SECTION 01150

MEASUREMENT AND PAYMENT

A. SCOPE

Under this heading shall be included the methods of measurement and payment for items of work under this Contract.

B. ESTIMATED QUANTITIES

All estimated quantities for unit price items, stipulated in the Bid Form, or other Contract Documents, are approximate and are to be used as a basis for estimating the probable cost of the work and for comparing the bids submitted for the Project. The actual amounts of work done and materials furnished under price items may differ from the estimated quantities. The basis of payment for work and materials will be the actual amount of work done and material furnished. The Contractor agrees to make no claim for damages, anticipated profits or otherwise on account of any difference between the amounts of work actually performed and materials actually furnished and the estimated amounts included in the Bid Form.

C. LUMP SUM AND UNIT PRICE QUANTITIES

All quantities are for unit price or lump sum items stipulated in the Bid Form. The Contractor, having read and understood the Bidding Documents and examined the Project sites and adjoining areas, and being familiar with the obstacles and conditions that will affect proposed work, hereby offers and agrees to furnish all labor, products, and services needed to provide work in accordance with the Bidding Documents and will provide a properly itemized listing for each bid item, supported by sufficiently substantially data, to permit evaluation of partial pay requests.

1. Mobilization, Demobilization, Insurance & Bonds

There will be no separate measurement of the items under this heading. Payment for this item will be on the basis of the lump sum price in the Bid Form. The lump sum price for this item shall not exceed 5% of the total of all bid items in the Base Bid (not including the Supplementary Work Allowance).

Payment shall include all compensation for mobilization, demobilization, insurance requirements and bonds for the project. Payment for 75% of the item shall be made when the Contractor completes project mobilization and satisfies the insurance and bonding requirements to the satisfaction of the Owner. Payment for the remaining 25% of the item shall be after demobilization and completion of the work to the satisfaction of the Owner.

2. Remove Existing Tank and Store On-Site

There will be no separate measurement of the items under this heading. Payment for this item will be on the basis of the lump sum price in the Bid Form. Payment includes all labor, equipment and materials required for the removal of the existing tank and placing it at an on-site location designated by the JWSC representative.

3. Reinforced Concrete Foundation for Tank including Demo of Existing Foundation

There will be no separate measurement of the items under this heading. Payment for this item will be on the basis of the lump sum price in the Bid Form. Payment includes all labor, equipment and materials required for the installation of the tank foundation including demolition of the existing tank foundation and cutting existing piles as described in the bid documents.

4. Miscellaneous Concrete Pads/Foundations

Measurement and payment for this item will be on the basis of the unit price in the Bid Form. Payment includes all labor, equipment and materials required to install the concrete pads and foundations, not included as part of other items, shown on the bid documents including reinforcement.

5.-14. Remove and Replace Pipe Supports

There will be no separate measurement of the items under this heading. Payment for this item will be on the basis of the lump sum price in the Bid Form. Payment includes all labor, equipment and materials required for the removal and replacement of pipe and pipe supports as described in the bid documents. This item includes all welding, testing, concrete foundations and fittings required to install the section of pipe associated with the item.

15. Install 5 HP Blower

There will be no separate measurement of the item under this heading. Payment for this item will be on the basis of the lump sum price in the Bid Form. Payment includes all labor, equipment and materials required for the furnishing and installation of the blower as described in the bid documents.

16. Install 100 HP Blower and Control Panel

There will be no separate measurement of the item under this heading. Payment for this item will be on the basis of the lump sum price in the Bid Form. Payment includes all labor, equipment and materials required for the furnishing and installation of the blower and control panel, with shelter, as described in the bid documents. The cost for furnishing and installing the concrete pad under the blower and control panel shall be included in Bid Item 4.

17.-18. Install Motor-Actuated BFV

There will be no separate measurement of the items under this heading. Payment for this item will be on the basis of the lump sum price in the Bid Form. Payment includes all labor, equipment and materials required for to complete the work as described in the bid documents.

19.-20. Install Lever-Operated BFV

There will be no separate measurement of the items under this heading. Payment for this item will be on the basis of the lump sum price in the Bid Form. Payment includes all labor, equipment and materials required for to complete the work as described in the bid documents.

21. SCADA Allowance

This item is an allowance based on the SCADA quote provided in Appendix B. The contractor shall coordinate all SCADA work and provide support work based on the quote provided in Appendix B. Payment for the contractor's work shall be included in Bid Item 22.

22. Miscellaneous Items including support work for SCADA/ instrumentation, final site cleanup and restoration necessary for a complete job but not otherwise listed in this proposal

There will be no separate measurement of the items under this heading. Payment for this item will be on the basis of the lump sum price in the Bid Form. Payment includes all labor, equipment and materials required for to complete the work as described in the bid documents.

D. SUMMARY OF ITEM TOTALS

The Bidder shall fill in the appropriate totals which shall be used as a basis for comparison of bids. The Owner reserves the right to award the Contract in the best interest of the Owner. The total Contract amounts will be determined upon

completion of the project using the quantities actually incorporated into the project corresponding to the unit prices and lump sum amounts in the Bid Proposal.

Payment shall be considered to cover the cost of all labor, supervision, material, equipment and performing all operations necessary to complete the work in place. The items listed in the proposal shall be considered as sufficient to complete the work in accordance with the Plans and Specifications; incidental items of work not listed in the bid form shall be a part of the item with which it is associated and shall be included in the cost of the unit shown on the bid form. The unit of measurement shall be the unit shown in the proposal. Payment will be based upon the actual quantity multiplied by the unit price.

END OF SECTION 01150

SECTION 02100

CLEARING AND GRUBBING

1. SCOPE:
Under this heading shall be included the furnishing of all labor, materials and equipment and performing of all operations necessary for clearing and grubbing all areas and disposal of all unsuitable material.

2. LIMITS:
Clearing and grubbing under this Contract shall be performed within the area necessary to perform the work as shown on the plans.

3. CLEARING:
Completely clear, remove and satisfactorily dispose of all unsuitable materials resting on or protruding above the surface of existing ground. Clearing includes trees (unless designated for preservation), stumps, bushes, grass, rubbish, refuse, scrap iron, rubble and all other deleterious materials. Excavate for stumps if necessary.

4. GRUBBING:
Completely grub the entire designated area free of all roots, stumps, logs, rubbish and other deleterious materials to a depth of at least two feet below existing ground. If no further excavation is to be made within the limits of Work under this heading then the holes caused by the removal of stumps, trees and rocks shall be filled and compacted with suitable material and graded to conform with surrounding surface.

5. BENCH MARKS:
The Contractor shall maintain and protect all benchmarks, monuments, settlement monitoring devices and other reference points. Any reference point damaged or destroyed as a result of the Contractor's operations or negligence shall be repaired or replaced at no cost to the Owner.

6. DISPOSAL:
Disposal of all cleared and grubbed materials by burning will only be permitted when weather conditions are favorable, subject to the Owner’s regulations and conditions.

7. MEASUREMENT AND PAYMENT:
Measurement and payment for work under this Section shall be in accordance with Section 01150.

END OF SECTION

SECTION 02210

EROSION AND SEDIMENT CONTROL

1. GENERAL:

a. RELATED LAND DISTURBING DOCUMENTS:

1. Land Disturbing Activity Permit (LDA) is required for each project over 1.0 acres and is part of the Work associated with the project. The Contractor is required to comply with the best management practices for the control of erosion and sediment from the work site.

2. NPDES General Permit No. GAR 100000 for the discharge of storm water associated with construction activity for projects five (5) acres and larger and for projects fifty (50) acres and larger. Both the Owner and the Contractor are primary permittees (any entity that has submitted a Notice of Intent) of the Erosion, Sedimentation and Pollution Control Plan (ES&PCP). The Owner provides the ES&PCP to the Contractor. A copy of this permit will be provided to the Contractor and the Contractor shall comply with its provisions until the work is completed and accepted by the Owner.

The Contractor cannot start work until seven (7) days after the Owner has filed the Notice of Intent (NOI).

If the disturbed area is five (5) acres or larger the project is governed by the NPDES Permit for the discharge of stormwater associated with construction activity as shown in the Erosion, Sedimentation and Pollution Control Plan.

If the disturbed area is fifty (50) acres or larger, both the Erosion, Sedimentation and Pollution Control Plan (ES&PCP) and the Comprehensive Monitoring Plan (CMP) must be submitted to EPD with the Notice of Intent. The ES&PCP and CMP will indicate when, where and how often the site inspection and water testing should be conducted. Inspections and monitoring will be made by the BGJWSC.

b. DESCRIPTION OF WORK:

Under this section shall be included all measures both temporary and permanent to control erosion and sedimentation, and protect all surface waters and property both on and off site. This shall include all labor, materials and equipment necessary to meet the requirements of this Section. The Contractor shall not begin work until he is in full compliance with the LDA Permit that has been approved for the work associated with this project. Failure to install and maintain erosion control and sedimentation on the site shall constitute a violation of this permit for each day on which such failure

occurs.

c. EROSION AND SEDIMENTATION ACT - DEFINED:
It is the intent of this Specification that the Project and the Contractor comply with all applicable requirements of the State of Georgia Erosion and Sedimentation Control Act of 1975 as amended and any County or Municipal Soil Erosion Ordinance.

The Manual for Erosion and Sediment Control in Georgia further defines practices and requirements. All erosion and sedimentation control measures must be designed for a 25-year, 24-hour rain event. The Contractor is responsible for maintaining all sediment and erosion control measures on the project site during construction. The Contractor is responsible for any damage caused due to failure to implement these requirements. A Soil Erosion and Sedimentation Control Permit has been obtained by the Owner. Periodic inspections will be made by the BGJWSC. The Contractor is to cooperate with the person performing these inspections.

d. COORDINATION WITH CONTRACT PLANS:
A Soil Erosion and Sedimentation Control Plan will be provided to the Contractor and is to be implemented as a part of the procedures necessary to implement requirements of the Act and Ordinance.

2 PRODUCTS:
Not applicable to this specification section.

3. EXECUTION:

a. IMPLEMENTATION:
Implementation of the requirements of the Act is based on the following principles:

1. The disturbed area and the duration of exposure to erosion elements should be minimized.

2. Stabilize disturbed areas immediately.

3. Retain or accumulate runoff.

4. Retain sediment.

5. Do not encroach upon watercourses.

4. SYMBOLS:
The Soil Erosion and Sedimentation Control Plan contain standard symbols for the different types of measures for implementing the Act. These symbols are defined for conditions, design criteria and construction specifications in Chapter 6 of the

Manual and on the Drawings.

5. SPECIFIC REQUIREMENTS:

a. Obtain the LDA permit from the appropriate authority.

b. All erosion and control measures must be installed prior to initiation of construction activity.

c. A temporary construction egress pad shall be installed and maintained at any point where construction vehicles enter a paved road, street or parking area. The pad shall be used to prevent mud from leaving the construction area. The pad shall be constructed as shown in the Manual for Erosion and Sediment Control.

d. All disturbed areas shall be grassed by sodding or seeding, fertilizing, mulching and watering to obtain a ground cover which prevents soil erosion.

e. All measures installed for sediment control shall be checked at the beginning and end of each day when construction is occurring to ascertain that the measures are in place and functioning properly.

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f. Sewer trenches will not be excavated more than can be properly backfilled by the end of work day.

g. Erosion control measures shall be inspected by the Contractor after each rainfall event and at least daily during prolonged periods of continuous rainfall. Contractor shall make repairs and adjustments as necessary to maintain the effectiveness of all sediment and erosion control measures.

h. The contractor shall remove all silt fencing after permanent grassing is established and accepted by the Owner.

END OF SECTION

SECTION 02221

EXCAVATION, TRENCHING AND BACKFILL
FOR UTILITY SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

This section specifies the requirements for excavation, trenching, and backfilling for all underground utility systems. Underground utility systems include water mains and services, sanitary sewers and services, storm drains, and sanitary sewer force mains.

PART 2 - MATERIALS

2.1 BEDDING

A. Bedding material shall meet the following requirements:

1. Coarse sands and gravels with maximum particle size of 40 mm (1-1/2 inches), including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry.

2. Fine sand and clayey gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures.

2.2 BACKFILL

A. Backfill material shall consist of suitable excavated materials or imported gravel meeting the requirements of #57 stone.

B. All backfill material shall be free of stones, concrete and clay lumps larger than a cubic foot. Roots, stumps and rubbish which will decompose will not be permitted in the backfill. Backfill material shall have its moisture content corrected, as may be necessary before being placed in the trench to bring the moisture content to approximately "optimum" for good compaction. Any rock, stone, concrete, clay lumps larger than a cubic foot in volume, rubbish and debris shall be removed from the site and properly disposed of by the Contractor.

PART 3 - EXECUTION

3.1 GENERAL

Underground piping and utility systems which are to be installed in trenches whose lowest point of excavation is below the existing ground level and are unaffected by an excavation for structures, may be installed at any time during the course of the work. Piping and systems to be installed in or over fill, backfill or new embankments shall not be installed until all earthwork has been completed to rough grade, nor until settlement of the fill or embankment has taken place.

3.2 LOCATION AND PROTECTION OF UTILITIES AND STRUCTURES

A. It shall be the responsibility of the Contractor to acquaint himself with the location of all utilities and structures both present and proposed, also all existing surface structures which may be affected by work under the Contract. The location of any underground structures furnished, shown on the Drawings or given on the site are based upon the available records but are not guaranteed to be complete or correct, and are given only to assist the Contractor in making a determination of the existence of underground structures.

B. Overhead utilities, poles, etc., shall be protected against damage by the Contractor, and if damaged by the Contractor, shall be replaced by him. The Contractor shall notify those who maintain utilities sufficiently in advance of the proposed construction so that they may locate, uncover and disclose such work. If the progress of construction necessitates the removal or relocation of poles, overhead utilities and obstructions, the Contractor shall make all arrangements and assume all costs of the work involved.

C. The Contractor shall provide for the continuance of the flow of any sewers, drains, water pipes, and water courses, and the like. Where such facilities, water courses, or electric overhead wires or conduits are interfered with by the work of the Contractor, the interruption shall be a minimum and shall be scheduled in advance with the Engineer and the utility owner.

D. The Contractor shall restore all facilities interfered with to their original condition or acceptable equivalent. The cost of such restoration or damage caused directly by his work shall be paid for by the Contractor and shall be included in the prices bid for the items to which it pertains.

3.3 EXCAVATION AND TRENCHING

A. Excavation

Excavate all materials encountered.

B. Caution in Excavation

The Contractor shall proceed with caution in the excavation and preparation of the trench so that the exact location of underground structures in the trench zone may be determined before being damaged. He shall be held responsible for the repair or replacement of such structures when broken or otherwise damaged because of his operations.

C. Trench Excavation

Trenches shall be wide enough to permit proper installation of pipe fittings and placing and compacting bedding and backfill materials. The width of the trench shall be sufficient to accommodate compaction equipment. Whenever possible, the clear width of the trench at the top of the pipe should not exceed the pipe outside diameter plus 24 inches.

D. Alignment and Grade

Trenches shall be excavated on the alignments shown on the Drawings, and to the depth and grade necessary to accommodate the pipes at the elevations shown. Where elevations of the invert or centerline of a pipe are shown at the ends of a pipe, the pipe shall be installed at a continuous grade between the two elevations.

E. Over Excavation

Excavation in excess of the depth required for proper shaping shall be corrected by bringing to grade the invert of the ditch with compacted coarse, granular material at no additional expense to the Owner. Bell holes shall be excavated to relieve bells of all load, but small enough to insure that support is provided throughout the length of the pipe barrel.

Excavation in excess of the depths required for manholes and other structures shall be corrected by placing a sub-foundation of 1500 psi concrete, at no additional expense to the Owner.

F. Rock Excavation

Rock found in trench shall be removed for a depth of at least six (6) inches below the bottom of the pipe.

3.4 SHEETING AND SHORING

Excavations, shall be properly shored, sheeted and braced by the Contractor to maintain excavation in a condition to permit the safe and efficient installation of all items of Contract work. Braced and sheeted trenches and open trenches shall comply with all state laws and regulations, and local ordinances relating to

safety, life, health and property. Also, this shall conform to the Occupational Safety and Health Standards for Excavations, Final Rule (29 CFR Part 1926) as printed in the October 31, 1989 issue of the Federal Register.

3.5 DEWATERING AND PROTECTION AGAINST WATER

A. The Contractor shall remove water from the site and shall lower the ground water level as necessary to complete the excavations to the required depths and so that all required work can be accomplished in the dry. The Contractor shall perform well construction, well pointing, sheeting, ditching, and pumping, and shall construct necessary drains, channels and sumps to keep his excavations and new structures clear of ground water, storm water or sewage and to keep his construction areas dry during the progress of the work.

B. Adequate measures and protection shall be provided by the Contractor to protect his work from damage from uplift due to ground water, storm water, or flood water. Any damages which may result due to dewatering shall be the Contractor's responsibility.

C. All water discharged by pumping operations shall be discharged so as not to interfere with work under this Contract or with existing structures and operations. Water from dewatering operations shall be conveyed to the existing drainage features, using piping and pumping facilities provided by the Contractor. Route of dewatering pipe shall be subject to the Engineer's review. Discharge facilities and water quality shall comply with applicable regulations of State and Federal agencies.

D. Dewatering operations shall be uninterrupted and continuous during the course of the work so as not to endanger any construction in place or to present a hazard to workmen in and around the site. The Contractor shall take all measures necessary including, but not limited to, standby equipment and constant attendance to ensure that the dewatering system remains operational and effective throughout the period of time that it is required.

E. No water shall be allowed to run over any uncompleted portions of the work. No units of the work shall be constructed under water. The cost of dewatering shall be included in the price bid for the item of work for which it is required.

3.6 REMOVAL AND REPLACEMENT OF UNSUITABLE FOUNDATION MATERIAL

A. When the trench is excavated to the plan depth or as required by these Specifications, and soft or other material not suitable for bedding purposes is encountered in the trench, the Contractor shall immediately

notify the Engineer for inspection and measurement of the unsuitable material to be removed. Where, in the opinion of the Engineer, the subgrade of the pipe trench is unsuitable material, the Contractor shall remove the unsuitable material to a depth of 6” for the full width of the trench and furnish and place stone backfill in the trench to stabilize the subgrade. Payment for removal and replacement of unsuitable material shall be in accordance with the requirements of the Measurement and Payment Section.

B. Attention is invited to the fact that the presence of water does not necessarily mean that stone backfill is required. If well points or other types of dewatering will remove the water, the Contractor shall be required to completely dewater the trench in lieu of stone backfill. Removal and replacement of unsuitable material with stone backfill will be limited to areas where well pointing and other conventional methods of dewatering will not produce a dry bottom.

C. No payment will be made for any overdepth excavation of soft unstable material due to the failure of the Contractor to provide adequate means to keep the trench dry.

D. No payment will be made for any overdepth excavation of the unsuitable material and replacement not inspected and measured by the Engineer prior to excavation.

3.7 PLACEMENT OF BEDDING MATERIALS

A. Bedding material shall be placed and compacted up to the springline of the pipe.

B. Bedding material around the pipe shall be installed with care. Care shall be used to insure that sufficient material has been worked under the haunch of the pipe to provide adequate side support. Precautions must be taken to prevent movement of the pipe during placing of the material through the pipe haunch.

C. Avoid contact between the pipe and compaction equipment. Compaction of bedding shall be done so that compaction equipment will not damage the pipe.

D. ASTM D2321 "Underground Installation of Flexible Thermoplastic Sewer Pipe" shall be used in conjunction with the above.

3.8 PLACEMENT OF BACKFILL MATERIAL

A. Backfilling operations in this work are referred to herein as Backfilling at the Pipe Zone, Type"A" and Type "B". Type A backfilling shall be used

where trenches cross under roadways, paved areas, and structures. Type B backfilling shall be used in all other areas.

B. Type "A" backfill shall consist of suitable excavated materials or imported gravel placed in the trench in 6 inch thick layers from one foot above the pipe to finished grade. Each 6-inch layer shall be compacted before additional material is placed in the excavation. The density of the backfilled material after compaction shall be equal to 100 percent of the maximum density obtainable at optimum moisture content as determined by the Standard Proctor Test (ASTM D698). No water shall be used to secure compaction except for adding water to the backfill material before placing in the trench to bring moisture content to approximately "optimum" for good compaction.

C. Type "B" Backfilling shall consist of suitable excavated materials or imported gravel placed in the trench in 12 inch thick layers from the spring line of the pipe to finished grade. Each 12 inch thick layer shall be compacted before additional backfill material is placed in the excavation. The density of the backfilled material after compaction shall be equal to 95 percent of the maximum density obtainable at optimum moisture content as determined by the Standard Proctor Test (ASTM D698). Water shall be added to backfill material only before being placed in the trench in order to bring the moisture content to approximately "optimum" for good compaction.

3.9 CONSTRUCTION ALONG HIGHWAYS, STREETS AND ROADWAYS

A. Operations

Excavation, trenching and backfilling along highways, streets and roadways shall be in accordance with the applicable regulations of the Georgia State Highway Department with reference to construction operations, safety, traffic control, road maintenance and repair.

B. Removing And Resetting Fences

Where existing fences must be removed to permit construction, the Contractor shall remove such fences. As construction progresses, reset the fences in their original location and to their original condition. All costs of removing and resetting fences and such temporary works as may be required shall be included in the prices for the utility line or as provided for in the Bid Proposal.

C. Protecting Trees, Shrubbery And Lawns

Trees and shrubbery along trench lines shall not be disturbed unless absolutely necessary. Trees and shrubbery necessary to be removed shall be properly heeled-in and re-planted. Heeling-in and re-planting shall be done under the direction of an experienced nurseryman. Where utility trenches cross established lawns, sod shall be cut, removed, stacked and

maintained in suitable condition until replaced.

Topsoil underlying lawn areas shall likewise be removed and kept separate from general excavated materials. Removal and replacement of sod shall be done under the direction of an experienced nurseryman.

D. Protection of Traffic

Provide suitable signs, barricades and lights for protection of traffic, in locations where traffic may be endangered by construction operations. All signs removed by reason of construction shall be replaced as soon as condition which necessitated such removal has been cleared. No highway, street or roadway shall be closed without first obtaining permission from the proper authorities.

E. Drainage Structures

All side ditches, culverts, cross drains and other drainage structures shall be kept clear of excavated material and be free to drain at all times.

