PROJECT MANUAL FOR
YORK COUNTY– NEW HERITAGE GRAVITY SEWER – PHASE 2

Date: November 2020

OWNER:

YORK COUNTY, ENGINEERING DEPARTMENT
PO BOX 148
6 SOUTH CONGRESS STREET
YORK, SOUTH SC 29745
(803) 684-8571
(803) 684-8596 FAX

Engineer:

Kyle T. Crager, P.E.
C/O Michael Baker International
700 Huger Street
Columbia, SC 29201
803-231-3849

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York County Technical Specifications

Additional Information

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00 10 25 MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 SCOPE

A. This Section includes specification for the measurement and payment of the various elements of the Work; with provisions applicable to lump sum prices, unit prices, and allowances, if applicable.

B. The Contractor shall receive no payment for any portion of the work until it is installed. The only exception to this is payment for stored materials on site if the Contract provides for the payment of stored materials. Partial payment may be requested for items partially installed.

1.2 LUMP SUM ITEMS

A. Lump Sum measurement will be for the entire item, unit of work, structure, or combination thereof, as specified and as indicated in the Bid Form. Measurement and payment for all bid items indicated as Lump Sums shall include the cost of all labor, materials and equipment necessary to furnish, install, clean, test, and place each bid item into operation; including permitting, general conditions, overhead and profit.

B. In order for the Contractor to request progress payments against Lump Sum items, Contractor shall provide a disaggregation or breakdown in sufficient measurable detail that is acceptable to the Owner/Engineer.

C. Payment

1. Payment will be made at the lump sum price proportional to the completion percentages approved by the Owner/Engineer.

1.3 UNIT PRICE ITEMS

A. Quantity and measurement estimates stated in the Bid Form are estimates for bidding purposes only. Actual payments shall be based on actual quantities installed, in-place, as measured and/or verified by the Owner/Engineer.

B. Unless otherwise provided in the General Conditions, the bid unit prices shall be in effect throughout the contract duration, regardless of variances between the estimated quantities and the actual installed quantities.

C. The Contractor shall make no claim, nor receive any compensation, for anticipated profits, loss of profit, damages, or any extra payment due to any difference between the amounts of work actually completed, or materials or equipment furnished, and the estimated quantities

D. Unless otherwise approved by the Owner/Engineer, any unit quantities exceeded may not be invoiced until the estimated quantity is increased by contract change order.

E. Contractor shall assist Owner/Engineer by providing necessary equipment, workers, and survey personnel as required to measure quantities.

F. Measured quantities shall be rounded to the nearest whole integer, unless the value of the unit price exceeds $100, in which case measured quantities shall be rounded to the nearest half unit.

G. Measurement

1. Measurement for progress payment shall be made by, or approved by, the Owner/Engineer based on the estimated effective quantity installed. The effective quantity installed represents the actual units or quantities installed, adjusted for incomplete elements or components.

2. Unless otherwise provided for in the Bid Form, unit price items are all-inclusive of all related work, direct and indirect, to provide a complete and functional item. For example, underground water pipe installation would include pipe, trenching, shoring, dewatering, bedding, installation, backfill, testing, flushing, disinfection, and commissioning; including all labor, materials and equipment necessary to furnish, install, clean, test, and place into operation; including permitting, general conditions, overhead and profit.

3. The final measurement shall be based on actual quantities, jointly measured by Contractor and Owner/Engineer, complete, fully, tested and placed into service.

H. Payment

1. Progress payments shall be in accordance with the contract documents based on estimated effective quantities installed, paid at the bid unit price.

2. The final payment shall be based on actual quantities, fully installed, tested and placed into service, paid at the bid unit price.

PART 2 - BID ITEMS

2.1 GENERAL CONSTRUCTION (PART A)

A. Mobilization/Demobilization and Related Expenses (Items 1 & 2)

1. Method of Measurement: Mobilization/Demobilization and Related Expenses shall be a lump sum. This Item is meant for non-recurrent and general expenses related to establishment and close out of the Work. Construction staking shall be a separate line item (Item 2) measured as lump sum.

