area, then applying a coat of resin thickened with mill fiber.
   2. Pipe Gouges: Gouges that penetrate the interior resin veil shall be repaired by cleaning the gouge area, drying the cleaned area, applying a one layer of fiberglass patch, and then over coating the patched area with a coat of resin thickened with mill fiber.

3.3 PIPELINE CLEANING

A. The pipe manufacturer shall certify that their pipe is capable and guaranteed to withstand pressure cleaning methods by pulling a cleaning skid nonstop through section to be cleaned. The pipe shall withstand a cleaning pressure of not less than 2,000 PSI at the pump gauge from the water pressure nozzles of the cleaning skid.

END OF SECTION

APPENDIX A

PIPELINE AND MANHOLE INSPECTION DATA

Note: This information is located at the following box.com link: https://app.box.com/s/9b9ryzv3k7v481ctrsw4waz5rgecwbz0 and is provided for the Contractor's information only and were used by the Design Professional in preparing these Contract Documents. The information contained at this link is not actual Contract Documents.

APPENDIX B

PROPERTY RESTORATION RELEASE FORM

PROPERTY RESTORATION RELEASE FORM

EASEMENT GRANTOR:_____

Land Serial No. : _____

EASEMENT GRANTEE: South Valley Water Reclamation Facility

By signing below, Grantor acknowledges that the Contractor, _____, has restored Grantor's property substantially to the condition that existed immediately prior to the construction of the South Sewer Interceptor CIPP project as required in the Sewer Easement (Entry No. _____) and hereby releases the Grantee from any and all claims for damages from whatsoever cause incidental or related to the exercise by Grantee of the rights granted in said easements.

Dated this _____ day of _____, 20___.

GRANTOR:_____

By:_____

Its:_____