F. Maintaining Highways, Streets, Roadways and Driveways

The Contractor shall furnish proper equipment which shall be available for use at all times for maintaining highways, streets and roadways. All such streets, highways and roadways shall be maintained in suitable condition until completion and final acceptance of the work.

The Contractor shall repair all driveways that are cut or damaged and maintain them in suitable condition until completion and final acceptance of the work.

3.10 PROTECTION OF WATER SUPPLY PIPES

A. Parallel Installation

Water mains shall be laid at least ten (10) feet horizontally from any existing or proposed sanitary sewer, storm sewer or sewer manhole. The distance shall be measured edge to edge. When local conditions prevent a horizontal separation of 10 feet, the water main maybe laid closer to a sewer (on a case-by-case basis) provided the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer. The sewer materials and joints shall be the equivalent to water main standards of construction and be pressure tested as required in Section 02700 to assure water-tightness.

B. Crossing

Water mains crossing sewers, storm sewers or sanitary sewers shall be laid to provide a separation of at least 18 inches between the bottom of

the water main and the top of the sewer. At the crossings, one full length of water pipe shall be located so that both joints will be as far apart as possible. When local conditions prevent a vertical separation of 18 inches, the sewer passing over or under the water mains shall be constructed of materials and with joints that are equivalent to water mains standards of construction and shall be pressure tested as required in Section 02710 to assure water-tightness.

C. Special Conditions

When water mains cross under sewers, additional measures shall be taken by providing:

1. A vertical separation of at least 18 inches between the bottom of the sewer and the top of the water main;

2. That the one full length of water pipe be centered at the point of crossing so that the joints will be equidistant and as far as possible from the sewer; and, special structural support for the water and sewer pipes be installed if required.

3. The sewer force main shall be constructed of water pipe materials and subjected to hydrostatic test, as prescribed in Section 02710 - Sewer Force Mains.

3.11 REMOVE AND REPLACE PAVEMENT

A. Pavement and base course which must be removed for constructing sewers, manholes, force mains, water lines, and all other appurtenances in streets shall be replaced in accordance with BGJWSC requirements.

B. The top 18 inches of subgrade material immediately under the paving base and also road shoulder shall be carefully removed and kept separate from the rest of the excavated material. This material shall be placed in the top 18 inches of the backfill. Further compaction shall be accomplished by leaving the backfilled trench open to traffic while maintaining the surface with crushed stone or gravel. Settlement in trenches shall be refilled with crushed stone or gravel, and such maintenance shall continue until replacement of pavement.

C. Where utility lines are constructed on unpaved streets, roads or easements, the top 18 inches of soil shall be stripped and windrowed separate from the excavation from trenches. After the line has been installed and the backfill completed within 18 inches of the original grade, the salvaged surfacing shall be replaced. This work shall be considered as general clean-up along with the removal of surplus excavated materials from the site and the restoring of the surface outside trench limits to its

original condition, the cost of which shall be included in the price bid for the utility line.

3.12 WALKS, DRIVES, CONCRETE CURB AND GUTTER

A. Walks, driveways, and concrete curb and gutter designated for removal or are damaged during the course of construction shall be replaced.

B. Sidewalks, driveways, and concrete curb and gutter shall be removed by making a vertical saw joint between any existing sidewalk, driveway, or curb and gutter that is to remain in place and the portion that is to be removed. The subgrade shall be compacted in accordance with the requirements of the BGJWSC. Concrete shall be placed in accordance with BGJWSC requirements.

3.13 TESTING

A. General

The Contractor shall select a qualified independent testing laboratory, acceptable to the Engineer, for the purpose of identifying soils, checking densities, and classifying soils materials during construction. All testing will be paid for by the Contractor. Copies of all test results shall be furnished to the Engineer.

B. Moisture-Density Tests

Testing shall be in accordance with ASTM Methods D698. A test shall be performed on each type of material used in the work regardless of source. Tests will be accompanied by particle-size analyses of the soils tested (ASTM Methods D421 and D422). Changes in color, gradation, plasticity or source of fill material will require the performance of additional tests. Copies of all test results shall be furnished to the Engineer.

C. Field Density Tests

Tests shall be made in accordance with ASTM Method D1556. Tests shall be made in accordance with the following minimum schedule or as required by the soils technician or as may be directed by the Engineer:

One test for each lift of backfill for each 200 feet of trench or fraction thereof.

D. Submittals

1. The soils technicians will submit formal reports of all compaction tests and retests.

2. The reports are to be furnished to the Owner and the Engineer as

soon as possible upon completion of the required tests.

3. This report information is to include but not be limited to the following:

   a. Date of the test and date submitted.

   b. Location of test.

   c. Wet weight, moisture content and dry weight of field sample.

   d. Description of soil.

   e. Maximum dry density and moisture content of the lab sample which best matches the field sample in color, texture, grain size and maximum dry density.

   f. Ratio of field dry density to maximum lab dry density expressed as a percentage.

   g. Comments concerning the field density passing or failing the specified compaction.

   h. Comments about re-compaction if required.

E. Compaction Results

1. If any compaction test reveals that fill or backfill is not compacted as specified, the Contractor shall scarify and re-compact as required to achieve the specified density. Additional compaction tests shall be made to verify proper compaction. These additional tests, required due to failure of the original test shall be paid for by the Contractor.

2. The soils technician is to advise the Engineer and the Contractor's Superintendent immediately of any compaction tests failing to meet the specified minimum requirements. No additional lift is to be placed on a lift with any portion failing.

END OF SECTION

SECTION 02480

GRASSING AND SODDING

PART 1 - GENERAL

1.1 SUMMARY

This section specifies requirements for includes fertilizer, grassing and sodding.

1.2 GENERAL

All disturbed areas resulting from work under this Contract shall be grassed or sodded as shown on the Drawings. For roads under state jurisdiction, grassing on the right-of-way shall meet the requirements of the Department of Transportation Standard Specifications.

1.3 SUBMITTAL

Manufacturer's data shall be submitted to the Engineer on grass seed, sod and fertilizer before the materials are delivered to the project site.

PART 2 – MATERIALS

2.1 FERTILIZER

Fertilizer shall be 10-10-10, commercial fertilizer conforming to state fertilizer laws.

2.2 LIME

Lime shall be agricultural grade, ground limestone and shall meet the requirements of the Georgia Department of Agriculture. Lime shall be added based on the results of soil test.

2.3 STRAW MULCH

Straw mulch shall consist of straw or hay. The mulch shall be reasonable free of mature seed bearing stalks, roots, or bulblets and shall be free of Johnson Grass, Nutgrass, Sandbur, Wild Garlic, Wild Onion, Wild Mustard, Crotolaria, Pigweed, Witchweed, and Cocklebur.

2.4 WOOD CELLULOSE FIBER MULCH

Wood cellulose fiber mulch shall be made for wood chip particles manufactured

for discharging uniformly on the ground when applied by a hydraulic water sprayer. It shall remain in uniform suspension in water under agitation and blend with grass seed and fertilizer to form an homogenous slurry. It shall be dyed (non-toxic) an appropriate color to facilitate metering of material.

2.5 SEED

A. Seed shall meet the requirements of the Georgia Seed Laws and Rules and Regulations.

B. Seed shall be delivered in suitable sealed containers labeled in accordance with applicable laws and regulations and including name and location of the producer. The pure live grass seed mixture shall be as shown on the Drawings.

C. Mixtures of different types of seed called for in the seeding schedule shall be weighted and mixed in the proper proportions.

2.6 SOD

Sod shall be good quality, densely-rooted centipede grass, free from noxious weeds. The sod shall be obtained from areas where soil is reasonably fertile and contains a high percentage of loamy topsoil. Before cutting, the sod shall be raked free of all debris and the grass cut to two inches. The thickness of the sod shall be such as to contain practically all of the dense root system of the grass and not be less than 1 inch thick. Sod shall be cut into uniform strips not less than 12 inches in width and 24 inches in length.

PART 3 - EXECUTION

3.1 SOIL PREPARATION

A. Immediately before seeding, the soil shall be properly prepared for seeding. The areas shall be made smooth and uniform and shall conform with the finished grade and cross section shown on the Drawings. Area to be grassed, if not loose, shall be loosened to a minimum depth of 3 inches before lime, fertilizer, seed or sod is applied. Seeded areas shall be free of stones larger than 2 inches and of roots and debris of any size.

B. Seeded areas shall be moist when seeding and shall be kept moist by sprinkling until a good stand of grass is obtained and until the work is accepted by the Owner. Reseeding shall be done by the Contractor at his own expense as may be necessary to obtain a satisfactory stand of grass.

C. The Contractor shall use mulch or other additive materials when conditions do not allow an acceptable stand of grass to grow. Mulch and additive materials shall contain no weed seeds.

3.2 SEEDING

A. Seeding shall be performed during the periods and at the rates specified in the seeding schedule in the Drawings. Seeding shall not be performed when the ground is frozen or excessively wet.

B. Seeds are to be sown by a mechanical spreader either hand operated or machine operated. Seeding equipment shall be such as will continuously mix the seeds to prevent segregation

C. Immediately after the seed has been sown, the entire area shall be raked lightly and rolled to pack the soil firmly around the seed. Seeded areas shall be uniformly mulched with a continuous blanket of straw immediately after seeded. Straw shall be applied at a rate of 2 tons per acre.

3.3 SOD

A. Sod shall be placed between March 1st and December 1st. Sod shall be placed within 48 hours of cutting.

B. Sod shall be moist when laid and placed on a moist bed. Sod shall be placed within 48 hours of cutting. The sod strips shall be carefully placed by hand, beginning at the toe of slopes and progressing upward, with the length of the strip at right angles to the direction of flow of surface water. All joints shall be tightly butted and end joints shall be staggered at least 12 inches. The sod shall be immediately pressed firmly into contact with bed by tamping or rolling. Screened soil shall be used to fill all joints between strips.

C. Sod on slopes shall be pegged with sod pegs to prevent displacement. The sod shall be watered, mowed, weeded, repaired or otherwise tended to insure the establishment of a uniform healthy stand of grass.

3.4 HYDROSEEDING (WOOD CELLULOSE FIBER MULCH)

Hyrdoseeding shall be applied at a rate of 1500 pounds per acre in a slurry mixture of seed, fertilizer, and wood cellulose fiber mulch. The slurry mixture shall be regulated to ensure a uniform application of all materials at the rate specified.

3.5 MAINTENANCE AND RESEEDING

A. All seeded and sodded areas shall be maintained without payment until acceptance of the Contract and any regrading, refertilizing, reseeding or resodding shall be done at the Contractor’s expense. Any areas which fail to show a "catch" or uniform stand, for any reason whatever, shall be reseeded or resodded with the original mixture, and such reseeding or

resodding shall be repeated until final acceptance. The Contractor shall properly water, mow, and otherwise maintain all seeded and sodded areas until final acceptance.

B. Damage resulting from erosion, gulleys, washouts, or other causes shall be repaired by filling with topsoil, tamping, refertilizing, and reseeding or resodding by the Contractor at his expense if such damage occurs prior to acceptance of the Contract.

END OF SECTION

SECTION 03100

CONCRETE FORMWORK

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies formwork for cast-in-place concrete. Contractor assumes all responsibility for the design and engineering of the formwork as well as its construction and removal.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 3 Section “Concrete Reinforcement”
2. Division 3 Section "Structural Cast-in-Place Concrete”

1.2 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:

1. Design Formwork for the loads, lateral pressure, and allowable stresses outlined in Chapter 1, “Guide to Formwork for Concrete” ACI 347.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.

B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate the installation of joint materials, vapor retarder/barrier, and other related materials with placement of forms and reinforcing steel.

3.2 FORMS

A. General: Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits:

1. Provide Class A tolerances for all exposed concrete surfaces. Provide Class C for non-exposed surfaces.

B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in the Work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent cement paste from leaking.

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like for easy removal.

D. Provide temporary openings for clean-outs and inspections where interior area of formwork is inaccessible before and during concrete placement. Securely brace temporary openings and set tightly to forms to prevent losing concrete mortar. Locate temporary openings in forms at inconspicuous locations.

E. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

F. Provisions for Other Trades: Provide openings in concrete formwork to

accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.

G. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

H. Construct Formwork so that concrete surfaces will conform to the tolerance limits specified in Table 4.3.1, “Tolerances for Formed Surfaces” ACI 301.

I. Provide positive means of adjustment (wedges or jacks) of shores and to compensate for anticipated deflections and settlement in the Formwork during concrete placing operations

J. Form Coating shall be a field applied chemical concrete release agent capable of preventing bond between poured concrete and the form and shall contain no oil, or shall be a factory applied non-absorptive liner. Coat form before reinforcement is placed.

3.3 PREPARING FORM SURFACES

A. General: Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before placing reinforcement.

B. Do not allow excess form-coating material to accumulate in forms or come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.

1. Coat steel forms (if any) with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.

3.4 INSTALLING EMBEDDED ITEMS

A. General: Set and build into formwork anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.

B. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.5 REMOVING FORMS

A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work and not support other horizontal green concrete such as beams, floors, and similar parts of work, may be removed based on the following:

    a. Concrete compressive strength has reached 40% of design compressive strength, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained. New loads shall not be placed on the concrete until the concrete compressive strength is 70% of the concrete design compressive strength.

B. Formwork supporting weight of green concrete, such as floors, beams and concrete supporting green concrete such as columns and walls shall not be removed till concrete compressive strength reaches 70% of concrete design compressive strength, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.

C. Concrete test cylinders used to determine concrete compressive strength for the removal of forms are extra cylinders beyond any cylinders required by any other project specifications. These cylinders and testing are at the contractor's expense.

D. Reshoring of new concrete, see Section 3.8 RESHORING.

E. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

3.6 REUSING FORMS

A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use patched forms for exposed concrete surfaces except as acceptable to Engineer.

C. Form Ties shall be broken back at 1-inch from surface of concrete. Tie Cones, 1-inch diameter by 1-inch long, shall be used on all exposed concrete.

3.7 CAMBER OF FORMS

A. Camber slabs at midspan in increments of 1/8-inch per 10-foot of span and at end of cantilevers in increments of 1/8-inch per 5-foot of span unless indicated otherwise on PLANS.

B. Do not camber beams unless indicated on PLANS.

3.8 RESHORING

A. Reshore new construction until concrete being supported has reached the specified 28-day strength.

B. Place no live load on new construction while reshoring.

C. Complete reshoring as soon as practicable after stripping operations but not later than the end of the working day on which stripping occurs.

D. Reshore so as to distribute construction loads safely to the ground or over sufficient number of levels in such a manner that the design LIVE LOAD of the levels supporting shores is not exceeded. Refer to GENERAL NOTES for design LIVE LOAD capacities.

E. Contractor shall design the reshoring procedure. The reshoring shall be designed not to damage the both existing and new structures, maintain construction schedule, and protect the safety of the workers. The contractor shall be solely responsible for shoring and reshoring.

END OF SECTION 03100

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies concrete reinforcing, including all materials, labor, equipment and services necessary to complete work.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 2 Section "Portland Cement Concrete Paving"
2. Division 3 Section “Structural Cast-in-Place Concrete”
3. Division 3 Section “Concrete Formwork”

1.2 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections including number of sets. Sets in excess of the number indicated in the General Conditions will be discarded. One set will be retained by the structural department and the remaining sets will be returned to the Architect.

1. All submittals should be produced in a digital PDF format. Submittals will be checked and any comments will be added to the digital PDF file. The PDF file, with any comments, will be returned to the contractor.
2. The contractor is responsible to check all submittals for accuracy and coordination with other trade. This check is required to be performed by the contractor prior to making any submittals to the architect or engineer any submittals that do not have clear proof that the contractor performed this required choice will be returned without review.

B. Product data for proprietary materials and items, including reinforcement and others if requested by Architect.

C. Shop drawings for reinforcement detailing fabricating, bending, and placing concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, bent bar diagrams, and arrangement of concrete reinforcement.

Include special reinforcing required for openings through concrete structures. In addition, submit data on reinforcing support types to be used.

D. Material certificates in lieu of material laboratory test reports when permitted by Architect. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:

1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
2. ACI 318, "Building Code Requirements for Reinforced Concrete."
3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."

B. Materials and installed work may require testing and retesting at any time during progress of Work. Tests, including retesting of rejected materials for installed Work, shall be done at Contractor's expense.

PART 2 - PRODUCTS

2.1 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615 Grade 60, deformed.

B. Steel Wire: ASTM A185, plain, cold-drawn steel.

C. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar-type supports complying with CRSI specifications.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
2. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).
3. Tie wire shall not be less than 16-gauge black annealed wire.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate the installation of joint materials, vapor retarder/barrier, and other related materials with placement of forms and reinforcing steel.

3.2 PLACING REINFORCEMENT

A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as specified.

1. Avoiding cutting or puncturing vapor retarder/barrier during reinforcement placement and concreting operations. Repair damages before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Architect. Support reinforcing within the following tolerances from the positions shown on the drawings or specified herein:

1. For clear concrete protection and for depth “d” in Flexural members, walls, and compression members where “d” is:
   a. 8 inches or less ---- plus or minus 1/4 inch;
   b. More than 8 inches ---- plus or minus 1/2 inch; but the cover shall not be reduced by more than one-half of the specified cover.
2. For longitudinal location of bends and ends of bars:
   a. +/- 2 inches except at discontinuous ends of members where tolerance shall be +/- 1/2" Inch.
3. For spacing:
   a. +/- 1 inch except that total number of bars shall not be reduced.

D. Place reinforcement to maintain minimum coverages as required for concrete protection in accordance with ACI 318. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

E. Vertical Bars in piers shall be offset one bar diameter at lapped splices. Furnish templates for setting dowels.

F. “Continuous” Bars, unless otherwise indicated on drawings, shall be lapped 50 diameters at splices. Provide Corner Bars at corner conditions.

G. Splices not shown in contract documents shall be subject to approval.

H. Support all Reinforcing Bars.

I. Space Bar Supports a maximum of 4-feet on center with the first support not greater than 1-foot from the ends of the bars. Tie to prevent displacement during the concreting operations. Provide #4 support bars at 48-inches spacing where not supported otherwise.

J. Reinforcement shall not be “field” bent after being embedded in hardened concrete except where specifically shown on the Drawings.

3.3 PLACEMENT/WELDED WIRE FABRIC

A. Welded Wire Fabric shall be placed in specified positions in the forms and held in place, before and during the placing of concrete, by means of Support Bars or wire chairs and ties.

B. Bar supports shall be for Reinforcing Bars. Install welded wire fabric flat sheets. Do not use rolled wire. Lap adjoining pieces at least 12 inches and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

C. Welded Wire Fabric shall not be “pulled-up” into position during concrete placing operations.

END OF SECTION 03200

SECTION 03250

CONCRETE JOINT ACCESSORIES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish all labor, materials, equipment and incidentals required to make all joints tight in the concrete as detailed on the Drawings and as specified herein.

1.2 RELATED WORK

A. Section 03300: Structural Cast-in-Place Concrete.

1.3 SUBMITTALS

A. Manufacturer's product data for all materials required to establish compliance with these specifications shall be submitted in accordance with Division 1 – General Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Waterstops for joints shall be of the highest grade virgin polyvinyl chloride (PVC) meeting the latest revision of Corps of Engineers, Specification CRD-C-572. No scrap or reclaimed PVC shall be used in the compound. Waterstops for construction and expansion joints shall meet the following requirements:

a. 6” ribbed center-bold type with a ½” I.D. and 1” O.D.
b. Water absorption: 0.15% max per ASTM D570
c. Tear resistance: 300 lbs/in min. per ASTM D624
d. Ultimate elongation: 350% min. per ASTM D638
e. Tensile strength: 2000 PSI min. per ASTM D638
f. Low Temp Brittleness: Passes @ 35°F (-37°C) per ASTM D746
g. Stiffness in flexure: 700 PSI min per ASTM D747
h. Specific Gravity: 1.38 max per ASTM D792

i. Acceleration Extraction:
i.1 Tensile Strength: 1600 PSI min. per Corps of Engineers
i.2 Elongation: 300% min. per Corps of Engineers

j. Effect of Alkali
Both per CRD-C-572
j.1 Weight change: +0.25% - 0.10%
j.2 Hardness change: ± 5 points

B. Premolded joint filler (PJF) for interior expansion joints shall be self-expanding cork consisting of preformed strips that have been formed from clean granulated cork particles securely bound together by a synthetic resin of an insoluble nature. The PJF shall be capable of expanding 140 percent of its original thickness, which shall be ¾-inch unless shown otherwise on the Drawings. The PJF shall meet the specification requirements of the latest revision of Corps of Engineers, Specification CRD-C-509, Type III and ASTM D 1752, Type III.

C. Backer-rod shall be high-grade extruded closed-cell polyethylene foam that is completely compatible with polysulfide and urethane type sealants. Backer-rod shall also be ultraviolet stable, resistant to oils, chemicals, ozone and weathering. The size of the rod shall be 1.25 times the width of the joint.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install waterstops centered in the joint for all joints where indicated on the Drawings. Waterstops shall be continuous around all corners and intersections so that a continuous seal is provided. Splices shall be made in accordance with the manufacturer's recommendations, subject to acceptance of the Engineer. The finished splices shall provide a cross-section that is dense and free of porosity. Waterstops shall be provided with factory formed corners, intersection pieces, splicing unions and approved joint cementing compounds.

B. Secure waterstop in the correct position using grommets, pre-punched holes, or of hot-rings spaced at 12 inches on center along the length of the waterstop. Wire tie to reinforcing steel with 16 gage black angled steel tying wire.

C. The ties shall be secured to the reinforcing such that the waterstops will remain in the required position during concrete placement.

END OF SECTION 03250

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes cast-in-place concrete, including reinforcement, concrete materials, mix design, placement procedures, and finishes.

1.2 SUBMITTALS

A. Product Data: Submit two (6) copies for each manufactured material and product indicated.

B. Design Mixes: Submit two (6) copies for each concrete mix indicated.

C. Shop Drawings: Submit six (6) copies - Include details of steel reinforcement placement including material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports.

D. Material certificates test reports: Submit digital PDF copies.

E. Laboratory test reports for concrete materials and mix design test. Submit digital PDF copies.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

B. Comply with ACI 301, "Specification for Structural Concrete," and ACI 318, “Building Code Requirements for Reinforced Concrete,” including the following, unless modified by the requirements of the Contract Documents.

1. General requirements, including submittals, quality assurance, acceptance of structure, and protection of in-place concrete.
2. Formwork and form accessories.
3. Steel reinforcement and supports.
4. Concrete mixtures.
5. Handling, placing, and constructing concrete.