2. Basis of Payment: Mobilization/Demobilization and Related Expenses shall be paid for on a lump sum basis. This price and payment shall be full compensation for all costs associated with initiating and completing the Contract, exclusive of the cost of materials. Payment shall include compensation for all expenses related to moving equipment onto and away from the jobsite, performance and payment bonds and other securities required, insurances, necessary permits and fees, posting required notices, project sign, Engineer's and Contractor's field office installation including hooking up initial utilities, site preparation, removal of field offices and temporary utilities and roadways, removal of signs, submittal of all record documents, and the general costs associated with initiating the Work on site to assure that it is proceeding in a continuous manner. No additional payment shall be made for interim mobilization or demobilization associated with shutdown of Work by Contractor or Owner.

3. Basis of Payment: Mobilization, demobilization and related expenses shall also include all Contract general requirements including but not limited to full compensation for furnishing construction schedules including baseline and periodic updates; providing and maintaining the quality control plan; providing the project superintendent, project manager and project Engineer (if applicable) full-time; on-site field office and Engineer's field office; recurring expenses following initial mobilization; providing and maintaining dumpsters, security, fencing, and dust control; monthly utility charges; construction photographs; ongoing maintenance of Record Drawings; equipment maintenance; surveying, survey controls, and project closeout costs; and all temporary facilities, labor, equipment and materials required for or incidental to the Work for which separate payment is not provided under other Bid Items.

    a. Payments shall be made in three equal installments. The first two (2) installments shall coincide with the first two (2) monthly payment requisitions, contingent upon Owner acceptance of the baseline construction schedule and demonstration of satisfactory construction progress, as determined by the Owner/Engineer. The third installment shall be made when the Contractor has completed all construction activity, including final cleanup, punch list Items, and satisfactory submission of Record Drawings.

    b. Insurance and bond premiums and permit fees shall be paid in full at the time the cost is incurred.

    c. The cost for this Item shall not exceed five percent (5%) of the Total Bid Price, excluding this Item itself.

B. Clearing and Grubbing (Item 3)

1. Method of Measurement: Clearing and Grubbing shall be measured as the number of acres for the Work completed as shown in the drawings.

2. Basis of Payment: Payment for Clearing and Grubbing shall be based upon an acreage basis for Work completed as shown. Payment shall be made for full compensation of all labor, equipment and materials required for removing and disposing of all trees, stumps, bushes, shrubs, vegetation, logs, rubbish, and other objectionable material and all other Items necessary to complete the Work as shown and specified but not included for payment under other Bid Items.

C. Vibration Monitoring (Item 5)

1. Method of Measurement: Vibration Monitoring per SCDOT requirements shall be a lump sum.

2. Basis of Payment: Payment for Vibration Monitoring shall be a lump sum. Refer to the specifications and drawings.

D. Grassing (Part A, Item 6)

1. Method of Measurement: Grassing shall be measured in acres.

2. Basis of Payment: Payment for Grassing shall be a unit price per acreage.

E. Landscaping/Trail Replacement Allowance (Item 7)

1. Method of Measurement: Landscaping/Trail Replacement Allowance shall be a lump sum. This item includes repair to all walking trails, wooden bridges and landscaping on Line A near Station 16+25, and repair or replacement to sidewalks and paved cart paths on Line C near Station 1+00 and from approximately Station 3+25 to Station 4+00. The work shall include removal of all demolished debris and replacement, complete, in service, with like materials.

2. Basis of Payment: Landscaping/Trail Replacement shall be paid for on a lump sum basis.

F. Miscellaneous Erosion and Sedimentation Control (Item 4, 8, 9, & 10)

1. Method of Measurement: Miscellaneous Erosion and Sedimentation Control shall be lump sum. This Item shall include costs related to erosion and sedimentation control that may be required over the term of the Work for the entire Contract. Silt fence shall be a separate line Item (Item 4) measured in linear feet and paid for as a unit price per linear foot. Turf reinforcement mats for bank stabilization is a separate line item (Item 10) measured in square yards and paid for as a unit price per square yard. Rip rap is a separate line item (Item 9) measured in tons and paid for as a unit price per ton.