C. Concrete Testing Service: Engage a testing agency acceptable to Engineer to perform material evaluation test.

D. Materials and installed work may require testing and retesting at any time during progress of Work. Tests, including retesting of rejected materials for installed Work, shall be done at Contractor's expense.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Formwork: Furnish formwork and form accessories according to ACI 301 and ACI 347 “Guide to Formwork for Concrete”.

B. Steel Reinforcement:

1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
2. Plain-Steel Wire: ASTM A 82, as drawn.
3. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
4. Deformed-Steel Welded Wire Fabric: ASTM A 497, flat sheet.

C. Concrete Materials:

1. Portland Cement: ASTM C 150, Type I.
   a. Use one brand of cement throughout project.
2. Normal-Weight Aggregate: ASTM C 33, uniformly graded, not exceeding 1-inch nominal size.
3. Lightweight Aggregate: ASTM C 330.
4. Water: Complying with ASTM C 94.
5. Fly Ash is not permitted in interior slab mix design. Limited Fly Ash content to a maximum of 15% of cement content in remaining mix designs.
6. Calcium chloride is not permitted.

D. Admixtures:

1. Air-Entraining Admixture: ASTM C 260.
2. Water-Reducing Admixture: ASTM C 494, Type A.
3. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
4. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
5. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

E. Vapor Retarder: Multi-ply reinforced polyethylene sheet, ASTM E 1745, Class C, not less than 7.8 mils thick; or polyethylene sheet, ASTM D 4397, not less than 6 mils thick.

1. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a No. 4 sieve and 10 to 30 percent passing a No. 100 sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

F. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a No. 4 sieve and 10 to 30 percent passing a No. 100 sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

G. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

H. Curing Materials:

1. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
2. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf.
3. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
4. Water: Potable.
5. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B to be utilized on interior slabs that receive VCT or ceramic tile. Membrane-forming curing compound shall dissipate in 14 days without effecting subsequent floor covering installation – Contractor shall submit product data (6 copies) to the Project Manager for approval prior to use. The contractor shall verify curing compound compatibility with floor covering manufacturer prior to use.
6. Clear, Solvent-Borne or Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A on all exterior concrete walks, docks, slabs and interior slabs that are to be left exposed.
7. Contractor shall verify and coordinate with the Project Manager and the manufacturer’s factory representative prior to finishing any integrally colored concrete or concrete which is designated for chemical staining to insure compatibility and design performance.

2.2 CONCRETE MIXES

A. Comply with ACI 301 requirements for concrete mixtures.

B. Prepare design mixes, proportioned according to ACI 301, for normal-weight concrete determined by either laboratory trial mix or field test data bases, as follows:

1. Compressive Strength (28 Days)

    a. Footings, slab and wall: 4000 psi (27.6 MPa)

2. Slump:

    a. Walls: 6 inches to 8 inches
    b. Foundation system: 2 inch minimum to a 5 inch maximum.
    c. Slump Limit for Concrete Containing High-Range Water-Reducing Admixture: Not more than 8 inches after adding admixture to plant- or site-verified, 2- to 3-inch slump.
    d. All other concrete shall have a slump of 2 inch minimum to 5 inch maximum.
    e. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of

        1. 6.0 percent within a tolerance of plus or minus 1.0 percent where concrete is exposed to freezing and thawing.
        2. Air content of trowel-finished interior concrete floors shall not exceed 4.0 percent.

2.3 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with ASTM C 94 and ASTM C 1116.

1. When air temperature is between 85 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.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.

2. For mixer capacity larger than 1 cu. yd. increase mixing time by 15 seconds for each additional 1 cu. yd.

C. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Formwork: Design, construct, erect, shore, brace, and maintain formwork according to ACI 301 “Standard Specifications for Structural Concrete: and ACI 347 “Guide to Formwork for Concrete”.

B. Vapor Retarder: Install, protect, and repair vapor-retarder sheets according to ASTM E 1643; place sheets in position with longest dimension parallel with direction of pour.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.
2. Cover vapor retarder with fine-graded granular material, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch.

C. Steel Reinforcement: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

D. Joints: Construct joints true to line with faces perpendicular to surface plane of concrete.

1. Construction Joints: Locate and install so as not to impair strength or appearance of concrete, at locations indicated.

2. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-third of the concrete thickness, as follows:

a. Exterior Sidewalks and Ramps Tooled Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with

groover tool to a radius of 3/8 inch. Repeat grooving of contraction joints after applying surface finishes.

b. Interior Slabs-On-Grade 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 concrete develops random contraction cracks.

E. Tolerances: Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

3.2 CONCRETE PLACEMENT

A. Comply with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.

B. Do not add water to concrete during delivery, at Project site, or during placement.

C. Consolidate concrete with mechanical vibrating equipment.

D. Prior to concrete placement, inspect all formwork, reinforcing and cast embed items.

E. The Contractor shall notify all required trades prior to placement of concrete to allow sufficient time to complete installation of slab/foundation embeds and conduits.

F. The Contractor shall provide notification to the concrete testing laboratory a minimum of 24 hours prior to placement of concrete.

3.3 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/8 inch in height rubbed down or chipped off.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Completely remove fins and other projections.

1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, or painting.
2. Do not apply rubbed finish to smooth-formed finish.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.4 FINISHING UNFORMED SURFACES

A. General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on the surface.

1. Do not further disturb surfaces before starting finishing operations.

C. Scratch Finish: Apply scratch finish to surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finish, unless otherwise indicated.

D. Float Finish: Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

1. After completion of all screeding, consolidating and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Check and level surface plane to a variation tolerance not exceeding 1/8” maximum (lowest spot to highest spot) in 10 ft when tested with a 10 ft straightedge. Correct areas of nonconformity as required. Uniformly slope surfaces to floor drains where applicable. Immediately after the leveling, refloat surface to a uniform, smooth, ganular texture. The intent of the above criteria is to establish a maximum tolerance to be allowed for dips and rises in the concrete surface. The general contractor will be solely responsible for meeting these requirements.

E. Trowel Finish: Apply a hard trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.

1. After floating, begin first trowel finish operation using power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance and with a surface plane variation tolerance not exceeding:

a) F(F): 30 Flatness
b) F(L): 20 Levelness (Not applicable to sloped floor areas)
As specified in ASTM E 115

Slab finishes not meeting specified tolerances shall be corrected by grinding or by removal and replacement of defective work as directed by the Architect, at the Contractor's expense.

F. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile or epoxy floor coating is to be installed by either thickset or thin-set methods. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.

G. Nonslip Broom Finish: Apply a nonslip broom finish to surfaces indicated on guide plans and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.5 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection, and follow recommendations in ACI 305R for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions occur 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.

C. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.

D. Cure formed and unformed concrete for at least seven days as follows:

1. Moisture Curing: Keep surfaces continuously moist with absorptive cover, water saturated and kept continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges with 4” lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 36 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period. On interior areas designated “exposed concrete” and specified herein to receive a curing sealer, provide a second coat of sealer 14 days after initial coat.

E. 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.

1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
2. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

F. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F. Mixing water may be chilled 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 reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.

4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Engineer.

G. The Contractor shall be responsible for providing proper and adequate ventilation during finishing and for a minimum of 12 hours following the finishing process, during curing, to ensure that there is not a harmful build-up of vapors or fumes.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified independent testing and inspecting agency approved by Engineer project manager to sample materials, perform tests, and submit test reports during concrete placement. Tests will be performed according to ACI 301.

1. Testing Frequency: One composite sample for each day's pour of each concrete mix exceeding 5 cu. yd., plus one set for each additional 50 cubic yards or fraction thereof.
2. Materials and installed work may require testing and retesting, as directed by Engineer, at any time during progress of work. Retesting of rejected materials and installed work shall be done at the Contractor’s expense.
3. Submit concrete cylinder test reports as results are available.

END OF SECTION 03300

SECTION 03600

NON-SHRINK GROUT

PART 1 - GENERAL

1.1 SCOPE

A. Under this heading shall be included the furnishing and installation of non-shrink grouts. Non-shrink grouts shall be used for the following types of work: setting base plates, bearing plates, handrails, and machinery bases; and for patching and repair of all watertight structures.

B. Included is all labor, materials, equipment, tools and energy necessary to accomplish the grouting work.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Patching and repair of concrete surfaces, where non-shrink grout is not specified nor noted on the Contract Plans, is included under Cast-in-Place Concrete, Section 03300.

B. Grouting and re-pointing of masonry joints is included under Unit Masonry Assemblies, Section 04810.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Non-Shrink/Non-Metallic Grout (Type "A")

1. Grout shall be factory-mixed containing natural aggregates formulated to be used at any consistency from extremely fluid to damp pack (Plastic). The grout shall be similar in finished appearance to adjacent concrete or mortar. The grout shall be free of gas producing agents, oxidizing catalysts and inorganic accelerators.

2. The compressive strength of the grout in-place, when placed in a plastic consistency, shall meet or exceed the following:

4,000 psi	at 1 Day
6,000 psi	at 3 Days
7,500 psi	at 7 Days
9,500 psi	at 28 Days

3. Grout placed in a fluid consistency shall meet or exceed an in-place, twenty-eight day (28) compressive strength of at least 15 percent (15%) greater than the required concrete strength specified, or 5,000 psi, which ever is greater.

B. Non-Shrink/Metallic Aggregate Grout Type "B"

1. Grout shall be factory-mixed, containing specially graded and processed ferrous metallic aggregate and graded natural aggregates with a cementitous system formulated to be used at any consistency from extremely fluid to damp pack. The grout shall be free of gas producing agents, oxidizing agents and organic accelerators.

2. The compressive strength of the grout in-place, when placed in a plastic consistency, shall meet or exceed the following:

4,000 psi	at 1 Day
6,000 psi	at 3 Days
8,000 psi	at 7 Days
10,000 psi	at 28 Days

3. Grout placed in a fluid consistency shall have an in-place, twenty-eight-day (28) compressive strength of not less than 7,000 psi.

C. Water

1. Water shall be potable.

PART 3 - EXECUTION

3.1 GROUTING SCHEDULE

A. Grouting under this Contract shall be done in accordance with the applicable items in the following schedule, unless noted otherwise:

Grouting Applications	Grout Type*
Column base plates	"A" or "B"
Bearing plates	"A" or "B"
Concrete surface repair and patch work	"A"
Metal handrails	"A"
Machinery Bases	"B"

B. Type "A" grout shall be used for all applications where grout will be exposed to salt water, brackish water, salt water spray or corrosive environment.

3.2 GROUT CONSISTENCY

A. Grout may be placed in a damp pack (plastic) or flowable (fluid) consistency to suit job conditions and as specified herein; however, grout shall be placed in a damp pack (Plastic) consistency wherever possible to provide the highest strength grout.

B. Damp pack (plastic) grout shall be used for grouting vertical surfaces with holes having at least one surface dimension less than the hole depth and for holes left by removal of fasteners and form ties. Damp pack (plastic) grout may be used for column base plates, bearing plates, machinery bases and precast concrete elements where either horizontal dimension of the element being grouted is less than 16 inches.

C. Flowable or fluid grout shall be used for all other applications.

3.3 SURFACE PREPARATION

A. General

1. Concrete surfaces to receive grout shall be rough and reasonably level. Laitance shall be removed to sound concrete. The surfaces, including bolt holes shall be saturated with water for twenty-four (24) hours prior to grouting, unless otherwise recommended by the grouting manufacturer.

2. Where grout is to be used to repair damaged concrete surfaces, the damaged or honeycombed concrete shall be removed to sound concrete by chipping.

3. Metal surfaces to receive grout shall be derusted, cleaned of oil, grease and other deleterious substances by means of appropriate solvents, wire brushing or a combination of both.

B. Formwork

1. Forms shall be provided for grout placed at a flowable (fluid) consistency.

2. Forms shall be strong, tight and shall be braced so they will not leak or buckle under the weight of fluid grout. On the placing side, forms shall extend 3 inches from base plate, unless otherwise indicated, and shall slant at a 45 degree angle. Grout shall be poured directly on the slanted face. On other sides, the form shall be placed 2- inch or more away from base of the bedplate and 1 inch or more higher than the underside of the plate.

   a. Forms shall be caulked with grout or a sand-cement mortar to prevent leakage. Expanded polystyrene or other means shall be used to caulk between foundation and portions of the element being grouted to seal off areas where grout is not required.

   b. Provide air relief openings to avoid entrapment of air.

3.4 GROUT PREPARATION, PLACEMENT AND CURING

A. Grout shall be mixed to proper consistency, placed, and cured as instructed by the grout manufacturer. A paddle-type mortar mixer or other suitable mechanical mixer shall be used unless otherwise allowed.

B. Any nearby vibrating machinery or equipment should be shut down to avoid disturbing the bonding or initial set of freshly placed grout.

C. Mixing water temperature shall not be less than 40 Degrees F. nor exceed 80 degrees F. unless more stringent conditions are required by the grout manufacturer.

D. Grout shall be placed at a temperature of 65 to 75 Degrees; and maintained at this temperature range for twenty-four (24) hours and above 40 Degrees F. thereafter until the grout strength exceeds 4,000 psi.

E. Grout used for concrete surface repair and patchwork shall be applied to a small area and allowed to cure to determine color compatibility (subject to Engineer's review).

END OF SECTION 03600

SECTION 04810

UNIT MASONRY ASSEMBLIES

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 unit masonry assemblies consisting of the following:

1. Concrete masonry units (CMUs).
2. Mortar and grout.
3. Reinforcing steel.
4. Masonry joint reinforcement.
5. Miscellaneous masonry accessories.
6. Masonry-cell insulation.

1.3 DEFINITIONS

A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths (f'_m) at 28 days.

B. Determine net-area compressive strength (f'_m) of masonry by testing masonry prisms according to ASTM C 1314.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls with all reinforcement shown and control joints.

C. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:

1. Masonry units.

    a. Include material test reports substantiating compliance with requirements.
    b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include brand, type, and name of manufacturer.
3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
4. Grout mixes. Include description of type and proportions of ingredients.
5. Reinforcing bars.
6. Joint reinforcement.

D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports, per ASTM C 780 for mortar mixes required to comply with property specification.
2. Include test reports, per ASTM C 1019 for grout mixes required to comply with compressive strength requirement.

E. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

F. Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

G. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

1.6 QUALITY ASSURANCE

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.

C. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

D. Coordinate Construction with Special Inspector.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
2. Where 1 wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

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. Products: Subject to compliance with requirements, provide one of the products specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not uses units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

2.3 CONCRETE MASONRY UNITS (CMUs)

A. Shapes: Provide shapes indicated and as follows:

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide square-edged units for outside corners, unless otherwise indicated.

B. Integral Water Repellent: Provide units made with integral water repellent.

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive according to ASTM E 514, with test period extended to 24 hours, show no visible water or leaks on the back of test specimen.

    a. Products:

        1) Addiment Incorporated; Block Plus W-10.
        2) Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block.
        3) Master Builders, Inc.; Rheopel.

C. Concrete Masonry Units: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi.
2. Weight Classification: Lightweight.
3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

2.4 CONCRETE AND MASONRY LINTELS

A. General: Provide either concrete or masonry lintels, at Contractor's option, complying with requirements below.

B. Concrete Lintels: Precast units made from concrete matching concrete masonry units in color, texture, and compressive strength and with reinforcing bars indicated or required to support loads indicated. Cure precast lintels by same method used for concrete masonry units. Use Cast Crete lintels or equal.

C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.5 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.

D. Masonry Cement: ASTM C 91.

1. Products:

a. Lafarge North America Inc.; Magnolia Masonry Cement or Lafarge Masonry Cement.

E. Mortar Cement: ASTM C 1329.

1. Products:

a. Lafarge North America Inc.; Lafarge Mortar Cement or Magnolia Superbond Mortar Cement.

F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Products:

a. Bayer Corporation, Industrial Chemicals Div.; Bayferrox Iron Oxide Pigments.
b. Davis Colors; True Tone Mortar Colors.
c. Solomon Grind-Chem Services, Inc.; SGS Mortar Colors.

G. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.

H. Aggregate for Grout: ASTM C 404.

I. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Products:

a. Addiment Incorporated; Mortar Kick.
b. Euclid Chemical Company (The); Accelguard 80.
c. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Morset.
d. Sonneborn, Div. of ChemRex; Trimix-NCA.

J. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.

1. Products:

a. Addiment Incorporated; Mortar Tite.
b. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.
c. Master Builders, Inc.; Color Cure Mortar Admix or Rheomix Rheopel.

K. Water: Potable.

2.6 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951.

1. Interior Walls: Hot-dip galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized, carbon steel.
3. Wire Size for Side Rods: W1.7 or 0.148-inch diameter.
4. Wire Size for Cross Rods: W1.7 or 0.148-inch diameter.
5. Wire Size for Veneer Ties: W1.7 or 0.148-inch diameter.
6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.

7. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.7 MISCELLANEOUS ANCHORS

A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.

B. Dovetail Slots in Concrete: Furnish dovetail slots with filler strips, of slot size indicated, fabricated from 0.034-inch, galvanized steel sheet.

C. Anchor Bolts: Headed steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

D. Postinstalled Anchors: Provide chemical or torque-controlled expansion anchors, with capability to sustain, without failure, a load equal to six times the load imposed when installed in solid or grouted unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

1. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 service condition (mild).

2.8 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

2.9 MASONRY-CELL INSULATION

A. Loose-Granular Fill Insulation: Perlite complying with ASTM C 549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation).

2.10 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers:

    a. Diedrich Technologies, Inc.
    b. EaCo Chem, Inc.
    c. ProSoCo, Inc.

2.11 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Limit cementitious materials in mortar to portland cement, mortar cement, and lime.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type S.
2. For reinforced masonry, use Type S.

D. Pigmented Mortar: Use colored cement product.

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.

3. Mix to match Architect's sample.

E. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

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

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

F. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:

1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
7. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry

surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

3.4 MORTAR BEDDING AND JOINTING

A. Lay concrete masonry units as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.

3.5 MASONRY-CELL INSULATION

A. Pour granular insulation into cavities to fill void spaces. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of insulation to 1 story in height, but not more than 20 feet.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.

B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 LINTELS

A. Provide concrete or masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

B. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.8 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

3.9 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.10 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION 04810

SECTION 15000

MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

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

B. It is recognized that separate sub-contracts may be instituted by THIS CONTRACT'S GENERAL CONTRACTOR with others. It is the responsibility of THIS CONTRACT'S GENERAL CONTRACTOR to completely inform, coordinate and advise those sub-contractors as to all of the requirements, conditions and information associated with providing and installing their portion of the total job.

1.02 IMPOSED REGULATIONS:

A. Applicable provisions of the State and Local Codes and of the following codes and standards in addition to those listed elsewhere in the specifications are hereby imposed on a general basis for mechanical work. In each case, the prevailing edition shall be the current adopted edition of the state where the project is located.

1. *International Mechanical Code.*
2. *International Gas Code.*
3. *International Energy Conservation Code.*
4. *International Fire Code.*

1.03 SCOPE OF WORK:

A. Provide all labor, materials, equipment and supervision to construct complete and operable mechanical systems as indicated on the drawings and specified herein. All materials and equipment used shall be new, undamaged and free from any defects.

1.04 EXISTING SERVICES AND FACILITIES:

A. Damage to Existing Services: Existing services and facilities damaged by the Contractor through negligence or through use of faulty materials or workmanship shall be promptly repaired, replaced, or otherwise restored to previous conditions by the Contractor without additional cost to the Owner.

B. Interruption of Services: Interruptions of services necessary for connection

to or modification of existing systems or facilities shall occur only at prearranged times approved by the Owner. Interruptions shall only occur after the provision of all temporary work and the availability of adequate labor and materials will assure that the duration of the interruption will not exceed the time agreed upon.

C. Removed Materials: Existing materials made unnecessary by the new installation shall be removed, shall remain the property of the Owner and shall be stored at a location and in a manner as directed, or, if classified by the Owner's authorized representative as unsuitable for further use, shall become the property of the Contractor and shall be removed from the site.

1.05 PRODUCT WARRANTIES:

A. Provide manufacturer's standard printed commitment in reference to a specific product and normal application, stating that certain acts of restitution will be performed for the Purchaser or Owner by the manufacturer, when and if the product fails within certain operational conditions and time limits. Where the warranty requirements of a specific specification section exceed the manufacturer's standard warranty, the more stringent requirements will apply and modified manufacturer's warranty shall be provided. In no case shall the manufacturer's warranty be less than one (1) year.

1.06 PRODUCT SUBSTITUTIONS:

A. General: Materials specified by manufacturer's name shall be used unless prior approval of an alternate is given by addenda. Requests for substitutions must be received in the office of the Architect at least 10 days prior to opening of bids.

PART 2 - PRODUCTS

2.01 GENERAL MECHANICAL PRODUCT REQUIREMENTS:

A. Standard Products: Provide not less (quality) than manufacturer's standard products, as specified by their published product data. In addition to the indication that a particular product/model number is acceptable, comply with the specified requirements. Do not assume that the available off-the-shelf condition of a product complies with the requirements; as an example, a specific finish or color may be required.

B. Uniformity: Where multiple units of a general product are required for the mechanical work, provide identical products by the same manufacturer, without variations except for sizes and similar variations as indicated.

C. Product Compatibility, Options: Where more than one product selection is specified, either generically or proprietarily, selection is Purchaser's or

Installer's option. Provide mechanical adaptations as needed for interfacing of selected products in the work.

D. Equipment Nameplates: Provide a permanent operational data nameplate on each item of power operated mechanical equipment, indicating the manufacturer, product name, model number, serial number, speed, capacity, power characteristics, labels of tested compliance, and similar essential operating data.

E. Locate nameplates in easy-to-read locations. When product is visually exposed in an occupied area of the building, locate nameplate in a concealed position (where possible) which is accessible for reading by service personnel.

PART 3 - EXECUTION

3.01 PRODUCT INSTALLATION, GENERAL:

A. Except where more stringent requirements are indicated, comply with the product manufacturer's installation instructions and recommendations, including handling, anchorage, assembly, connections, cleaning and testing, charging, lubrication, startup, test operation and shut-down of operating equipment. Consult with manufacturer's technical experts, for specific instructions on unique product conditions and unforeseen problems.

B. Protection and Identification: Deliver products to project properly identified with names, model numbers, types, grades, compliance labels and similar information needed for distinct identifications; adequately packaged or protected to prevent deterioration during shipment, storage and handling. Store in a dry, well ventilated, indoor space, except where prepared and protected by the manufacturer specifically for exterior storage.

C. Permits and Tests: Provide labor, material and equipment to perform all tests required by the governing agencies and submit a record of all tests to the Owner or his representative. Notify the Architect five days in advance of any testing.

END OF SECTION

SECTION 15005

MECHANICAL COORDINATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 QUALITY ASSURANCE:

A. Coordinate the actual location of all mechanical work visible in finished spaces with the Architect/Engineer. This includes air distribution devices, exposed ductwork, thermostats, humidistats, switches, sensors, etc.

PART 2 - PRODUCTS

2.01 MECHANICAL PRODUCT COORDINATION:

A. Power Characteristics: Refer to the electrical sections of the specifications and the electrical drawings for the power characteristics available for the operation of each power driven item of equipment. The electrical design was based on the typical power requirements of the equipment manufacturers scheduled or specified. Any modifications to the electrical system which are required due to the use of an approved equivalent manufacturer shall be made at no additional cost to the owner. All changes must be clearly documented and submitted for review by the Architect/Engineer prior to purchasing equipment. Coordinate purchases to ensure uniform interface with electrical work. The mechanical contractor shall furnish a detailed list of equipment electrical characteristics to the electrical contractor for the purpose of preparing the coordination affidavit required by Division 16.

B. Coordination of Options and Substitutions: Where the contract documents permit the selection from several product options, and where it becomes necessary to authorize a substitution, do not proceed with purchasing until coordination of interface of equipment has been checked and satisfactorily established.

C. Firestopping: Refer to architectural drawings for the locations of all fire rated ceilings, floors and walls. The contractor shall furnish detailed shop drawings of all firestopping details to be used for both piping and ductwork. All firestopping details shall be U.L. listed and subject to approval by the Authority having jurisdiction.

PART 3 - EXECUTION

3.01 INSPECTION AND PREPARATION:

A. Substrate Examination: The Installer of each element of the mechanical work must examine the condition of the substrate to receive the work, and the conditions under which the work will be performed, and must notify the Contractor in writing of conditions detrimental to the proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

B. Do not proceed with the installation of sleeves, anchors, hangers, roof penetrations and similar work until mechanical coordination drawings have been processed and released for construction. Where work must be installed prior to that time in order to avoid a project delay, review proposed installation in a project coordination meeting including all parties involved with the interfacing of the work.

3.02 CUTTING AND PATCHING:

A. Structural Limitations: Do not cut structural framing, walls, floors, decks and other members intended to withstand stress, except with the Architect's or Engineer's written authorization.

B. Where authorized, cut opening through concrete (for pipe penetrations and similar services) by core drilling or sawing. Do not cut by hammer-driven chisel or drill.

C. Other work: Do not endanger or damage other work through the procedures and processes of cutting to accommodate mechanical work. Review the proposed cutting with the Installer of the work to be cut, and comply with his recommendations to minimize damage. Where necessary, engage the original Installer or other specialists to execute the cutting in the recommended manner.

D. Where patching is required to restore other work, because of either cutting or other damage inflicted during the installation of mechanical work, execute the patching in the manner recommended by the original Installer. Restore the other work in every respect, including the elimination of visual defects in exposed finishes, as judged by the Architect. Engage the original Installer to complete patching of the following categories of work:

1. Exposed concrete finishes and exposed masonry.
2. Waterproofing and vapor barriers.
3. Roofing, flashing and accessories.
4. Interior exposed finishes and casework, where judged by the Architect to be difficult to achieve an acceptable match by other means.

3.03 COORDINATION OF MECHANICAL INSTALLATION:

A. General: Sequence, coordinate and integrate the various elements of mechanical work so that the mechanical plant will perform as indicated and be in harmony with the other work of the building. The Architect/Engineer will not supervise the coordination, which is the exclusive responsibility of the Contractor. Comply with the following requirements:

1. Install piping, ductwork and similar services straight and true, aligned with other work and with overhead structures and allowing for insulation. Conceal where possible.
2. Arrange work to facilitate maintenance and repair or replacement of equipment. Locate services requiring maintenance on valves and similar units in front of services requiring less maintenance. Connect equipment for ease of disconnecting, with minimum of interference with other work.
3. Equipment located above ceilings shall be installed in a position and elevation which allows complete and adequate maintenance access through the ceiling grid or access panel while standing safely on a ladder. If this is not possible, a suitable maintenance platform must be provided per IMC.
4. Give the right-of way to piping systems required to slope for drainage (over other service lines). Piping shall be located to avoid interference with ductwork and light fixtures.
5. Store materials off the ground and protected from standing water and weather.

B. Drawings: Conform with the arrangement indicated by the contract documents to the greatest extent possible, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, comply with the Architect's decision on resolution of the conflict.

C. Electrical Work: Coordinate the mechanical work with electrical work, and properly interface with the electrical service. In general, and except as otherwise indicated, install mechanical equipment ready for electrical connection. Refer to electrical sections of the specifications for electrical connection of mechanical equipment.

D. Duct Smoke Detectors: All HVAC duct smoke detectors, including smoke detectors for smoke dampers, shall be furnished and installed by Division 15 and shall be the photoelectric type unless noted otherwise. In buildings equipped with a fire alarm system, all duct smoke detectors must be compatible with the fire alarm system and must be connected to the fire alarm system for notification. All fire alarm wiring and associated devices shall be furnished and installed by the fire alarm system installer. In buildings not equipped with a fire alarm system, each duct smoke detector must have a remote device where actuation of the duct smoke detector

shall activate a visible and an audible signal in an approved location. Duct smoke detector trouble conditions shall activate a visible or audible signal in an approved location and shall be identified as “Air Duct Detector Trouble.” Each smoke detector shall be wired into the respective fan control circuit to automatically shut down the fan upon sensing the products of combustion.

E. Utility Connections: Coordinate the connection of mechanical systems with exterior underground utilities and services. Comply with the requirements of governing regulations, franchised service companies and controlling agencies. Provide a single connection for each service except where multiple connections are indicated.

3.04 COORDINATION OF MECHANICAL START-UP:

A. Seasonal Requirements: Adjust and coordinate the timing of mechanical system start-ups with seasonal variations, so that demonstration and testing of specified performance can be observed and recorded. Exercise proper care in off-season start-ups to ensure that systems and equipment will not be damaged by the operation.

B. Painting and Air Distribution: Coordinate the initial cleaning and start-up of the air distribution system, to occur prior to preparatory cleaning and general interior painting and decorating on the project. The HVAC system should not be operated until drywall work is completed. Drywall dust must not be allowed to contaminate the interior of air handing units and ductwork. Use high efficiency temporary filters until project closeout.

END OF SECTION

SECTION 15012

MECHANICAL STANDARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 QUALITY ASSURANCE:

A. Industry Standards: It is a general requirement that mechanical work comply with applicable requirements and recommendations of standards published by listed agencies and trade associations, except to the extent more detailed and stringent requirements are indicated or required by governing regulations.

B. Listing of Associations, Standards, and Abbreviations:

1. AGA *American Gas Association*
   1515 Wilson Blvd.
   Arlington, VA 22209
2. AMCA *Air Movement & Control Association*
   30 W. University Dr., Arlington Heights, IL 60004
   302/394-0150
3. ARI *Air-Conditioning and Refrigeration Institute*
   4301 North Fairfax Drive, Suite 425,
   Arlington, VA 22203
   703/524-8800
4. ASHRAE *American Society of Heating, Refrigerating & Air Conditioning Engineers, Inc.*
   1791 Tullie Circle, NE, Atlanta, GA. 30329
   404/636-8400
5. AWS *American Welding Society, Inc.*
   2501 NW 7th St., Miami, FL 33125
   305/642-7090
6. CISPI *Cast Iron Soil Pipe Institute*
   2020 K. St., NW, Washington, DC
   202/233-4536
7. NEBB *National Environmental Balancing Bureau*
   1611 North Kent St.,
   Arlington, VA 22209

8.	NEC	*National Electrical Code* by NFPA
9.	NEMA	*National Electrical Manufacturers Association* 1300 N 17th Street, Suite 1847 Rosslyn, VA 22209 703/841-3200
10.	NFPA	*National Fire Protection Association* 407 Atlantic Ave., Boston, MA 02210 617/482-8755
11.	SMACNA	*Sheet Metal & Air Conditioning Contractors National* Association, Inc. 8224 Old Courthouse Rd., Tysons Corner Vienna, VA 22180 703/790-9890
12.	TIMA	*Thermal Insulation Manufacturers Association* 7 Kirby Plaza Mt. Kisco, NY 10549 912/241-2284
13.	UL	*Underwriters' Laboratories, Inc.* 207 East Ohio St., Chicago, IL 60611 312/642-6969

PARTS 2 AND 3 - PRODUCTS AND EXECUTION

A. Not applicable.

END OF SECTION

SECTION 15013

MECHANICAL SUBMITTALS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 SUBMITTAL FORMS AND PROCEDURES:

A. The purpose of submittals is to demonstrate to the Architect/Engineer that the Contractor understands the design concept. The Architect/Engineer's review of such drawings, schedules, or cuts shall not relieve the Contractor from responsibility for deviation from drawings or specifications unless he has, in writing, called the Architect/Engineer's attention to such deviations at the time of submission, and has received from the Architect/Engineer, in writing, permission for such deviations. All submittals must be completely checked by the Contractor prior to submission for review.

B. Quantities: Except as otherwise indicated in other sections, submit 5 copies. Quantity indicated does not include copies required for regulatory agencies.

C. Submittals shall be made for all items contained in the following specification sections:

1. Mechanical Coordination
2. Mechanical Identification
3. Pipe, Tube, and Fittings
4. Hangers and Supports
5. Piping Systems Insulation
6. Fire Protection System
7. Domestic Water Piping System
8. Soil, Waste and Vent Piping System
9. Water Heaters and Accessories
10. Plumbing Fixtures
11. Ductwork and Accessories
12. Air Distribution
13. Fans
14. Electric Heaters
15. Air-Cooled Air Conditioners
16. Mechanical Sound, Vibration and Seismic Control

17. Mechanical Testing, Adjusting and Balancing

D. Response to Submittals: A Submittal Review Report shall be issued by the Architect/Engineer with the following classifications for each item:

1. "No Exceptions Taken": No corrections, no marks. Contractor shall submit copies for distribution.
2. "Make Corrections Noted": A few minor corrections. Items may be ordered as marked up without further resubmission. Submit copies for distribution.
3. "Revise and Resubmit": Minor corrections. Item may be ordered at the Contractor's option. Contractor shall resubmit drawings with corrections noted.
4. "Rejected": Major corrections or not in accordance with the contract documents. No items shall be ordered. Contractor shall correct and resubmit drawings.

E. Coordinate mechanical submittals through the Contractor for the general work, and mark each submittal with his name and the date of the transmittal to the Architect/Engineer. Prior Approvals or Submittals must be received by mail or be hand delivered. Submittal data received by facsimile machine is not acceptable and will not be reviewed.

PART 2 - PRODUCTS

2.01 SUBMITTAL REQUIREMENTS:

A. General: Each specification section shall list the required submittal items. All submittal items shall conform to the requirements listed below. For each major section of submittal data, include a summary page which lists items and model numbers for each piece of equipment.

B. Shop Drawings: Prepare mechanical shop drawings to accurate scale except where diagrammatic representations are specifically indicated. Show clearance dimensions of critical locations, and show dimensions of spaces required for operation and maintenance of equipment. Show piping connections and other service connections, and show interface with other work including structural support. Indicate by note, the portions of mechanical work shown on the shop drawings which deviated from the indication of work in the contract documents, and explain the reasons for the deviations. Show how such deviations coordinate with interfacing deviations on shop drawings for other portions of the work, currently or previously submitted.

C. Manufacturer's Data: Where pre-printed data is submitted for more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which of the variations is to be provided. Delete or mark-out significant portions of preprinted data which are not applicable. Where operating ranges are

shown, mark data to show portion of range required for project application. Expansion or elaboration of standard data to describe a non-standard product must be processed as a shop drawing submittal. For each product include the manufacturer's production specifications, installation or fabrication instructions, nearest source of supply (including telephone number), sizes, weights, speeds, operating capacities, piping and service line connection sizes and locations, statements of compliance with required standards and governing regulation (include manufacturer's signed statements if not covered in printed data), performance data (where applicable) and similar information needed to confirm compliance with the requirements.

D. Certifications: Where specifically indicated, submit with notarized execution.

E. Test Reports: Submit test reports which have been signed and dated by the firm performing the test and prepared in the manner specified in the standard or regulation governing the test procedures as indicated.

F. Manufacturer's Product Warranties: Where pre-printed and published warranty includes substantial deviation from required warranty (as judged by the Architect or Engineer), product is automatically disqualified from use on the project, except where manufacturer prepares and issues a specific product warranty on the product, stating that it is in lieu of the published warranty, and is executed by an authorized officer, and complies with the requirements. Warranties shall comply with the requirements of individual specification section where those requirements exceed the manufacturer's standard warranty.

PART 3 - EXECUTION

3.01 CLOSEOUT REQUIREMENTS:

A. Operating Instructions: Submit manufacturer's operating instructions for each item of mechanical equipment and supplement with additional project application instructions where necessary. Prepare and submit specific operating instructions for charging, start-up, control or sequencing of operation, phase or seasonal variations, shut-down, safety and similar operational instructions. Prepare in typewritten form in completely explained and easily understood English language.

B. Maintenance Manuals: Organize each copy of the required system maintenance manuals to include an index followed by thumb-tab marked sections for each of the following:

1. System operating instructions.
2. Emergency instructions including addresses and telephone numbers of service sources.
3. Regular system maintenance procedures including lubrication.

4. Spare parts listing and stocking recommendations.
5. Inspection, adjusting, rebalancing, cleaning, parts replacement, and similar maintenance instructions and recommendations, including the proper use of tools and accessories.
6. Valve schedule and control diagram for each system.
7. Manufacturer's data for each operating item in each system.
8. Manufacturer's product warranties and guarantees relating to the system and equipment items in the system.
9. Corrected or approved issues of submittal items relating to the system.
10. Bind each maintenance manual in one or more vinyl-covered, 2", 3-ring binder, plus pocket-folder type binders for folded drawings, and mark the back spine of each binder with system identification and volume number.

C. Maintenance Materials: Deliver to Owner’s representative at the location as directed, in containers or packages suitable for storage and fully identified.

D. Guarantees: Where indicated as "Certified", provide guarantee which, in addition to execution by an authorized officer of each guarantor, is attested to by the Secretary of each guarantor and bears the corporate seal.

END OF SECTION

SECTION 15015

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in the manufacture of identification systems required for this product.

B. Submittals: Submit manufacturer's data on materials and submit a sample of each type required.

PART 2 - PRODUCTS

2.01 MECHANICAL IDENTIFICATION MATERIALS:

A. Engraved Plastic-Laminate Signs:

1. General: Provide engraving stock melamine plastic laminated, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core, letter color, except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
2. Thickness: 1/16 inch, except as otherwise indicated.
3. Fasteners: Self-tapping stainless steel screws, except contact type permanent adhesive where screws cannot or should not penetrate the substrate.

2.02 LETTERING AND GRAPHICS:

A. General: Coordinate names, abbreviations and other designations used in the mechanical identification work, with the corresponding designations shown, specified or scheduled. Provide numbers, lettering recommended by manufacturers or as required for proper identifications and operation/maintenance of the mechanical systems and equipment.

B. Multiple Systems: Where multiple systems of the same generic name are

shown and specified, provide identification which indicates the individual system number as well as the service; as examples, Heat Pump No. HP-1, Exhaust Fan No. EF-1.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION:

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting and other covering or finish, install identification after completion of covering or painting.

B. Mechanical Equipment Identification: Install an engraved plastic laminate sign on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for all major items of mechanical equipment.

END OF SECTION

SECTION 15016

MECHANICAL WORK CLOSEOUT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 DOCUMENTATION PROCEDURES:

A. Signed Commitments: Do not proceed with transfer of mechanical plant to the Owner for operation until warranties, performance certifications and similar commitments to be signed by Contractor and other entities have been executed and transmitted to Architect (for Owner's records).

1.03 RECORD DRAWINGS:

A. Explanation: Except where otherwise indicated, mechanical drawings (contract drawings) prepared by Architect/Engineer, contract/drawings, are diagrammatic in nature and may not show locations accurately for various components of mechanical systems. Shop drawings, including coordination drawings, prepared by Contractor shall show certain portions of work more accurately to scale and location, and in greater detail.

B. General Recording Procedure: Maintain a white-print set, blue-line or black-line, of mechanical contract drawings and shop drawings in clean, undamaged condition, for mark-up of actual installations which vary substantially from the work as shown. Mark-up whatever drawings are most capable of showing the installed conditions accurately; however, where shop drawings are marked, record a reference note on appropriate contract drawing. Mark with erasable pencil and use multiple colors to aid in the distinction between work of separate mechanical systems. In general, record every substantive installation of mechanical work which previously is either not shown or shown inaccurately, but in any case record the following:

1. Underground and aboveground piping, both exterior and interior, drawn to scale and fully dimensioned.
2. *“Mechanical Project Record"* shall be maintained as part of the *"Project Record"* specified in Division 1.

PART 2 – PRODUCTS

2.01 NOT APPLICABLE:

PART 3 - EXECUTION

3.01 CLOSEOUT PROCEDURES:

A. General Coordination: Sequence closeout procedures properly, so that work will not be endangered or damaged, and so that every required performance will be fully tested and demonstrated.

B. System Performance Test Run: At the time of mechanical work closeout, check each item in each system to determine that it is set for proper operation. With Owner's representative and Architect/Engineer present, operate each system in a test run of appropriate duration to demonstrate compliance with performance requirements. During or following test runs, make final corrections or adjustments of system to refine and improve performances wherever possible, including noise and vibration reductions, elimination of hazards, better response of controls, signals and alarms, and similar system performance improvements. Provide testing or inspection devices as may be requested for Architect's/Engineer's observation of actual system performances. Demonstrate that controls and items requiring service or maintenance are accessible. Test run shall be scheduled to coincide with Engineer's final inspection of the mechanical work.

C. Cleaning and Lubrication: After final performance test run of each mechanical system, clean system both externally and internally. Clean dirt and debris from air handling systems and install new filters. Flush piping system by operating drains and similar means, and clean strainers and traps. Lubricate both power and hand operated equipment and remove excess lubrication. Touch-up minor damage to factory painted finishes and other painting specified as mechanical work; refinish work where damage is extensive.

D. General Operating Instructions: In addition to specified training of Owner's operating personnel specified in individual mechanical sections, and in addition to preparation of written operating instructions and compiled maintenance manuals specified, provide general operating instructions for the total mechanical plant. Conduct a walk-through explanation and demonstration for orientation and education of Owner's personnel to be involved in continued operation of building and its mechanical plant.

1. Describe each basic mechanical system and how its control system functions, including flow adjustments, temperature control and similar operations.

2. Explain and point out identification system, displayed diagrams, signals, alarms and similar provisions of the work.
3. Describe basic sequencing requirements and interlock provisions for system start-up, phasing, coast-down, shut-down and seasonal operations.
4. Emphasize emergency procedures and safety provisions for protection of equipment and safety of occupants during equipment malfunction, disasters, power failures and similar unusual circumstances, and describe system limitations and precautions including weather adjustments.
5. Outline basic maintenance procedures.

E. Demonstrate what adjustments have been made and can continue to be made to reduce noise and vibration, improve system output, decrease energy consumption and similar performance improvements.

F. Point out operational security provisions, safety, unavoidable hazards and similar operator limitations. Display and conduct a "thumb-through" explanation of maintenance manuals, record drawings, meter readings and similar service items.

G. Construction Equipment: After completion of performance testing and Owner's operating instructions and demonstrations, remove installers tools, test facilities, construction equipment and similar devices and materials used in execution of the work but not incorporated in the work.

3.02 CONTINUED SYSTEM OPERATIONS:

A. Final Acceptance: At time of substantial completion of mechanical work, Owner's operating personnel will take over operation of mechanical systems. However, until time of final acceptance, respond promptly with consultation and services on whatever operation or maintenance problems may remain or arise in continued operation of mechanical plant.

END OF SECTION

SECTION 15094

HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 SUBMITTALS:

A. Provide manufacturer's data, test reports, and product warranties on all items.

PART 2 - PRODUCTS

2.01 HANGERS AND SUPPORTS:

A. General: Except as otherwise indicated, provide factory-fabricated piping hangers and supports of the type specified complete with bolts and washers. Comply with the manufacturer's published product information. Size hangers and supports properly for piping and weight of the medium being transported. Provide insulation shields for all insulated piping.

B. Hangers for domestic hot and cold water piping shall be copper plated band type with adjusting nut; Grinnell, Fig. CT-69, B-Line Fig. B 3172CT, or equivalent by Michigan Hanger, PHD Manufacturing or Hubbard Enterprises/Holdrite.

C. Hangers for cast iron or plastic drain and vent piping shall be Clevis type, B-Line Fig. B 3100, or equivalent by Grinnell, Michigan Hanger, PHD Manufacturing or Hubbard Enterprises/Holdrite.

D. Special Hangers: Special hangers and attachments shall be as detailed or indicated on the drawings.

PART 3 - EXECUTION

3.01 HORIZONTAL PIPING SUPPORT:

A. Maximum spacing of hangers and supports for above-ground horizontal pipe and tubing shall be as follows:

1. Cast-iron pipe (all sizes) shall be supported at not more than five-foot intervals and near each hub or hubless pipe joint and at multiple fittings as required.

B. Steel Pipe:

Nominal Pipe Size (inches)	Support Spacing (feet)
1-1/4 & smaller	7
1-1/2	9
2	10
2-1/2	11
3 & larger	12

C. Copper Tubing:

Tubing Size (inches)	Support Spacing (feet)
3/4 & smaller	5
1 to 2-1/2	6
3	10
4 and larger	12

D. Plastic Pipe:

Nominal Pipe Size (inches)	Support Spacing (feet)
3/4	3.0
3/4 to 1	3.5
1-1/4 to 1-1/2	4.0
2 to 2-1/2	4.5
3 and larger	5.5

E. Prevent electrolysis in the support of copper tubing by the use of hangers and supports which are copper plated, or by other recognized industry methods.