2. Basis of Payment: Payment for Miscellaneous Erosion and Sedimentation Control shall be full compensation for all labor, equipment, materials and incidentals necessary to control erosion, including but not limited to, furnishing, installing, maintaining, and removal of the erosion and sedimentation control devices, stone for filtration devices, filter boxes, straw mulch, erosion control blankets, and all else incidental thereto for which separate payment is not provided under other Bid Items.

G. Sewer Main and Manhole Testing (Item 11)

1. Method of Measurement: Sewer Main and Manhole Testing shall be measured as a lump sum.

2. Basis of Payment: Sewer Main and Manhole Testing shall be paid for on a lump sum basis.

H. As-built Survey Drawings (Item 12)

1. Method of Measurement: As-built Survey Drawings shall be measured as a lump sum.

2. Basis of Payment: As-built Survey Drawings shall be paid for on a lump sum basis.

2.2 DUCTILE IRON GRAVITY SEWER PIPE, APPURTENANCES, AND MANHOLES (PART B)

A. Ductile Iron Sewer Pipe Outside of Pavement (Items 13 through 17 and Items 29 through 37)

1. Method of Measurement

a. Sewer pipe of the type and size specified in the Bid Form will be measured in place on a linear foot basis. Measurement for payment does not signify that the sewer line is accepted.

b. Measurement of sewer pipe for length will be along the horizontal centerline of the pipe with no deduction for fittings and will be to the center of manholes. Measurement for depth will be from the original ground surface, as determined by the Owner/Engineer to the invert of the pipe. Measurement will be to the nearest whole foot.

2. Basis of Payment

a. Payment for furnishing and installing sewer pipe will be made for the respective quantities as determined above at the unit price bid. This price and payment shall be full compensation for dewatering and removing unsuitable solids, backfilling and compaction as detailed and specified, restoring the trench surface to grade, furnishing gravel bedding and encasement, furnishing, laying, jointing, and all incidental work, including driving and removing sheeting and bracing and all else incidental thereto, for which separate payment is not provided under other items in the Bid Form.

b. Payment will be made for pipe only when it is installed in the ground and no so-called proportional payment shall be made for pipe on the site but not yet installed

B. Gravity Jack and Bore (Item 18 and 38)

1. Method of Measurement: Gravity Jack and Bore will be measured in linear foot.

2. Basis of payment: Payment for Gravity Jack and Bore compensation will include excavation of launch and receive pits, dewatering, the steel casing pipe, spacers per specifications, ductile iron pipe lined with ceramic epoxy or bonded polyethylene per specifications, restrained joints and spacers through casings, water tight casing seals, air vents, completed in-place, and all incidental work, including driving and removing sheeting and bracing and all else incidental thereto, for which separate payment is not provided under other items in the Bid Form.

C. Precast Concrete Manholes (Items 19, 20, 26, 28, 39, 40, 43, and 46)

1. Method of Measurement: Precast Concrete manholes will be measured in vertical feet from the invert of the lowest pipe of the manhole to the top of the manhole frame. . Frame with watertight cover shall be a separate line item (Item 26 and Item 43) measured as an individual quantity and paid for as a unit price per each quantity. Manhole vents shall be a separate line item (Item 28 and Item 46) measured as an individual quantity and paid for as a unit price per each quantity.

2. Basis of Payment: Payment for furnishing and installing concrete manholes complete in place will be made for the quantity as above determined at the price per vertical foot bid, which price and payment shall be full compensation for all excavation (except rock and boulder), backfilling, for furnishing and installing precast sections and bases, platforms, damproofing, screened gravel subbase, all forms, reinforcing, concrete and masonry materials, top slabs for shallow manholes if used, and all else incidental thereto, for which separate payment is not provided under other items in the Bid Form.

D. Tie-In to Existing Manholes and Doghouse-Type Manholes (Items 23-26 and 41-42)

1. Method of Measurement: Tie-ins to existing manholes and installation of doghouse-type manholes will be measured as a lump sum per item.

2. Basis of Payment: Payment for tie-ins to existing manholes shall include the cost of plugging and bypass pumping, cored and sealed connections to the existing manhole per details and specifications, complete, and in service as a lump sum per connection. Payment for a doghouse-type manhole shall include all excavation (except rock and boulder), backfilling, for furnishing and installing cast-in-place concrete base, precast riser sections, platforms, damproofing, screened gravel subbase, all forms, reinforcing, concrete and masonry materials, top slabs for shallow manholes if used, cost of bypass pumping, tapping the existing sewer line, plugging and abandonment of the existing downstream line, and all else incidental thereto, for which separate payment is not provided under other items in the Bid Form, paid for each location.