F. Branch piping located in walls, partitions or pipe chases shall be rigidly supported inside the wall or chase.

3.02 VERTICAL PIPING SUPPORT:

A. Cast Iron Pipe: Support at each floor and support at each base and roof level with pipe clamps.

B. Plastic Piping: Support at 8-feet maximum intervals and near each joint.

C. Copper Tubing: Support at riser tops and 5 feet maximum on center for pipe 1-1/2” and larger and 4 feet on center for pipe 1-1/4” and smaller. Use copper plated pipe clamps.

D. Steel Pipe: Supports at top and bottom of riser and on 10-feet maximum centers.

E. Fixture Supports: See Fixture Schedule. Provide concealed supports and carriers recommended by the manufacturer of the fixtures and equipment to suit the structural and finish conditions.

3.03 ADJUSTMENT OF HANGERS AND SUPPORTS:

A. Adjust hangers and supports to bring piping to proper level, elevations and slopes.

END OF SECTION

SECTION 15993

STAINLESS STEEL PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SCOPE OF WORK:

Furnish all labor, materials, equipment and incidentals required and install and test all stainless steel pipe and fittings as shown on the Drawings and specified herein. The piping system will be used for the transport of high purity, gaseous oxygen. The piping system shall be constructed of stainless steel and cleaned of potential contaminants to minimize flammable hazards.

1.2 DESCRIPTION OF SYSTEM:

A. Stainless steel piping shall be installed for use in locations as shown on the Drawings.

B. The Contractor shall furnish all labor, materials, equipment and incidentals necessary to install and test all stainless steel pipe and fittings as specified herein.

C. The equipment and materials specified herein are intended to be standard types of stainless steel pipe and fittings for use in transporting high purity, gaseous oxygen.

1.3 QUALIFICATIONS:

A. Stainless steel pipe and fittings shall be furnished by manufacturers who are experienced in the manufacture of the items to be furnished. The pipe and fittings shall be designed, fabricated, and installed in accordance with the best practices and methods and shall be suitable for the intended service.

B. Field-welding of stainless steel piping shall be performed by persons with a current certification from the American Welding Society appropriate for the welding of stainless steel pipe.

1.4 SUBMITTALS:

A. Shop drawings, including piping layouts and schedules, shall be submitted to the Engineer for review and shall include dimensioning, fittings,

locations of valves and appurtenances, joint details, methods and locations of supports, cleaning plan and all other pertinent technical specifications for all piping to be furnished.

B. Shop drawing submittals for piping under this Section shall include all data and information required for the complete piping systems. All dimensions shall be based on the actual equipment to be furnished. Types and locations of pipe hangers and/or supports shall be shown on the piping layouts for each pipe submittal.

PART 2 - PRODUCTS

2.1 GENERAL:

A. Pipe and fittings shall be seamless or welded, austenitic stainless steel pipe Grade Type 304L conforming to ASTM A-240 and ANSI B36.19. Finish on sheets shall be 2B and finish on plates shall be No. 1.

B. All pipe and fittings shall be manufactured in accordance with ASTM A-778 or A-774 from sheet or plate to I.P.S. dimensions. Pipe for the low pressure air systems shall be designed for a rated working pressure of at least 50 psi at 250 F and shall be ANSI B36.19, Schedule 10S, minimum.

C. Stainless steel nuts, anchor bolts, brackets, fasteners, supports, etc. shall be schedule 40, type 316.

D. All pipe shall be fabricated by die forming or rolling true to dimension and round within a tolerance of plus or minus 1/16-inches. The two edges of sheet shall be brought to line so as not to leave a shoulder on the inside of the pipe. Ends of pipe and fittings shall be perpendicular to the longitudinal axis. Pipes shall be straight within maximum of ⅛-inch deviation over 10 feet. All pieces shall be marked with gage and type of stainless steel.

E. All fittings shall be fabricated of the same material as the pipe and of wall thicknesses at least as heavy as the pipe. Fittings shall be reinforced as required to withstand the internal pressure and provide structural integrity. Elbows greater than 16 inches in diameter shall be formed smooth or made up of mitered straight sections welded together in at least five (5) segments. Elbows 16 inches in diameter or less shall be formed smooth. Dimensions of fittings shall conform to ANSI B16.9.

F. Welding shall be performed by qualified welders in conformance with standard procedures for the application, by the shielded arc, inert gas, MIG or TIG method. Filler wire shall be added to all welds to provide for a

cross section and weld metal equal to or greater than the parent metal. Weld deposit shall be smooth and evenly distributed and have a crown of no more than 1/16 inches on both sides of the weld. No cracks or crevices shall be allowed. Butt welds shall have full penetration to interior and exterior of the joint. Excessive weld deposits, slag, spatter, and projections shall be removed by grinding.

G. After manufacture, all pipe and fittings shall be passivated by immersion in a pickling solution of six percent (6%) nitric acid and three percent (3%) hydrofluoric acid at 140° F for a minimum of fifteen (15) minutes. The surface shall be free of iron particles or other foreign material. A complete neutralizing operation shall follow by immersion in a trisodium phosphate rinse.

H. The welds of shop-welded assemblies shall be cleaned and scrubbed with pickling solution and thoroughly rinsed after fabrication.

PART 3 – CLEANING

3.1 GENERAL REQUIREMENTS:

A. Cleaning of the piping system can be accomplished either by precleaning all piping before installation and maintaining the clean condition during construction, by completely cleaning the piping system after construction, or by a combination of the two.

B. A detailed written procedure including the sequence for construction and cleaning shall be established and carefully followed throughout the project. Additional guidance on oxygen cleaning is available in G-4.1, *Cleaning Equipment for Oxygen Service* and EIGA Doc 33.

C. A system shall be considered clean for oxygen service when internal organic, inorganic, and particulate matters have been extensively removed. Removal of contaminants such as greases, oils, thread lubricants, dirt, water, filings, scale, weld spatter, paints, or other foreign material is essential. See 3.5.3 for guidance on acceptance criteria.

D. The cleaning of oxygen pipelines may be accomplished by any one or a combination of more than one of the following methods:

– Chemical cleaning (acid or alkali) and passivation;
– Pigging;
– Mechanical scraping;
– Grit, sand or shot blasting;
– Dry carbon dioxide ice blasting;

– Water blasting;
– Solvent washing (Solvents prohibited by the Montreal Protocol shall not be used. Refer to relevant national, European, or U.S.regulations);
– high pressure detergent cleaning;
– high temperature detergent cleaning; or
– high velocity gas purge.

E. If any items of equipment cannot be furnished clean, arrangements shall be made for them to be cleaned at or local to the site to meet the required standards. Visual inspection of equipment items shall be carried out just before installation to ensure that the required standard of cleanliness has not been compromised.

F. Branch lines and parallel lines shall be treated as separate systems for the purpose of cleaning, and the final tie-ins shall be made after cleaning is completed.

G. The pipe sections shall be welded together using a recognized welding process. It is essential that the internal weld surfaces are smooth and substantially free of slag, beads, or loose debris thereby preserving the internal cleanliness.

H. The pipeline shall be subject to a pneumatic pressure test at the pressure required by the code to which the pipeline has been constructed.

I. On completion of final cleaning, all aboveground connections can be installed including precleaned and pre-tested tees, valves, fittings, branch piping, and other items.

3.2 INSPECTION:

A. After satisfactory completion of the construction, testing, and cleaning processes, the piping shall be inspected at both the inlet and discharge ends and at all accessible points to assess the condition of the internal surface. If considered necessary, according to the quality control procedure, samples can be taken at all accessible openings by wiping the internal surface of the pipeline with white, lint-free cloths or filter papers of a type that have not been treated with optical brighteners.

B. The examination should be conducted using one or more of the following procedures:

– Visual inspection of the internal surfaces using white light to ensure that the cleaning has been effective and that a gray metal finish, free of grease, loose rust, slag, scale, and other debris has been achieved.

– Inspection of end sections of internal bore by ultraviolet (UVA) light to verify the absence of oil or grease; and

– Inspection of wipes (if taken) by bright white light and UVA light to verify the absence of oil or grease.

B. When UVA light examination is required, all samples and openings shall be inspected by a suitable UVA light source to verify that there is no evidence of hydrocarbon contamination. A slight discoloration of the sample is acceptable providing that the sample does not exhibit fluorescence when subjected to UVA light examination. The following criteria shall generally apply to the selection of the UVA light source to be used for the fluorescent detection of hydrocarbon contaminants on pipe surfaces or wipes:

– The light wavelength shall be in the range 250 nm to 400 nm; and

– The light source shall be a spotlight using either a mercury vapour or halide lamp together with a suitable filter that provides a light intensity of at least 5.0 mW/cm2 at 30 cm (12 in). Normally, UVA light sources using fluorescent tubes are not suitable for this application and should be avoided.

C. If at any stage during the precleaning or in-situ cleaning process an acceptable standard of cleanliness has not been achieved and there is evidence of contamination due to heavy corrosion, adhered particulate matter, oil, grease, or similar hydrocarbon-based material present in the debris collected during pigging, the contractor shall submit to the purchaser proposals and method statements for achieving a satisfactory standard of cleanliness.

D. Records of cleaning activities and details of inspections on oxygen service pipelines shall be established and maintained.

PART 4 - CONSTRUCTION

4.1 GENERAL CRITERIA:

A. The total installation of the piping system including testing and cleaning shall be undertaken by an organization with a proven record of experience in pipeline construction. The fabrication, testing, and cleaning procedures shall have been reviewed and approved by the owner before the pipeline is installed. The detailed construction program including the sequence of

testing and cleaning procedures shall be defined to suit specific project requirements.

B. Systems of work shall be in place to ensure the safety of the construction personnel in the fabrication and erection areas.

C. Every effort shall be made to ensure the quality and the operational safety of the piping being installed.

D. All necessary precautions and measures shall be taken to protect materials and piping from damage caused during off-loading, storing, installation, or other activities. Piping shall be carefully stored and handled to prevent contamination of the interior of the pipe and to prevent damage to the exterior protective coating (if applied).

E. A formal construction plan shall be developed that provides for a comprehensive, logical progression of work including proper supervision, regular inspection, and verification.

4.2 PIPE FABRICATION AND WELDING:

A. Piping shall be assembled by welding except at connection to valves, meters, or other equipment where threaded or flanged joints are permitted.

B. To preserve the internal cleanliness of the piping, the internal weld surfaces shall be smooth and substantially free of slag, beads or loose debris. The required weld surface finish can be achieved broadly by various methods such as:

-By using the gas tungsten arc welding (GTAW), also known as tungsten inert gas (TIG), weldingprocess for the root pass in conjunction with, if so desired, an internal argon or other suitable backing gas. Subsequent weld passes can be made using either the GTAW or other weld processes as preferred. This process will in itself produce the desired smooth finish on the internal weld surface. Other welds such as final tie-ins can also use the GTAW root pass to achieve the desired internal weld surface finish; or

-By using the manual metal arc (MMA) welding technique, also known as the shielded metal arc welding (SMAW), followed by cleaning of the internal weld surfaces with wire brush or blade tool pigs to remove slag, beads, and loose debris and thereby achieve the desired finish.

C. Inspection shall be made of all pipe spools and components prior to assembly to ensure that flange or weld faces are clean and that there is no dirt or contamination inside the pipe. Any debris or foreign material

inside the pipe shall be removed before pipe welds or flange connections are made.

D. All pipe welding shall be performed in accordance with welding procedures and by welders qualified to the procedures in accordance with the piping code as defined in the project specification.

E. No backing rings shall be used for the welding of carbon, stainless steel, or Monel piping intended for oxygen service for the following reasons:

-Gaps between the backing ring and the pipe wall can trap dust and debris, which cannot easily be removed during the cleaning processes. Accumulated particulate debris could act as a potential source of combustible material;

-The absence of backing rings facilitates the use of pigs for cleaning operations; and

-Backing rings can act as impact sites.

F. The longitudinal seams of welded pipe in adjoining pipe sections shall be staggered. On precleaned systems, internal line-up clamps for welding shall not be used to avoid the risk of contamination.

4.3 ASSEMBLY AND INSTALLATION:

A. Pipe stress at flanged joints shall be minimized. Piping shall not be hung from flanges of compressors or other equipment without adequate supports.

B. Gaskets shall be installed in accordance with the equipment drawings. Gaskets shall be correctly sized to ensure that no part of the gasket projects beyond the inner wall of the pipe into the flowing gas stream. The use of gasket sealants shall be avoided to prevent extrusion of the sealant material into the pipeline system.

C. The reuse of any gasket is prohibited; it is essential that new gaskets be inserted every time a flange is released. If a joint leaks on pressure test, the joint shall be remade using new gaskets and bolts.

D. Gaskets, nuts, and bolts shall be visually inspected to ensure that they are clean and in good condition.

E. All valves shall be supplied with identification tags or plates and installed in the location defined by the design drawings. Identification tags or plates shall remain attached to each valve after installation.

F. All valves shall be installed in accordance with the piping design drawings and handled in a way that maintains their cleanliness and prevents ingress of moisture, oil, dust, and other contaminants. Particular care should be taken with valves, whether manual, automated, or pressure relief, to ensure that both the flow direction and orientation are correct.

G. The use of valve lubricants should be avoided whenever possible but, if required, they shall be oxygen compatible and used sparingly.

H. Before welding any valve into a piping system, the valve shall either be fully opened or the top works removed to prevent thermal distortion of the valve components. Soft seats and other components vulnerable to damage by heat shall be removed. After welding, soft seats, and other vulnerable components can be replaced following which the valve shall be checked for ease of operation and remedial action taken if excessive force is required to operate the valve.

I. Supports, guides, and anchors shall be positioned and secured before the installation of the piping.

J. All welded connections such as earth clamps or supports attached directly to process piping or equipment intended for service at elevated pressures shall be made before pressure testing.

4.4 INSPECTION AND EXAMINATION:

A. During construction, regular on-site inspections shall be made to ensure that correct procedures for installation and maintenance of pipeline cleanliness are being observed. After completion of construction, the pipeline should be inspected and tested in accordance with the relevant piping code and procedures as defined in the project specification. Such inspections should, as a minimum, verify the following:

– pipe concentricity;
– specified wall thickness;
– internal cleanliness;
– protective coating integrity;
– absence of mechanical damage (e.g., gouges, dents, etc.);
– joint preparation;
– welding fit-up;
– welding; and
– absence of arc burns.

4.5 NON-DESTRUCTIVE TESTING:

A. Pressure tests should be conducted pneumatically using dry, oil-free air or nitrogen to minimize the possibility of contamination.

B. After installation, all piping shall be tested for a minimum of one hour at twice the design operating pressure or at 4 psi, whichever is greater. Defective joints shall be repaired and retested to the owner's satisfaction. It is the intent of this specification that all piping be installed "gas" and "water" tight. Any and all joints found to be otherwise shall be promptly repaired and faulty materials removed from the project site.

END OF SECTION

DIVISION 16 - ELECTRICAL

16010 - BASIC ELECTRICAL REQUIREMENTS

1.1 QUALITY ASSURANCE

A. All electrical work shall be in accordance with the following codes and agencies:

1. The National Electrical Code (NFPA-70), 2014 Edition.
2. The International Building Code, 2015 Edition with South Carolina modifications.
3. Regulations of the local utility company concerning metering and service entrance.
4. State and local ordinances governing electrical work.

B. All materials shall be new and shall conform to standards where such have been established for the particular material. All UL listed equipment shall bear the UL label.

1.2 PERMITS

A. Obtain all permits and inspections required for the work involved. Deliver to the owner all certificates of inspection.

1.3 WARRANTY

A. The contractor shall warrant to the owner that all work shall be free from defects and will conform to the contract documents. This warranty shall extend not less than one year from the date of beneficial use.

1.4 DRAWINGS

A. The drawings indicate the general arrangement of electrical equipment, based on one manufacturer's product. Coordinate installation of equipment with all other trades. Do not scale drawings for connection locations. Bring all discrepancies to the immediate attention of the engineer.

B. Contractor shall install and circuit all electrical work as indicated on drawings unless specific building construction requires a change or rerouting of this work. He shall keep a record of the location of all concealed work, including the underground utility lines. He shall document all changes in the manner specified by the General Conditions, Special Conditions and Supplementary General Conditions to the Electrical Work.

1.5 EQUIPMENT REQUIRING ELECTRICAL SERVICE

A. Review all specification sections and drawings for equipment requiring electrical service. Provide service to and make connections to all such equipment.

B. Drawings are based on design loads of one manufacturer. If equipment actually furnished have loads, numbers of connections, or voltages other than those indicated on the drawings, then control equipment, feeders, and overcurrent devices shall be adjusted as required, at no additional cost to the owner. Such adjustments are subject to review by the engineer.

C. Catalog numbers indicated with equipment, devices and lighting fixtures are for convenience only. Errors or obsolescence shall not relieve the furnishing of items which meet the technical description given in specifications, noted, or required by function designated.

1.6 SHOP DRAWINGS

A. The Contractor shall submit for review by the Engineer a complete schedule and data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, such as catalogs, cuts, diagrams, performance curves, and charts published by the manufacturer, to show conformance to specification and drawing requirements; model numbers alone will not be acceptable. Complete electrical characteristics shall be provided for all equipment.

B. Submittals shall be made for each of the following items:

Panelboard	Automatic Transfer Switch
Enclosed Circuit Breakers	Generator
Wiring Devices	Lighting Fixture
Surge Protection	Junction Boxes

Short Circuit/Coordination Study/Arc Flash Hazard Analysis

C. Each individual submittal item for materials and equipment shall be marked to show specification section and paragraph number which pertains to the item.

D. Prior to submitting shop drawings, review the submittal for compliance with the Contract Documents and place a stamp or other confirmation thereon which states that the submittal complies with Contract requirements. Submittals without such verification will be returned disapproved without review.

1.7 SCHEDULING OF OUTAGES

A. Electrical work requiring interruption of electrical power which would adversely affect the normal operation of other portions of the owner's property, shall be done at other than normal working hours. Normal working hours shall be considered 8:00 a.m. to 6:00 p.m., Monday through Friday. Schedule the interruption of electrical power three working days prior to actual shutdown.

1.8 SITE INVESTIGATION AND RENOVATION CONDITIONS

A. Prior to submitting bids for the project, visit the site to become familiar with existing conditions. The project shall be restored to its existing condition, with the exception of work under this contract, prior to final payment.

B. Provide additions and alterations to existing work required to produce a complete electrical installation. Cutting, channeling, chasing, or drilling of walls, partitions, ceilings, or other surfaces and support, or anchorage of conduit, or other electrical work, shall be done without damage to other piping or building equipment.

1.9 PRODUCT DELIVERY, STORAGE, HANDLING, AND PROTECTION

A. Provide a dry, weather tight space for storing materials. Store packaged materials in original undamaged condition with manufacturer's labels and seals intact. Handle and store material in accordance with standards to prevent damage. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable. Replace damaged materials.

1.10 CLEANING AND PAINTING

A. Remove oil, dirt, grease and foreign materials from all equipment to provide a clean surface. Touch up scratched or marred surfaces of lighting fixtures, panelboard and cabinet trims, and equipment enclosures with paint manufactured specifically for that purpose.

1.11 SHORT CIRCUIT/COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

A. Scope

1. The contractor shall furnish short-circuit and protective device coordination studies which shall be prepared by the equipment manufacturer.
2. The contractor shall furnish and Arc Flash Hazard Analysis Study per NRPA 70E – Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

B. Submittals For Construction

1. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. No more than five (5) bound copies of the complete final report shall be submitted.
2. The report shall include the following sections:
   a. One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations
   b. Descriptions, purpose, basis and scope of the study

c. Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings
d. Protective device time versus current coordination curves with associated one line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings
e. Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout
f. Incident energy and flash protection boundary calculations
g. Comments and recommendations for system improvements, where needed
h. Executive Summary including source of information and assumptions made

C. Qualifications

1. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies. The Registered Professional Electrical Engineer shall be a full-time employee of the electrical power equipment manufacturer (Square D, Eaton or GE).

D. Studies

1. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer. The coordination study shall begin with the utility company's feeder protective device and include all of the electrical protective devices down to and include the largest feeder circuit breaker and motor starter in the 480 Volt system. The study shall also include variable frequency drives, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear.
2. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

E. Data Collection

1. Contractor shall furnish all field data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract.

F. Short-Circuit and Protective Device Evaluation Study

1. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.
2. Transformer design impedances and standard X/R ratios shall be used when test values are not available.

3. Provide the following:
    a. Calculation methods and assumptions
    b. Selected base per unit quantities
    c. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted
    d. Source impedance data, including electric utility system and motor fault contribution characteristics
    e. Typical calculations
    f. Tabulations of calculated quantities
    g. Results, conclusions, and recommendations
4. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault
   at each:
    a. Electric utility's supply termination point
    b. Enclosed breaker
    c. 480V and 240V panelboards
    d. Reduced voltage starters
    e. Standby generators and automatic transfer switches
5. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
6. Protective Device Evaluation:
    a. Evaluate equipment and protective devices and compare to short circuit ratings

G. Protective Device Coordination Study

1. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.
2. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.
3. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
4. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
5. Plot the following characteristics on the curve sheets, where applicable:
    a. Electric utility's protective device
    b. Medium voltage equipment relays
    c. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
    d. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
    e. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
    f. Conductor damage curves
    g. Ground fault protective devices, as applicable
    h. Pertinent motor starting characteristics and motor damage points

6. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

H. Arc Flash Hazard Analysis

1. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.
2. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.
3. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (enclosed breaker, pump control panel, wet well, junction box, generator and automatic transfer switch) where work could be performed on energized parts.
4. The Arc-Flash Hazard Analysis shall include all MV, 480V locations and significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.
5. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.
6. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude.
7. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

I. Report Sections

1. Input Data
2. Short-Circuit Data
3. Recommended Protective Device Settings
   a. Circuit Breakers:
4. Incident energy and flash protection boundary calculations.
   a. Arcing fault magnitude
   b. Device clearing time
   c. Duration of arc
   d. Arc flash boundary
   e. Working distance
   f. Incident energy
   g. Hazard Risk Category
   h. Recommendations for arc flash energy reduction

J. Field Adjustment

1. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study.
2. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

3. Notify Owner in writing of any required major equipment modifications.

K. ARC FLASH WARNING LABELS

1. The vendor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
2. The label shall have an orange header with the wording, "WARNING, ARC FLASH HAZARD", and shall include the following information:
   a. Location designation
   b. Nominal voltage
   c. Flash protection boundary
   d. Hazard risk category
   e. Incident energy
   f. Working distance
   g. Engineering report number, revision number and issue date
3. Labels shall be machine printed, with no field markings
4. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
   a. For each 480 and applicable 240 volt enclosed breaker and disconnects, one arc flash label shall be provided
   b. For each reduced voltage starter, one arc flash label shall be provided
   c. For each panelboard, one arc flash label shall be provided
5. Labels shall be field installed by the contractor.