E. Creek Crossings (Items 21 and 22)

1. Method of Measurement: Creek Crossings will be measured as a lump sum. Payment for anti-seep collars shall be per unit.

2. Basis of Payment: Payment for Creek Crossings shall be paid for on a lump sum basis and shall include concrete encasement where specified, performing the work and diverting the creek to install the new sewer, restoring all creek features to pre-construction elevations, installing all soil erosion control devices, and all else required to complete the creek crossings. Anti-seep collars shall include excavation, dewatering, concrete placement and compacted backfill to original grades.

F. Abandonment of Existing Utilities (Item 27 and Item 44)

1. Method of Measurement: Abandonment of Existing Utilities shall use Flowable Fill measured in cubic yards for each utility line abandoned in place.

2. Basis of Payment: Abandonment of Existing Utilities shall be full compensation for furnishing all the necessary labor, equipment, tools and materials required for abandonment of utilities as shown of the Contract Drawings, cutting pipelines as required, excavation and backfill, removal and disposal of pipe contents, permanent plugging of the pipe, furnishing and placement of flowable fill into the abandoned pipe, and all incidental Work required to complete the Work as shown and specified but not included for payment under other Bid Items.

G. Abandonment of Existing Manholes (Item 45)

1. Method of Measurement: Abandonment of Existing Manholes shall be paid for as an individual quantity

2. Basis of Payment: Abandonment of Existing Manholes shall be full compensation for furnishing all the necessary labor, equipment, tools, and materials required for abandonment of manholes as shown of the Contract Drawings.

2.3 MISCELLANEOUS CONTINGENCIES (PART C)

A. Removal and Disposal of Unsuitable Soils (Item 47)

1. Method of Measurement: Removal and Disposal of Unsuitable Soils shall be measured in cubic yards.

2. Basis of Payment: Removal and Disposal of Unsuitable Soils shall be paid for on a unit price per cubic yards, hauled to a landfill licensed to accept the materials.

B. Trench Rock Excavation (Item 48)

1. Method of Measurement: Trench Rock Excavation shall be measured in cubic yards.

2. Basis of Payment: Trench Rock Excavation shall be paid for on a unit price per cubic yards, including hauling from the site.

C. Additional Stone Bedding (Item 49)

1. Method of Measurement: Additional Stone Bedding shall be measured in tons.

2. Basis of Payment: Additional Stone Bedding shall be paid for on a unit price per ton, including delivery, hauling, and storage.

D. Asphalt Surface (Item 50)

1. Method of Measurement: Replacement of Asphalt Pavement shall be measured on a per square yard basis as actually placed.

2. Payment for bituminous concrete pavement, complete in place and approved by the Owner/Engineer, will be made for the quantity determined above at the price bid. This price and payment shall be full compensation for cleaning and priming the edges of the existing pavement; furnishing and installing aggregate base and preparing the surface for pavement; furnishing and placing tack coat; furnishing, placing and maintaining any required initial pavement; furnishing and maintaining final pavement to the dimensions shown on the Drawings; compaction of all pavement; furnishing and installing all pavement markings; maintaining and repairing damaged pavement throughout the warranty period; and all else incidental thereto for which payment is not provided under other items in the Bid Form.

   a. If the thickness of pavement ordered placed by the Owner/Engineer is greater than that specified, payment will be prorated on the basis of the thickness of material actually ordered placed. No payment will be made for

any additional pavement not specifically ordered in writing by the Owner/Engineer.

b. No additional payment will be made for leveling course if required.

E. Macadam Base Course (Item 51)

1. Method of Measurement: Aggregate Base Course shall be measured in tons.

2. Basis of Payment: Aggregate Base Course shall be paid for on a unit price per ton. The aggregate shall be 6” Macadam Base Course per SCDOT Section 305 and the unit price cost shall include delivery, hauling, storage, installation, compaction, and testing.