16100 - BASIC MATERIALS

2.1 RACEWAYS

A. The following specifications and standards are incorporated into and become a part of this specification:

1. Underwriter's Laboratory, Inc. Publications 1, 6, 467, 651, 797, 1242.
2. American National Standards Institute C-80.1, C-80.3.

B. Raceway is required for all wiring, unless specifically indicated or specified otherwise. The minimum size of conduit shall be ¾", but shall not be less than size indicated on the drawings or required by the NEC.

C. Conduits shall be aluminum rigid conduit (ARC) except for the following conditions:

1. Conduits installed within concrete slabs shall be or schedule 80 heavy wall PVC. Where transition is made from raceway in slab to any type of raceway out of slab, make transition with an ARC elbow.
2. Conduits installed in direct contact with earth shall be schedule 80, heavy wall PVC.
3. Use flexible conduit for connections to motors, dry type transformers and all vibrating equipment.
   a. Length shall not exceed 18."

b. Maintain ground continuity through flexible conduit with a green equipment grounding conductor.
c. Liquid-tight flexible conduit shall be used in exterior installations.

D. ARC fittings shall be standard 6063 aluminum alloy threaded couplings, threaded hubs, bushings, and elbows. Non-metallic conduit fittings shall be of the same material as the conduit furnished and shall be the product of the same manufacturer.

E. All conduit support parts and hardware shall be stainless steel. Conduit clamps shall be two-part stainless steel (B-Line B2000) type. Conduit support channels shall be 1 ½" x 1 ½" – 12 gauge channel 304 stainless steel.

F. Leave all empty conduits with a 200 lb. test nylon cord pull line. Complete raceway runs prior to installation of wires or cables. Deformed conduits shall be replaced. Protect conduits against dirt, plaster, and foreign debris with conduit plugs.

G. Fasten conduit support devices to structure with wood screws on wood, toggle bolts on hollow masonry, expansion anchors on solid masonry or concrete, and machine bolts or clamps on steel. Nails are not acceptable. Seal all conduits penetrating building exterior with insulating electrical putty to prevent entrance of moisture.

H. Conduit shall be run parallel or at right angles to walls, ceilings, and structural members. Support branch circuit conduits at intervals not exceeding 10 feet, and within 3 feet of each box or change of direction. Provide an expansion and deflection coupling where conduits cross a building expansion joint.

2.2 WIRES AND CABLES

A. The following specifications and standards are incorporated into and become a part of this specification:

1. Underwriter's Laboratories, Inc. Publications 44, 83, 486, 493.
2. Insulated Cable Engineers Association Standards S-61-402, S-66-524.
3. National Electrical Manufacturer's Standards WC-5, WC-7.

B. Conductors shall be electrically continuous and free from short circuits or grounds.

C. All open, shorted, or grounded conductors and any with damaged insulation shall be removed and replaced with new material free from defects.

D. Conductor size shall be minimum of No. 12 AWG, unless larger size is required by the drawings or the NEC. Insulation voltage level rating shall be 600 volts. All wire and cable shall bear the UL label.

E. Conductors No. 10 and smaller shall be solid copper, 90 degrees C. type THWN/THHN. Conductors larger than No. 10 shall be stranded copper, 90 degrees C. type THWN/THHN, or XHHW. Fixture wire shall be No. 16 AWG silicone

rubber insulated, stranded fixture wire type SFF-2 or No. 16 thermoplastic nylon jacketed stranded fixture wire type TFFN.

F. Color code all conductors. No. 6 and smaller shall have solid color compound or coating. No. 4 and larger shall have solid color compound or colored phase tape; tape shall be installed on conductors in every box, termination point, cabinet, or enclosure. Coding shall be as follows:

1. 240/120 volt single phase three wire system: Phase A-black, Phase B-red, neutral-white.
2. 480Y/277 volt three phase four wire wye system: Phase A-brown, Phase B-orange, Phase C-yellow, neutral-grey.
3. Grounding conductors shall be green or green traced.

G. Maintain phase rotation established per N.E.C. at service equipment throughout entire project.

H. Group and lace with nylon tie straps all conductors within enclosures. Make splices in conductors only within junction boxes, wiring troughs, or other NEC approved enclosures. Do not splice conductors in pull boxes, panelboards, safety switches, or motor control enclosures. Identify each conductor as to circuit connection in all boxes and enclosures.

I. Terminate stranded conductors No. 10 AWG and smaller with crimp-type lug or stud. Crimp terminal shall be the configuration type suitable for terminal point.

J. Torque each terminal connection to the manufacturer's recommended torque value. A calibrated torquing tool shall be used to insure proper torque application.

2.3 BOXES

A. The following specifications and standards are incorporated into and become a part of this specification:

1. Underwriter's Laboratories, Inc. Publications 50, 467, 514.

B. Boxes shall be rustproof cast metal. Outlet boxes for GFI receptacles shall be 2 3/4" deep.

C. Outlet boxes for switches and receptacles in exposed wiring systems shall be cast FS type with matching device plate. For exterior installations, use spring weatherproof in-use type covers. Provide larger boxes as required for special purpose devices.

D. Dimensions of pull and junction boxes shall not be less than those required by the NEC for the number, size, and position of conductors entering the box. Wood supports within pull boxes are not acceptable. Provide box covers for all boxes.

E. All boxes shall be completely accessible and as required by the NEC. Provide an outlet box for each device. Box sizes shall be increased from those outlined above if required by Article 314 of the NEC.

F. Support every box from structure. Secure metal with sheet metal screws, solid masonry or concrete with expansion anchors.

G. Remove only knockouts as required and plug all unused openings. After completion, using indelible ink wide tip marker, indicate on the cover of each junction and pull box the designation of each circuit contained therein.

2.4 WIRING DEVICES

A. The following specifications and standards are incorporated into and become a part of this specification:

1. National Electrical Manufacturer's Association Publications WD-1, WD-5.

B. Weatherproof, 20 amp, 277 volt switches shall be Hubbell 1281-1750. Equivalent switches manufactured by Arrow Hart, Legrand, or Leviton are acceptable.

C. Ground fault interrupter (GFI) receptacles shall be Hubbell GFTWRST83. Special purpose receptacles shall be as specified on the drawings. Equivalent receptacles manufactured by Arrow Hart, Legrand, or Leviton are acceptable.

D. All devices installed in areas exposed to the weather shall be provided with a weatherproof, in-use type device plate.

E. All devices shall be provided with white finish.

2.5 CIRCUIT AND MOTOR DISCONNECTS

A. The following specifications and standards are incorporated into and become a part of this specification:

1. Underwriter's Laboratories, Inc. Publications 98, 198.2, 198.4.
2. National Electrical Manufacturer's Association Publications KS-1.

B. Products of General Electric, Eaton or Square D which comply with these specifications are acceptable.

C. Disconnect switches shall be heavy duty non-fusible safety switch type, unless fused type is indicated on the drawings, with the number of poles required to disconnect all ungrounded conductors serving the equipment.

1. Furnish a solid neutral when the circuit includes a neutral conductor.
2. Furnish an equipment grounding conductor lug bonded to the switch enclosure.
3. Furnish NEMA type 4X SS for all damp, wet, or exterior locations unless other types are indicated on the drawings.

D. Switches shall have the following features:

1. Quick-make, quick break switching mechanism.
2. Line terminal shields.
3. Provisions for padlocking in the "off" position.
4. Door interlocks to prevent door from opening when switch is closed. Provide inconspicuous means to defeat this interlock.
5. Permanent name plate indicating all ratings.
6. Arc chute for each pole.
7. 600 volt rating for 250 to 600 volt systems, 250 volt rating for systems below 250 volts.

E. Disconnect switches for three phase motors rated two horsepower and above shall be three pole non-fusible type.

F. Locate switches to provide full accessibility and working clearances required by the NEC. Locate adjacent to equipment served unless drawings indicate otherwise. Mount switch directly to structure or to metal channel depending upon field conditions. Mount switch handle between 36" and 60" above finished floor.

2.6 SUPPORTING DEVICES

A. Provide and install supporting devices which comply with manufacturer's standard materials, design, and construction in accordance with published standards and as required for complete installation.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices. Install hangars, supports, clamps, and attachments to support piping properly from building structure only. Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form water-tight seal.

2.7 ELECTRICAL IDENTIFICATION

A. Install engraved plastic - laminate sign on each major unit of electrical equipment. Provide a single line of text, 1/2" high lettering on 1 1/2" high sign (or 2" high sign if 2 lines required). Provide signs for each unit of the following:

1. Panelboards
2. Electrical cabinets and enclosures
3. Transformers
4. Motor controllers
5. Disconnect switches
6. Automatic Transfer Switches

3.1 GROUNDING SYSTEMS

A. Equipment grounding system shall be established with equipment ground conductors. The use of metallic raceways for equipment grounding is not acceptable. Unless indicated otherwise, provide equipment ground the same size as phase conductors.

B. The following specifications and standards are incorporated into and become a part of this specification:

1. Underwriter's Laboratories, Inc. Publications 44, 83, 467, 486, 493.
2. National Electrical Manufacturer's Association Standards WC-5, WC-7.

C. Grounding electrode conductors shall be bare or green insulated copper sized as indicated on the drawings. Equipment grounding conductors shall be green insulated type THW, THWN, or XHHW sized as indicated on the drawings. Where sizes are not indicated, grounding conductor shall be sized in accordance with NEC Article 250.

D. Each receptacle and switch device shall be furnished with a grounding screw connected to the metallic device frame. Provide a conductor termination grounding lug bonded to the enclosure of each transformer, motor controller, and disconnect switch.

E. Ground all non-current carrying parts of the electrical system, i.e., wireways, equipment enclosures and frames, junction and outlet boxes, machine frames, and other conductive items in close proximity with electrical circuits. Ground the neutral of all dry type transformers to building steel that shall serve as the grounding electrode for the separately derived system.

F. Grounding conductors for branch circuits are not shown on the drawings; however, grounding conductors shall be provided in all branch circuit raceways and cables, including flexible conduit. Grounding conductors shall be the same AWG size as branch circuit conductors.

G. The equipment grounding conductor shall be terminated with a screw or bolt used for no other purpose. Equipment grounding conductors shall terminate on panel board, grounding bus only. Do not terminate on neutral bus.

3.2 TRANSFORMERS

A. The following specifications and standards are incorporated into and become a part of this specification:

1. Underwriter's Laboratories, Inc. Publications 506.
2. National Electrical Manufacturer's Association Publication ST-20.

3. American National Standards Institute Publications C-57, C-89.2.

B. Products of General Electric, Eaton or Square D which comply with these specifications are acceptable.

C. Transformers shall be self-cooled, rated for continuous operation at rated KVA, 24 hours per day, 365 days per year with normal life expectancy. Transformers shall be rated for average temperature rise by resistance of 150 degrees C. in 40 degrees C. maximum ambient, 30 degrees C. average ambient unless otherwise indicated. Transformer insulation system shall be UL rated as 220 degrees C. system. Sound rating shall not exceed NEMA and ANSI standards for the KVA rating. Internal vibration dampening shall be provided on all transformers.

D. Transformer enclosures shall be open, ventilated, drip-proof with removable front and rear cover panels, suitable for floor mounting, for transformers rated 30 KVA and up. For transformers up to 25 KVA, transformers shall be totally enclosed, non-ventilated with a resin encapsulated core and coil and stainless steel housing.

E. Primary ratings shall be 480 volts, 1 phase, 2 wire. Secondary service shall be 240/120 volts, 1 phase, 3 wire. Nominal impedance shall be 4.5 percent minimum.

F. Core assemblies and the center ground connection point of the coil secondaries shall be grounded to their enclosures by adequate, flexible ground straps. Provide grounding lug at the strap to enclosure bonding location for connection of three conductors.

G. Dry type transformers larger than 15 kva shall be floor mounted; 15 KVA and below shall be wall mounted. Installation shall meet the requirements of the N.E.C. Article 450. Transformers shall be mounted on neoprene, waffle type vibration pads 5/8” thick minimum. Primary and secondary connections shall be made with flexible conduit. The secondary windings of each transformer shall be grounded in accordance with the NEC requirements for separately derived systems.

H. Do not install equipment over transformers, unless indicated on the drawings. Install secondary over current protective device within 10 feet horizontally from the transformer. Where none is indicated on the plans, provide an enclosed circuit breaker within 10 feet rated 125 percent of the transformer full load ampacity but not greater than the secondary conductor ampacity. Provide full working clearances as required by the NEC.

3.3 PANELBOARDS

A. The following specifications and standards are incorporated into and become a part of this specification:

1. Underwriter's Laboratories, Inc. Publications 50, 67,489.
2. National Electrical Manufacturer's Association Publications PB-1, AB-3.

B. Products of General Electric, Eaton or Square D which comply with these specifications are acceptable.

C. All panels and circuit breakers shall be UL listed and bear a UL label. Panels shall be of the dead front safety type. Provide panels complete with factory assembled circuit breakers connected to the bus bars. Number all panel boards in the following sequence: Circuits 1 and 2 - Phase A; circuits 3 and 4 - Phase B; circuits 5 and 6 - Phase C.

D. All bus bars shall be copper. Main lugs and main breaker shall be UL approved for copper or aluminum conductors and shall be of a size range for the conductors indicated on the drawings. Each panel shall contain a full size grounding bus and, when required, a full size insulated neutral bus. The neutral and ground busses shall have a sufficient number of lugs to singularly terminate each individual conductor requiring a connection. The ground bus shall be brazed or riveted to the panel enclosure, but not attached to the panel interior. Where designated, each "space' shall include all bussing, device supports and connections for future breaker installation.

E. Branch circuit panel board width shall be between 20 and 22 inches; depth shall be 5 3/4" maximum. Distribution panel board width shall be 32" minimum and depth shall be 14" maximum. Provide gutters and bending space to conform with the NEC. Key all panels throughout the project alike.

F. Circuit breakers shall be quick-make, quick-break, thermal magnetic type bolted to the bus. Multi-pole breakers shall be common trip and common reset type; tie handle connections are not acceptable. Interrupting ratings on 240 volt systems shall be 10,000 RMS symmetrical amps minimum and on 480 volt systems shall be 14000 RMS symmetrical amps minimum; provide higher ratings when indicated on the drawings.

G. Mount panel boards with top circuit not more than 6'-6" above finished floor. Enclosures shall be secured by a minimum of four fastening devices. Attach enclosure directly to masonry, concrete, or wood, maintaining a 1” rear clearance. Mount enclosure to metal channel for installations on steel structure or drywall.

H. Provide in each panel board a typewritten circuit directory mounted under clear plastic in metal holder in the door of the panel reflecting all field changes additions. Install push-in knock-out closure plugs in any unused knock-out openings.

END OF SECTION

APPENDIX A

GEOTECHNICAL INVESTIGATION

Geotechnical Engineering Investigation

Academy Creek WWTP in Brunswick
Brunswick, Georgia

July 31, 2018
Terracon Project No. ES185176

Prepared for:

Hussey Gay Bell
Savannah, Georgia

Prepared by:

Terracon Consultants, Inc.
Savannah, Georgia

July 31, 2018

Hussey Gay Bell
329 Commercial Drive
Savannah, Georgia 31406

Attn: Ms. Jennifer Oetgen
P: (912) 354-4626

Re: Geotechnical Engineering Investigation
Academy Creek WWTP in Brunswick
Brunswick, Georgia
Terracon Project No. ES185176

Dear Ms. Oetgen:

Terracon Consultants, Inc. (Terracon) has completed our Geotechnical Engineering Investigation for the above-referenced project. The services were performed in general accordance with our proposal No. PES185176 dated July 18, 2018 and supplemental change order dated July 26, 2018. This report presents the findings of the subsurface exploration and provides geotechnical recommendations for the proposed construction.

We appreciate the opportunity to be of service to you. Should you have any questions concerning this report or if we may be of further service, please contact us at your convenience.

Sincerely,
Terracon Consultants, Inc.

Yan Jiang, Ph.D., P.E.
Project Geotechnical Engineer

Guoming Lin, Ph.D., P.E., D.GE.
Senior Principal

cc: 1 – Client (PDF)
1 – File

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APPENDICES

EXECUTIVE SUMMARY

This report presents the results of our Geotechnical Engineering Investigation for the proposed tank and vertical pipe support in Academy Creek WWTP in Brunswick, Georgia. The investigation included a field exploration program and engineering evaluation of the subsurface conditions and foundation recommendations.

Based on the results of the subsurface exploration and analyses, we identified the following geotechnical considerations:

- In general, the subsurface soils consist of sands with variable relative density to the termination of CPT sounding at a depth of about 39 feet. A detailed discussion about the subsurface conditions is provided in **Section 3.1**.
- The groundwater table was estimated at a depth of approximately 4.5 feet BGS in two hand auger borings at the time of our field exploration.
- We performed settlement analyses for shallow foundations using the assumed structural loads discussed in **Section 2.0.** Based on the soil profile and settlement analysis, a shallow foundation system should be adequate for the support of the proposed structures.
- A net allowable bearing capacity of 2,500 pounds per square foot (psf) is recommended for shallow foundation design after achieving a stable subgrade. The allowable bearing capacity may be increased by 1/3 for transient wind load and seismic load conditions.
- For the seismic design, Terracon classifies the subject site as Site Class D in accordance with the International Building Code IBC (2012) and ASCE 7-10 Section 11.4.2.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and **the report must be read in its entirety** for a comprehensive understanding of the items and recommendations contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report's limitations.

GEOTECHNICAL ENGINEERING INVESTIGATION

Academy Creek WWTP in Brunswick
Brunswick, Georgia

Terracon Project No. ES185176
July 31, 2018

1.0 INTRODUCTION

Terracon has completed our Geotechnical Engineering Investigation for the proposed tank and vertical pipe support in Academy Creek WWTP in Brunswick, Georgia. The general location of the project site and its vicinity are shown on the Site Location Map in **Exhibit A-1**, **Appendix A**.

The investigation included a field exploration program and engineering evaluation of the subsurface conditions and foundation recommendations. The subsurface conditions within the proposed site were explored with one Cone Penetration Testing (CPT) sounding and three hand auger borings. The CPT sounding was pushed to a depth of approximately 39 feet below ground surface (BGS). The hand auger borings were drilled to approximately 5 feet BGS. The boring and sounding location are shown in **Exhibit A-2, Appendix A**. Detailed soil logs are also included in **Appendix A**.

The purpose of our investigation was to evaluate the existing subsurface conditions at the project site and develop conclusions and geotechnical recommendations for the proposed construction. The following study was conducted in accordance with our scope of services outlined in our proposal (Proposal No. PES185176) dated July 18, 2018 and supplemental change order dated July 26, 2018:

- subsurface soil conditions
- site preparation
- seismic considerations
- groundwater conditions
- foundation design and construction

2.0 PROJECT INFORMATION

Item	Description
Site location	The site is located at the intersection of T St and Newcastle St in Brunswick, Georgia. Latitude: 31.1665°, Longitude: -81.5025°
Existing improvements	The site is a waste water treatment facility.
Current ground cover	Concrete slab and grass field.
Existing topography	Relatively level.
Proposed improvements	The proposed project will include the construction of an 11,000 gallon liquid oxygen storage tank and vertical pipe support. The blower will also be replaced.
Finished floor elevation	Not provided
Maximum loads	The tank will have full weight of 120,000 lbs according to the email on July 18, 2018 from Chris Burke. The loading information on the vertical pipe support and blower was not provided and the settlement is not a concern based on the email on July 18, 2018 from Chris Burke **We assume that the tank will be support by a 10 feet by 10 feet concrete slab and no additional fill will be added on site for the settlement analyses.** If heavier structural loads are required or if more stringent settlement criteria are required, Terracon should be retained to perform an additional evaluation to determine if ground improvement measures or another foundation option is required.
Maximum allowable settlement	The following settlement criteria were assumed for the settlement analyses. Total settlement: 1 inch (assumed). Differential settlement: ½ inch over 40 feet (assumed).
Grading	It is anticipated that the site work will involve a minimal amount of cut / fill during site preparation.

Should any of the above information or assumptions be inconsistent with the planned construction, Terracon should be informed so that modifications to this report can be made as necessary.

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Based on the results of our field exploration program, we developed generalized soil profiles to represent the soil conditions of the project site, and they can be generalized as follows:

Description	Approximate Depth to Bottom of Stratum Below the Ground Surface (BGS)	Soil Classification based on CPT Soundings	Equivalent SPT N_{60}
Topsoil	0.5 foot or below	Silty sands with tree roots. (Please **note**: the depth/thickness of topsoil will vary, depending upon the near-surface soil disturbance during the site preparation.)	N/A
Stratum 1	5 feet	Sands	25 to 40
Stratum 2	33 feet	Sands	4 to 18
Stratum 3	39 feet (CPT termination)	Sands	15 to 50+

Details of subsurface conditions encountered at each sounding and boring location are presented in the individual CPT sounding and hand auger boring logs in **Appendix A** of this report. Stratification boundaries on the logs represent the approximate depth of changes in soil types; the transition between materials may be gradual.

3.2 Groundwater

The groundwater depth was not estimated at a depth of approximately 4.5 feet BGS in hand augers HA1 and HA2 while groundwater was not encountered during the CPT sounding at the time of our field exploration. It should be noted that groundwater levels tend to fluctuate with tidal, seasonal and climatic variations, as well as with construction activities. As such, the possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project. The groundwater table should be checked prior to construction to assess its effect on site work and other construction activities.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

The following evaluation and recommendations are based upon our understanding of the proposed construction and the results from our field exploration. If the above-described project conditions are incorrect or changed after this report, or subsurface conditions encountered during construction are significantly different from those reported, Terracon should be notified and these recommendations must be re-evaluated to make appropriate revisions.

4.1 Geotechnical Considerations

The subsurface conditions at this site are suitable for the proposed construction. The generalized soil profile is presented in **Section 3.1**.

We performed settlement analyses using the assumed structural loads and soil parameters derived from the CPT soundings. The assumed loading information is discussed in Section 2.0. Based on the results of our settlement analyses, the total settlements were estimated to be less than 1.0 inch. As such, the proposed building can be supported on a shallow foundation system.

Please note the type of foundation system required to support the proposed structure will depend upon the structural loads and development plan as well as the foundation performance requirements of the proposed structure. Terracon can provide further analyses on the foundation system or ground improvement options if the actual loading information is available.

During site preparation, no topsoil, organic matter, stumps, existing fill, or other deleterious materials should be left in place below any footings. All footings should bear on suitable natural soil, or on properly compacted structural fills. Compacted fill below any footings should be placed directly on the suitable natural soil.

We recommend Terracon be retained to test the footing subgrade during construction so that Terracon can provide additional recommendations to prepare the subgrade based on the conditions uncovered during the footing preparation.

4.2 Subgrade Preparation

The site clearing should strip topsoil, rootmat and organics as well as old utilities and foundations. Roots larger than one inch in diameter should be cut off two feet beneath the top of the subgrade. During the subgrade preparation, the near-surface soils with organics / soft soils (muck) should be removed with scrapers and bulldozers. Furthermore, to minimize the disturbance of the natural soils during the site work, we recommend track mounted lightweight equipment should be used as opposed to a rubber tired machine.

The site may have isolated soft / weak areas that may require deeper undercut and backfill to achieve a stable subgrade. As such, the contractor should be prepared to stabilize the ground

by undercutting and backfilling of these soft areas. The actual depth of undercut should be determined in the field by Terracon based on the subgrade conditions encountered in the field.

The subgrade soils may lose some of their strengths when rain and surface water infiltrates into them. We recommend an effective drainage system be installed in the proposed construction area to intercept rain and surface water.

We recommend a thorough field quality control program of proofrolling of the subgrade. The bottom of the excavation should be observed for potential unsuitable material. Hand auger boring and dynamic cone penetration (DCP) testing should be performed to evaluate and confirm the subgrade conditions. It is anticipated that some deeper subgrade soil undercutting and backfilling may be required in some isolated areas under the buildings and the parking lots during the subgrade preparation.

During the site preparation, no topsoil, organic matter, stumps, undocumented fill or other unsuitable materials should be left in place below any footings, slab and/or pavement. All foundation should bear on suitable natural soil, or on properly compacted structural fill. Compacted fill below any foundation should be placed directly on suitable natural soils.

We recommend Terracon be retained to test the footing, slab and/or pavement subgrade during construction so that Terracon can provide additional recommendations to prepare the subgrade based on the conditions uncovered during the subgrade preparation.

The following sections will present the details of earthwork and the recommendations for shallow foundations.

4.3 Demolition/Removal of Existing Structures

We understand the existing slab at the site will be demolished/removed to accommodate the proposed construction. The demolition/removal of the existing slab may leave old foundations and utilities at the site. These old foundations, utilities, and pavement should be removed. Any voids from the removal should be repaired by backfilling with compacted fill. The crushed concrete may be stockpiled for reuse as engineering fill, if desired. The crushed materials should be tested for gradation and impurity contents before its use.

4.4 Earthwork

Site preparation should include the installation of a site drainage system, topsoil stripping and grubbing, subgrade preparation, densification, and proofrolling. Due to the uneven ground surface of the site, the volume of asphalt and aggregate base may be significantly greater than the area times the asphalt/aggregate base thickness indicated in the boring logs. Deeper undercut may be needed in some localized areas to remove unsuitable materials.

4.4.1 Site Drainage

An effective drainage system be installed prior to site preparation and grading activities to intercept surface water and to improve overall shallow drainage. The drainage system may consist of perimeter ditches supplemented with parallel ditches and swales. Pumping equipment should be prepared if the above ditch system cannot effectively drain water away from the site, especially during the rainy season. The site should be graded to shed water and avoid ponding over the subgrade.

4.4.2 Densification and Proofrolling

Prior to fill placement on the subgrade, the entire building and pavement areas should be densified with a heavy-duty vibratory roller to achieve a uniform subgrade. The subgrade should be thoroughly proofrolled after the completion of densification. Proofrolling will help detect any isolated soft or loose areas that "pump", deflect or rut excessively, and also densify the near-surface soils for floor slab support.

A loaded tandem axle dump truck, capable of transferring a load in excess of 20 tons, should be utilized for this operation. Proofrolling should be performed under the Geotechnical Engineer's observation. Areas where pumping, excessive deflection or rutting is observed after successive passes of the proofrolling equipment should be undercut, backfilled and then properly compacted. It is anticipated that some amount of subgrade undercutting may be required under the footing during subgrade preparation.

4.4.3 Fill Material Consideration

Structural fill should be placed over a stable or stabilized subgrade. The properties of the fill will affect the performance of the footings and the floor slabs. The soils to be used as structural fill should be free of organics, roots, or other deleterious materials. It should be a non-plastic granular material containing less than 25 percent fines passing the No. 200 sieve.

Based on the hand auger borings, the proposed site mainly consists of silty sand or sands with silts in the upper 5 feet BGS. The silty sands or sands with silts are suitable for structural fill.

Areas to receive structural fills should be placed in thin (8 to 10 inches loose) lifts and compacted to a minimum of 95 percent of the soil's Modified Proctor maximum dry density (ASTM D-1557). The fill brought to the site should be within 3 percent (wet or dry) of the optimum moisture content and should meet the properties as described above.

Some manipulation of the moisture content (such as wetting, drying) will be required during the filling operation to obtain the required degree of compaction. The manipulation of the moisture content is highly dependent on weather conditions and site drainage conditions. Therefore, the

contractor should prepare both dry and wet fill materials to obtain the specified compaction during grading.

4.5 Floor Slabs

The proposed tank, vertical pipe support and blower can be supported by a shallow foundation system, provided that the proposed structure will not exceed the loads as provided in Section 2.0 and the structure has criteria of the allowable settlement of 1 inch or greater.

4.5.1 Floor Slab Design Recommendations

Item	Description
Net allowable bearing pressure[1]	2500 psf
Floor slab support	Compacted structural fill / inspected and tested natural ground[2].
Modulus of subgrade reaction	120 pounds per square inch per in (psi / in) for point loading conditions.
Base course/capillary break[3]	4 inches of free draining granular material.
Vapor barrier	Project Specific[4].
Structural considerations	Floor slabs should be structurally separated from columns and walls to allow relative movements[5].

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. It assumes any unsuitable fill or soft soils, if encountered, will be replaced with compacted structural fill.
2. Because the existing ground may have been filled or disturbed previously, we recommend the subgrade be inspected and tested with proofrolling after the topsoil is stripped as outlined in **Section 4.4** of this report.
3. The floor slab design should include a base course comprised of free-draining, compacted, granular material, at least 4 inches thick. The granular subbase may be graded aggregate base (GAB) or sands containing less than 5 percent fines (material passing the #200 sieve). GAB subbase can also help improve the workability of the subgrade, especially during rain periods.
4. The use of a vapor retarder should be considered beneath concrete slabs on the grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.
5. Floor slabs should be structurally independent of any building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation. Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience

indicates that any differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks that occur beyond the length of the structural dowels. The structural engineer should account for this potential differential settlement through the use of sufficient control joints, appropriate reinforcing or other means.

4.5.2 Floor Slab Construction Considerations

Prior to construction of grade supported slabs, varying levels of remediation may be required to reestablish stable subgrades within slab areas due to construction traffic, rainfall, disturbance, desiccation, etc. As a minimum, the following measures are recommended:

- The interior trench backfills placed beneath slabs should be compacted in accordance with recommendations outlined in **Section 4.4** of this report.
- All floor slab subgrade areas should be moisture conditioned and properly compacted to the recommendations in this report immediately prior to placement of the stone base and concrete.

4.6 Seismic Considerations

4.6.1 Seismic Design Parameters

According to the International Building Code (IBC) 2012 and ASCE 7-10, structures should be designed and constructed to withstand the effects of earthquakes and avoid failure during a maximum considered earthquake. The maximum considered earthquake (MCE) is a seismic event that has a 50-year exposure period with a 2% probability of exceedance. The 2500-year earthquake has a Moment Magnitude (Mw) of 7.3 and a Site Class Adjusted Peak Ground Acceleration (PGA_M) of 0.13g, as determined by data provided by the IBC 2012 and ASCE 7-10 Standards.

Based on the findings in the field exploration and our knowledge of the local geological formation in the project area, the site can be classified as Site Class D in accordance with International Building Code (IBC) 2012 and ASCE 7-10. The seismic design parameters obtained based on IBC2012 and ASCE 7-10 are summarized in table below. The design response spectrum curve, as presented in the appendix, was developed based on the S_{DS} and S_{D1} values according to IBC2012 and ASCE 7-10.

Table 4.8.1.1 Summary of Seismic Design Parameters

Site Location (Latitude. Longitude.)	Site Classification	S_s	S_1	F_a	F_v	S_{DS}	S_{D1}
31.1677° -81.5029°	D	0.163g	0.078g	1.600	2.400	0.174g	0.125g

- The IBC 2012 and ASCE 7-10 require a seismic Site Class determination based on the soils in the upper 100 feet. The current scope of work for this project included a field exploration to a maximum depth of 39 feet BGS. The seismic Site Class was determined based on the results of the field exploration and our knowledge of the geologic conditions of the site area.

5.0 GENERAL COMMENTS

Terracon should be consulted to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the project design and specifications. Terracon should also be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analyses and recommendations presented in this report are based upon the data obtained from the explorations performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between exploration locations, across the site, or may be caused due to the modifying effects of construction or weather. Bear in mind that the nature and extent of such variations may not become evident until construction has started or until construction activities have ceased.

If variations do appear, Terracon should be notified immediately so that further evaluation and supplemental recommendations can be provided. The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, and bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or hazardous conditions. If the owner is concerned about the potential for such contamination or pollution, please advise so that additional studies may be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project and site discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes, and then either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION

Image Courtesy of
Google Earth™

Project Manager:	YJ
Drawn by:	YJ
Checked by:	GL
Approved by:	GL

Project No.	ES185176
Scale:	N.T.S.
File Name:	
Date:	7/26/18

Terracon
Consulting Engineers & Scientists
2201 Rowland Avenue Savannah, Georgia 31404
Phone (912) 629 4000 Fax (912) 629 4001

SITE LOCATION MAP

Academy Creek WWTP in Brunswick
Brunswick, Georgia

Exhibit:

A-1

Image Courtesy of Google Earth™

NOTES:

ALL EXPLORATION LOCATIONS WERE LOCATED IN THE FIELD USING A GPS UNIT AND / OR SITE LANDMARKS. EXPLORATION LOCATIONS SHOULD BE CONSIDERED APPROXIMATE. DIAGRAM IS FOR GENERAL LOCATION ONLY; NOT INTENDED FOR CONSTRUCTION PURPOSES.

Project Manager:	YJ
Drawn by:	YJ
Checked by:	GL
Approved by:	GL

Project No.	ES185176
Scale:	N.T.S.
File Name:	
Date:	7/26/18

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Phone (912) 629 4000 Fax (912) 629 4001

EXPLORATION LOCATION PLAN

Academy Creek WWTP in Brunswick
Brunswick, Georgia

Exhibit:

A-2

Field Exploration Description

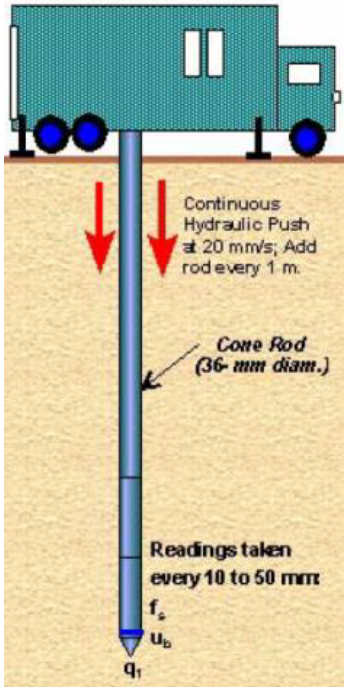
The locations of Cone Penetration Test (CPT) sounding and the hand auger borings were located in the field by Terracon using a hand-held GPS unit and in reference to the existing features. These test locations were discussed with the civil engineer prior to performing the field exploration. They are shown in the Exploration Location Plan in Exhibit A-2, should be considered approximate and are not intended for construction purposes.

Cone Penetration Testing

The CPT hydraulically pushes an instrumented cone through the soil while nearly continuous readings are recorded to a portable computer. The cone is equipped with electronic load cells to measure tip resistance and sleeve resistance and a pressure transducer to measure the generated ambient pore pressure. The face of the cone has an apex angle of 60° and an area of 10 cm^2. Digital data representing the tip resistance, friction resistance, pore water pressure, and probe inclination angle are recorded about every 2 centimeters while advancing through the ground at a rate between 1½ and 2½ centimeters per second. These measurements are correlated to various soil properties used for geotechnical design. No soil samples are gathered through this subsurface investigation technique.

CPT testing is conducted in general accordance with ASTM D5778 "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils."

Upon completion, the data collected were analyzed and processed by the project engineer.



Source: FHWA NHI-06-088

Hand Auger Borings

Hand auger borings were conducted in general accordance with ASTM D 1452-80, Standard Practice for Soil Investigation and Sampling by Auger Borings. In this test, hand auger borings are drilled by rotating and advancing a bucket auger to the desired depths while periodically removing the auger from the hole to clear and examine the auger cuttings. The soils were classified in accordance with ASTM D2488.

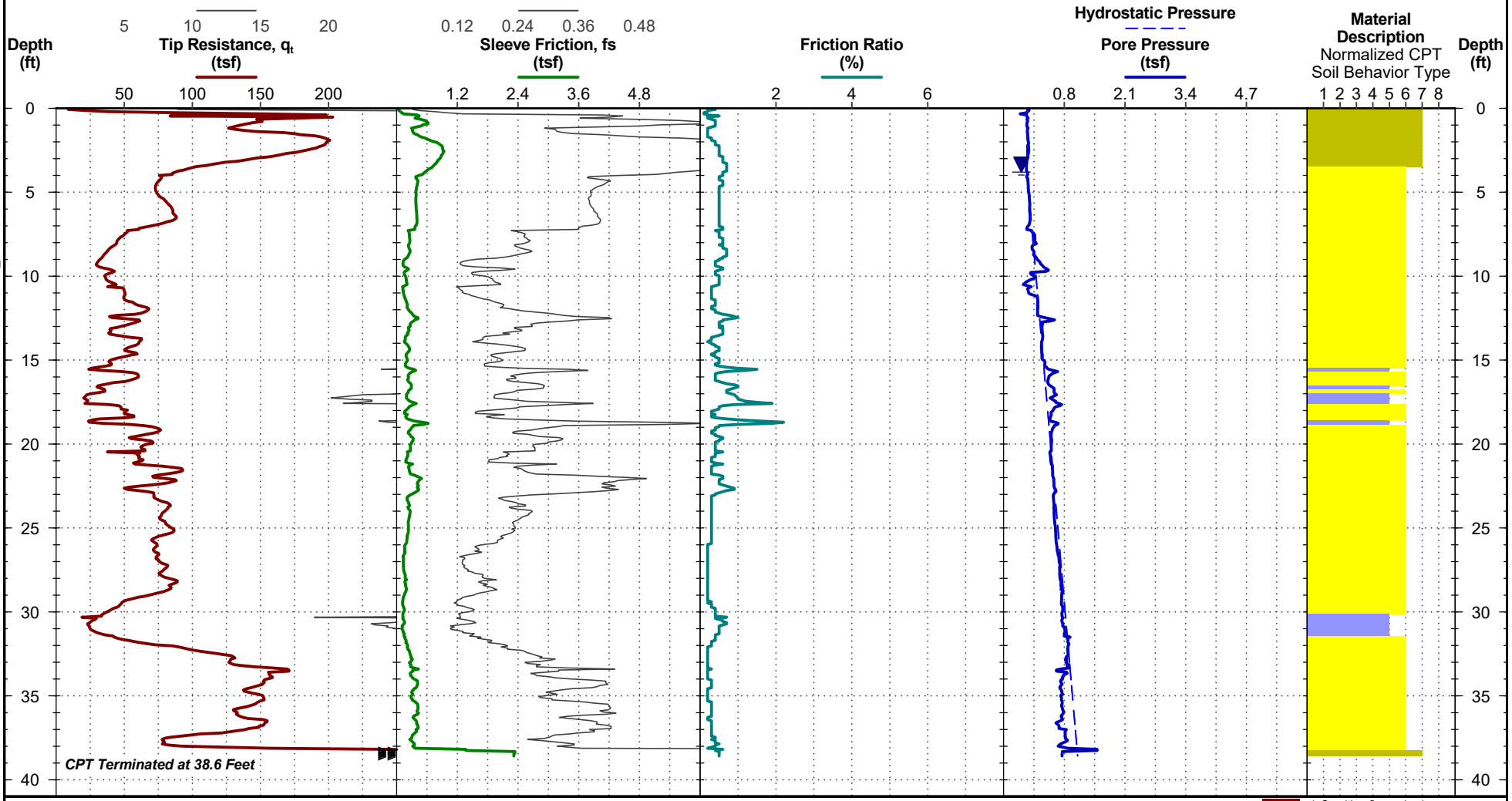
CPT LOG NO. C1

PROJECT: Academy Creek WWTP in Brunswick

CLIENT: Hussey Gay Bell
Savannah, GA

TEST LOCATION: See Exhibit A-2

SITE: Brunswick, GA



See Exhibit A-3 for description of field procedures.
See Appendix B for explanation of symbols and abbreviations.

CPT sensor calibration reports available upon request.

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

WATER LEVEL OBSERVATION
▼ 3.8 ft estimated water depth
(used in normalizations and correlations; see Appendix B)

Probe no. 4815

Terracon
2201 Rowland Avenue
Savannah, Georgia

CPT Started: 7/26/2018
CPT Completed: 7/26/2018
Rig: Pagani TG73-200
Operator: JB
Project No.: ES185176
Exhibit: A-5-1

Hand Auger Boring Log

Project Name: Academy Creek WWTP in Brunswick
Project No.: ES185185
Project Location: Brunswick, Georgia

Location	Depth (in)	Material Description	USCS Classification
HA1	0 to 6	Light brown silty SAND with grass and gravels (Topsoil)	SM
	6 to 48	Light brown fine SAND with silt	SP-SM
	48 to 60	Light brown silty SAND	SM
Groundwater @ 52" BGS. No mottling was encountered.			

Location	Depth (in)	Material Description	USCS Classification
HA2	0 to 6	Brown silty SAND with grass and gravels (Topsoil)	SM
	6 to 42	Light brown fine silty SAND	SM
	42 to 60	Gray SAND with silt	SP-SM
Groundwater @ 52" BGS. No mottling was encountered.			

Location	Depth (in)	Material Description	USCS Classification
HA3	0 to 6	Brown silty SAND with grass and gravels (Topsoil)	SM
	6 to 38	Light brown fine silty SAND	SM
	38 to 60	Brown and gray SAND with silt	SP-SM
NO groundwater was encountered. No mottling was encountered.			

Note BGS=Below ground surface

APPENDIX B
SUPPORTING INFORMATION

Exhibit B-1 Seismic Design Parameters

Exhibit B-2 General Notes

Exhibit B-3 Unified Soil Classification System

Exhibit B-4 CPT-based Soil Classification

Seismic Design Parameters Based on IBC2012 Code and ASCE 7-10 Standard

Terracon Project Name: Academy Creek WWTP in Brunswick

Terracon Project Number: ES185176

Site Location: Brunswick, Georgia

Latitude : 31.1677

Longitude : -81.5029

Site Class: D

Design Response Spectrum for the Site Class

S_s	0.163	S_1	0.078
F_a	1.600	F_v	2.400
S_{MS}	0.261	S_{M1}	0.187
S_{DS}	0.174	S_{D1}	0.125

	Period (sec)	Sa (g)
	0.000	0.070
T_0	0.144	0.174
	0.200	0.174
T_S	0.718	0.174
T	0.800	0.156
	0.900	0.139
	1.000	0.125
	1.100	0.113
	1.200	0.104
	1.300	0.096
	1.400	0.089
	1.500	0.083
	1.600	0.078
	1.700	0.073
	1.800	0.069
	1.900	0.066
	2.000	0.062

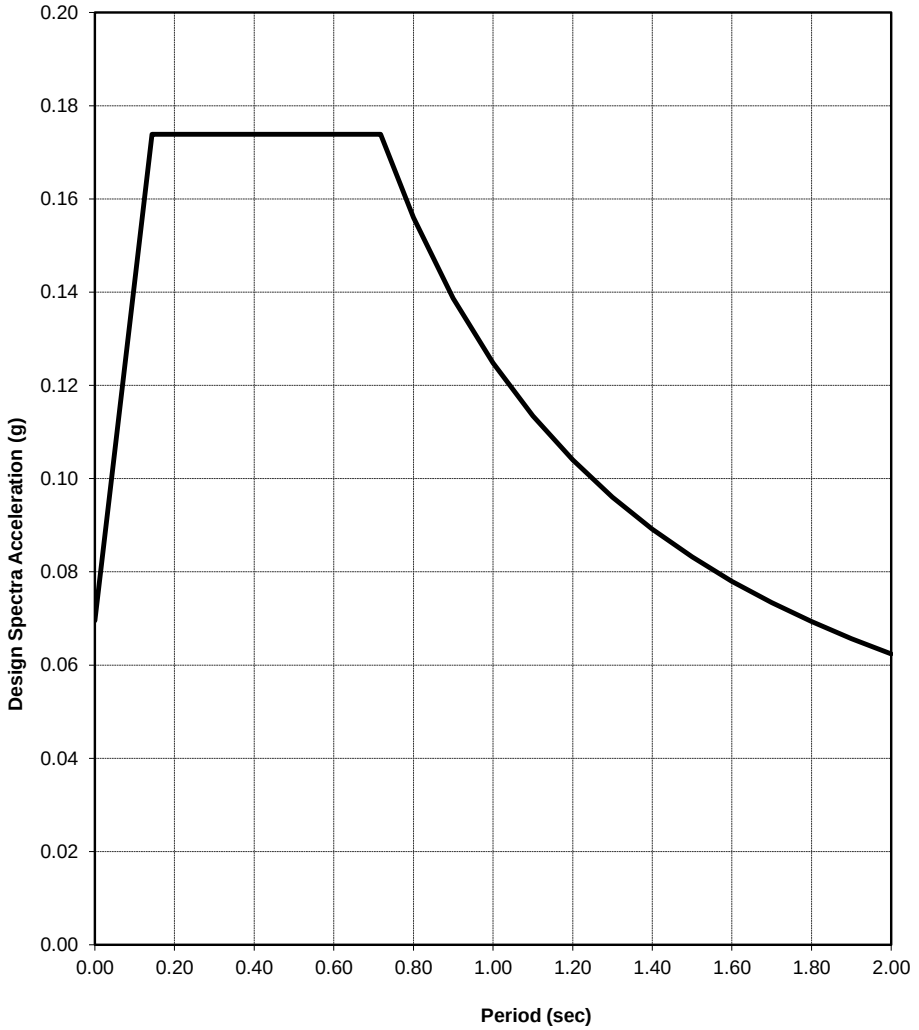
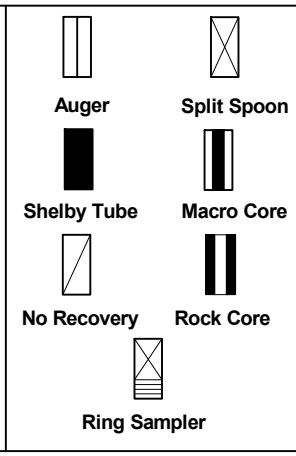


Exhibit B-1

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING



GROUNDWATER

Groundwater Initially Encountered

Groundwater Level After a Specified Period of Time

Static Groundwater Level After a Specified Period of Time

No Groundwater Observed

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	Hand Penetrometer
(T)	Torvane
(b/f)	Standard Penetration Test (blows per foot)
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.		CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Std. Penetration Resistance (blows per foot)**	**Descriptive Term (Consistency)**	**Undrained Shear Strength (kips per square foot)**	**Std. Penetration Resistance (blows per foot)**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium-Stiff	0.50 to 1.00	5 - 7
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 14
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	above 4.00	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Descriptive Term(s) of other constituents	Percent of Dry Weight
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]					Soil Classification	
					Group Symbol	Group Name[B]
Coarse Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]		GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]		GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH		GM	Silty gravel[F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]		SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3$[E]		SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH		SM	Silty sand[G,H,I]
			Fines Classify as CL or CH		SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]		CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]		ML	Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried	< 0.75	OL	Organic clay[K,L,M,N] / Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line		CH	Fat clay[K,L,M]
			PI plots below "A" line		MH	Elastic Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried	< 0.75	OH	Organic clay[K,L,M,P] / Organic silt[K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

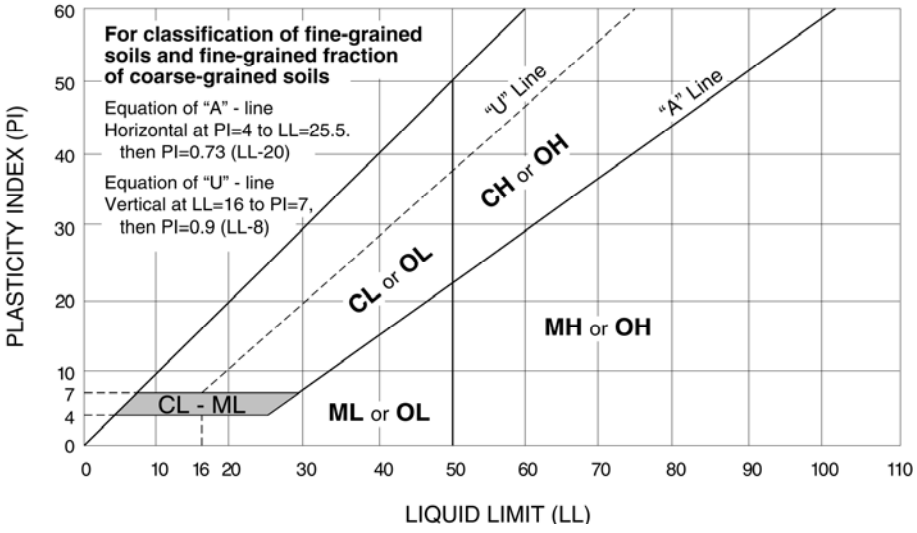
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



Terracon

Exhibit B-3

CPT GENERAL NOTES

DESCRIPTION OF MEASUREMENTS AND CALIBRATIONS

To be reported per ASTM D5778:

Uncorrected Tip Resistance, q_c
Measured force acting on the cone divided by the cone's projected area

Corrected Tip Resistance, q_t
Cone resistance corrected for porewater and net area ratio effects
$q_t = q_c + U2(1 - a)$

Where a is the net area ratio, a lab calibration of the cone typically between 0.70 and 0.85

Pore Pressure, U1/U2
Pore pressure generated during penetration
U1 - sensor on the face of the cone
U2 - sensor on the shoulder (more common)

Sleeve Friction, fs
Frictional force acting on the sleeve divided by its surface area

Normalized Friction Ratio, FR
The ratio as a percentage of fs to q_t, accounting for overburden pressure

To be reported per ASTM D7400, if collected:

Shear Wave Velocity, Vs
Measured in a Seismic CPT and provides direct measure of soil stiffness

DESCRIPTION OF GEOTECHNICAL CORRELATIONS

Normalized Tip Resistance, Q_t
$Q_t = (q_t - \sigma_{v0})/\sigma'_{v0}$

Over Consolidation Ratio, OCR
OCR (1) = $0.25(Q_t)^{1.25}$
OCR (2) = $0.33(Q_t)$

Undrained Shear Strength, Su
$Su = Q_t \times \sigma'_{v0}/N_{kt}$
N_{kt} is a geographical factor (shown on Su plot)

Sensitivy, St
$St = (q_t - \sigma_{v0}/N_{kt}) \times (1/fs)$

Effective Friction Angle, ϕ'
ϕ' (1) = $\tan^{-1}(0.373[\log(q_t/\sigma'_{v0}) + 0.29])$
ϕ' (2) = $17.6 + 11[\log(Q_t)]$

Unit Weight
$UW = (0.27[\log(FR)]+0.36[\log(q_t/atm)]+1.236) \times UW_{water}$
σ_{v0} is taken as the incremental sum of the unit weights

SPT N_{60}
$N_{60} = (q_t/atm) / 10^{(1.1268 - 0.2817Ic)}$

Soil Behavior Type Index, Ic
$Ic = [(3.47 - \log(Q_t))^2 + (\log(FR) + 1.22)^2]^{0.5}$

Small Strain Modulus, G_0
$G_0 = \rho Vs^2$

Elastic Modulus, Es (assumes $q/q_{ultimate}$ ~ 0.3, i.e. FS = 3)
Es (1) = $2.6\Psi G_0$
where $\Psi = 0.56 - 0.33\log Q_{t,clean\ sand}$
Es (2) = G_0
Es (3) = $0.015 \times 10^{(0.55Ic + 1.68)}(q_t - \sigma_{v0})$
Es (4) = $2.5q_t$

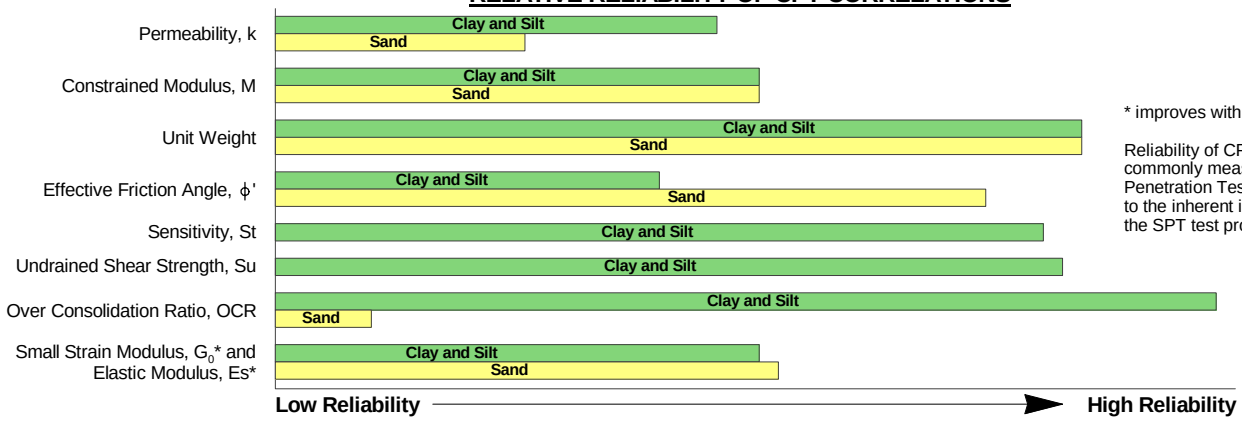
Constrained Modulus, M
$M = \alpha_M(q_t - \sigma_{v0})$
For Ic > 2.2 (fine-grained soils)
$\alpha_M = Q_t$ with maximum of 14
For Ic < 2.2 (coarse-grained soils)
$\alpha_M = 0.0188 \times 10^{(0.55Ic + 1.68)}$

Hydraulic Conductivity, k
For 1.0 < Ic < 3.27 $k = 10^{(0.952 - 3.04Ic)}$
For 3.27 < Ic < 4.0 $k = 10^{(-4.52 - 1.37Ic)}$

REPORTED PARAMETERS

CPT logs as provided, at a minimum, report the data as required by ASTM D5778 and ASTM D7400 (if applicable). This minimum data include tip resistance, sleeve resistance, and porewater pressure. Other correlated parameters may also be provided. These other correlated parameters are interpretations of the measured data based upon published and reliable references, but they do not necessarily represent the actual values that would be derived from direct testing to determine the various parameters. The following chart illustrates estimates of reliability associated with correlated parameters based upon the literature referenced below.

RELATIVE RELIABILITY OF CPT CORRELATIONS



* improves with seismic Vs measurements

Reliability of CPT-predicted N_{60} values as commonly measured by the Standard Penetration Test (SPT) is not provided due to the inherent inaccuracy associated with the SPT test procedure.

WATER LEVEL

The groundwater level at the CPT location is used to normalize the measurements for vertical overburden pressures and as a result influences the normalized soil behavior type classification and correlated soil parameters. The water level may either be "measured" or "estimated:"

Measured - Depth to water directly measured in the field

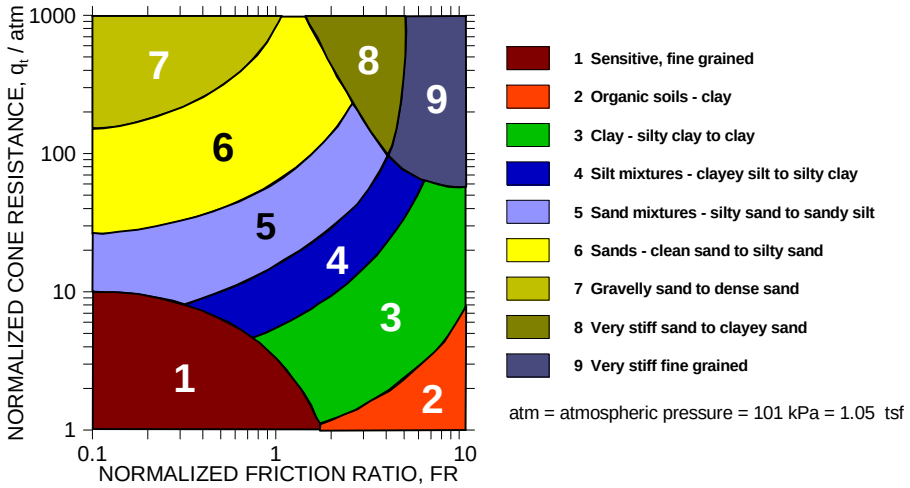
Estimated - Depth to water interpolated by the practitioner using pore pressure measurements in coarse grained soils and known site conditions

While groundwater levels displayed as "measured" more accurately represent site conditions at the time of testing than those "estimated," in either case the groundwater should be further defined prior to construction as groundwater level variations will occur over time.

CONE PENETRATION SOIL BEHAVIOR TYPE

The estimated stratigraphic profiles included in the CPT logs are based on relationships between corrected tip resistance (q_t), friction resistance (fs), and porewater pressure (U2). The normalized friction ratio (FR) is used to classify the soil behavior type.

Typically, silts and clays have high FR values and generate large excess penetration porewater pressures; sands have lower FRs and do not generate excess penetration porewater pressures. Negative pore pressure measurements are indicative of fissured fine-grained material. The adjacent graph (Robertson et al.) presents the soil behavior type correlation used for the logs. This normalized SBT chart, generally considered the most reliable, does not use pore pressure to determine SBT due to its lack of repeatability in onshore CPTs.



atm = atmospheric pressure = 101 kPa = 1.05 tsf

REFERENCES

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APPENDIX B

SCADA INTEGRATION QUOTE

Customer: Brunswick- Glynn JWSC
Project: Academy Creek WWTP Oxygen Piping Replacement
MR Quote #:Q18-5942, Rev. 0

October 18, 2018

Bill of Materials and Labor

Qty	Tag/Loop	Description	Price
		Basin No. 1	
1	AE-101	Dissolved Oxygen Sensor (M300 Part #30280777)	$2,059
1	AIT-101	Dissolved Oxygen Analyzer (InPro6800 (Part #52200965)	$2,539
		Manufacturer: Mettler-Toledo Process Analytics	
		Accessories:	
1	FSP-101	Field-mounted AC Power and Analog Surge Protector	$267
1		Optional Maintenance Kit (Part #52200024)	$718
2		Nameplates: Engraved Stainless Steel with Instrument Tag and Range (One for DO Sensor and one for transmitter)	$15
1	LCP-101	PLC-based Local Control Panel for Basin No. 1	$7,467
		Enclosure Size: 36" H x 30" W x 12" D	
		Enclosure Rating & Materials: NEMA 4X, #304 Stainless Steel	
		Solar Heat Protection: Powder-coated White Finish	
		PLC: Allen-Bradley MicroLogix 1400, 24 VDC with Memory Module	
		Available I/O: 20 DI, 14 DO, 4 AI, 2 AO	
		Wired I/O: 12 DI, 10 DO, 4 AI, 2 AO	
		AC Power Backup: Battery Backup with two (2) 9 AH Batteries	
		Communications #1: EnGenius Wireless Outdoor Ethernet Access Point (for Communicationas to SCADA System)	
		Communications #2: Fiber Optics Termination Panel for fiber cable to LCP-201 (Basin No. 2)	
		Operator Interface Terminal: Not Included	
		Heater & Thermostat	
		Bulkhead-mounted RF Surge Protector	
		3-point Door Latch, Padlockable	
		Analog Current Isolator, Phoenix Contact	
		AC Power Surge Protector	
		LED Light Fixture (mounts in top of panel)	
		GFI Utility Outlet	
		RTU Door Limit Switch	
		Digital I/O Surge Protection: Indicating Interposing Relays	
		Analog I/O Surge Protection: MR Kamikaze II Analog Surge Protector	
		Fiber Optics Cable from LCP-101 to LCP-201	
500	ft.	Corning 12-fiber 62.5/125 Indoor/Outdoor Riser-rated Fiber Optics Cable, OM1, Fiber Fiber connectors, terminations, and testing are included.	$1,029
		System Integration Services - Owner's Existing SCADA System	
		MR Systems will perform system integration services tn interface LCP-101 into the Owner's existing VTScada human-machine interface package. This includes the development of 3D graphics, trends, alarming and reports.	
		System Integration Services - Matheson Gas SCADA System	
		MR Systems will perform system integration services tn interface LCP-101 into the Owner's existing VTScada human-machine interface package. This includes the development of 3D graphics, trends, alarming and reports.	

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Qty	Tag/Loop	Description	Price
		Basin No. 2	
1	LCP-201	PLC-based Local Control Panel for Basin No. 2 Enclosure Size: 36" H x 30" W x 12" D Enclosure Rating & Materials: NEMA 4X, #304 Stainless Steel Solar Heat Protection: Powder-coated White Finish PLC: Allen-Bradley MicroLogix 1400, 24 VDC with Memory Module Available I/O: 20 DI, 14 DO, 4 AI, 2 AO Wired I/O: 12 DI, 10 DO, 4 AI, 2 AO AC Power Backup: Battery Backup with two (2) 9 AH Batteries Communications #1: EnGenius Wireless Outdoor Ethernet Access Point Communications #2: Fiber Optics Termination Panel for fiber cable from Basin No. 1 Communications #3: Fiber Optics Termination Panel for fiber cable to Basin No. 3 Operator Interface Terminal: Not Included Heater & Thermostat Bulkhead-mounted RF Surge Protector 3-point Door Latch, Padlockable Analog Current Isolator, Phoenix Contact AC Power Surge Protector LED Light Fixture (mounts in top of panel) GFI Utility Outlet RTU Door Limit Switch Digital I/O Surge Protection: Indicating Interposing Relays Analog I/O Surge Protection: MR Kamikaze II Analog Surge Protector	$7,818
		<u>Fiber Optics Cable from LCP-201 to LCP-301</u>	
300	ft.	Corning 12-fiber 62.5/125 Indoor/Outdoor Riser-rated Fiber Optics Cable, OM1, Fiber Fiber connectors, terminations, and testing are included.	$617
		<u>System Integration Services - Owner's Existing SCADA System</u> MR Systems will perform system integration services tn interface LCP-101 into the Owner's existing VTScada human-machine interface package. This includes the development of 3D graphics, trends, alarming and reports.	
1	LCP-301	PLC-based Local Control Panel for Basin No. 3 Enclosure Size: 36" H x 30" W x 12" D Enclosure Rating & Materials: NEMA 4X, #304 Stainless Steel Solar Heat Protection: Powder-coated White Finish PLC: Allen-Bradley MicroLogix 1400, 24 VDC with Memory Module Available I/O: 20 DI, 14 DO, 4 AI, 2 AO Wired I/O: 12 DI, 10 DO, 4 AI, 2 AO AC Power Backup: Battery Backup with two (2) 9 AH Batteries Communications #1: EnGenius Wireless Outdoor Ethernet Access Point Communications #2: Fiber Optics Termination Panel for Connection to LCP-21- on Basin No. 2 Operator Interface Terminal: Not Included Heater & Thermostat Bulkhead-mounted RF Surge Protector 3-point Door Latch, Padlockable Analog Current Isolator, Phoenix Contact AC Power Surge Protector LED Light Fixture (mounts in top of panel) GFI Utility Outlet	$7,467

Bill of Materials and Labor

Qty	Tag/Loop	Description	Price
		RTU Door Limit Switch Digital I/O Surge Protection: Indicating Interposing Relays Analog I/O Surge Protection: MR Kamikaze II Analog Surge Protector	
1		Fiber Optics Cable Terminations and Testing for LCP-301 Corning 12-fiber 62.5/125 Indoor/Outdoor Riser-rated Fiber Optics Cable, OM1, Fiber Fiber connectors, terminations, and testing are included.	$317
		System Integration Services - Owner's Existing SCADA System MR Systems will perform system integration services tn interface LCP-101 into the Owner's existing VTScada human-machine interface package. This includes the development of 3D graphics, trends, alarming and reports.	
		System Integration Services - Matheson Gas SCADA System MR Systems will perform system integration services tn interface LCP-101 into the Owner's existing VTScada human-machine interface package. This includes the development of 3D graphics, trends, alarming and reports.	
		Project Labor	
One Lot		**Project Engineering, Electrical Design, Mechanical Design, Drafting & Administrative Labor (including Travel & Living expenses)** as required to perform final system design and to prepare Submittals and Record Drawings as required by the Contract Documents.	$32,592
One Lot		**HMI Software Applications Development & Graphics Design Labor** (including Travel & Living expenses) as required by the Contract Documents.	$22,766
One Lot		**PLC Control Strategy Design & Programming Labor** (including Travel & Living expenses) to be performed as required by the Contract Documents.	$18,720
One Lot		**Field Service** (including Travel & Living expenses) to provide installation supervision calibrations, startup, training, etc. as required by the Contract Documents.	$10,828
N/A		**Electrical Installation or Terminations** (including Travel & Living expenses) to provide installation of conduit, wire, etc. as required by the Contract Documents.	
1 Year		**Onsite Comprehensive Warranty** (including Travel & Living expenses)	$744
One Lot		**Freight**	$1,011
		Subtotal of Labor and Materials:	**$116,974**
		State Sales Tax - NOT INCLUDED:	**$0**
		Total Project Cost:	**$116,974**

Bill of Materials and Labor

Qty	Tag/Loop	Description	Price

General Notes:

A *** Sales Representation ***
Mr. Scott Cockrell of Eco-Tech, Inc. in Canton, GA, is our local Sales Representative. Scott may be reached at 678-880-1203 (Office) or 678-251-6178 (Cell).

B *** Technical Questions ***
For technical or scope of supply questions contact Tom Hopkins of MR Systems, Inc. Tom may be reached at 678-325-2829 (Office) or 770-519-1299 (Cell).

C *** Installation of Conduit and Wire ***
This quotation **DOES NOT INCLUDE** the supply or physical installation of conduit or wire unless specifically noted above.

D *** Equipment Installation ***
This quotation **DOES NOT INCLUDE** physical installation of field instruments, pipe, tubing, fittings, isolation valves, instrument stands, instrument mounts, control panels, antennas, masts, wooden poles, or other devices or other equipment unless specifically noted above.

E *** Wiring Terminations ***
This quotation **INCLUDES** the termination of field wiring to field instruments, control panels, RTU panels, and/or other devices supplied under this scope of supply. Terminations of wiring to equipment

F *** Fiber Optics Cable ***
This quotation **INCLUDES** the supply of Fiber Optic Cable as specifically identified above. The Contractor shall be responsible for conduit and installation of the Fiber Optic Cable supplied by M/R

G *** Fiber Optic Cable Termination ***
This quotation **INCLUDES** the terminations and testing of the fiber optics cable.

H *** Coaxial Cable Installation ***
This quotation **DOES NOT INCLUDE** the physical installation of coaxial cable or other related components.

I *** Installation of Communications Towers or Poles ***
This quotation **DOES NOT INCLUDE** the supply or physical installation of Communication Towers or Poles.

J *** Contractor License Information ***
MR Systems' Georgia Electrical Contractors License Number is EN214384 (Non-Restricted).

K *This line has been intentionally left blank.*

L *** Terms and Conditions ***
MR Systems, Inc. General Terms & Conditions of Sale apply to any order resulting from this quotation. Please refer to the link provided below for a copy of our General Terms and Conditions of Sale.

https://www.mrsystems.com/sellersterms/

Customer: Brunswick- Glynn JWSC
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Bill of Materials and Labor

Qty	Tag/Loop	Description	Price

Revision Notes:

Rev. 0	First Issue - 2018-10-18 - THH