PART 3 - EXECUTION – NOT USED

END OF SECTION

00 41 00 BID FORM

Submitted: _____, 20____

York County Government
6 South Congress Street
York, SC 29745

Sir or Madam:

The undersigned, as Bidder, hereby declares that the only person or persons interested in the Bid, as principal or principals, is or are named herein and that no other person than herein mentioned has any interest in the Bid of the Contract to which the work pertains; that this Bid is made without connection or arrangement with any other person, company, or parties making a bid or proposal and that the Bid is in all respects fair and made in good faith without collusion or fraud.

The Bidder further declares that he has examined the site of the Work and, through personal knowledge and experience and/or subsurface investigations, has fully satisfied himself in regard to all conditions pertaining to such site and he assumes full responsibility therefore; that he has examined the Drawings and Specifications for the Work and from his own experience or from professional advice that the Drawings and Specifications are sufficient for the Work to be done; that he has examined the other Contract Documents and all addenda relating thereto, and that he has satisfied himself fully, relative to all matters and conditions with respect to the Work to which this Bid pertains.

The Bidder proposes and agrees, if this Proposal is accepted, to contract with York County Government (OWNER) in the form of contract specified, to furnish all necessary materials, equipment, machinery, tools, apparatus, transportation and labor and to perform all work necessary to complete the Work specified in the Bid and other Contract Documents.

The Bidder further proposes and agrees to commence substantial work on this project within 30 calendar days of a Notice to Proceed and agrees that the Work will be completed and ready for final payment **within 300 calendar days** of the Notice to Proceed.

The Bidder further agrees that the deductions for liquidated damages, as stated in the Agreement and General Conditions, constitute fixed, agreed, and liquidated damages to reimburse the OWNER for additional costs to the OWNER resulting from the Work not being completed within the time limit stated in the Contract Form. The liquidated damages shall be $500.00 for each consecutive calendar day thereafter.

The Bidder further agrees to execute a Contract and furnish satisfactory Performance and Indemnity and Payment Bonds, and the required Certificates of Insurance, within ten consecutive calendar days after receipt of Notice of Award of the Contract, and the undersigned agrees that in case of failure on his part to execute the said Contract and Performance and Indemnity and Payment Bonds within the ten (10) consecutive calendar days after the award of the Contract, the Bid guarantee accompanying his Bid and the money payable thereon shall be paid to the OWNER as liquidation of damages sustained by the OWNER; otherwise, the Bid guarantee shall be returned to the undersigned after the Contract is signed and the Performance and Indemnity and Payment Bonds are filed.

Acknowledgement is hereby made of the following Addenda received since issuance of the Bid Documents:

Addendum No._____ Dated:_____

Addendum No._____ Dated:_____

Addendum No._____ Dated:_____

Note:

All work performed by the Contractor as essential to the completion of the intent of the Contract Documents shall be paid in accordance with the Bid Schedule. No direct payment will be made for work performed which is not shown as a separate Bid Item. The undersigned proposes the following unit prices to be utilized on the Work or Extra Work should modifications or variations incorporate these items of work into the Work.

~~**Base Bid List**~~

~~**(The base bid of this bid document shall include all costs in a Lump Sum Amount for the items**~~

~~Insert Bid for~~

_____

~~**TOTAL BASE BID (SINGLE-PRIME) $ _____**~~

~~**Total (use words) _____**~~

INSERT UNIT PRICE BID FORM

Attached hereto is a cashier's check on the _____
_____Bank of _____
_____or Bid Bond for the sum
___ _____Dollars (_____), made payable
to_____ (Owner).

_____ L.S.
(Name of Bidder) (Affix Seal)

_____ L.S.
(Signature of Officer)

_____ L.S.
(Title of Officer)

Address:

P.O. Box_____ Street:_____

City:_____ State, Zip Code:_____

Telephone:_____ Fax:_____

Federal ID#:_____

Email address: _____

Contractor License type: _____ Contractor License number: _____

License status: _____ Expiration: _____

Classification: _____

The full names and residences of persons and firms interested in the foregoing bid, as principals, are as follows:

_____

_____

Name of the executive who will give personal attention to the work:

_____

_____

Attach list of subcontractors as required by Article 13.4 of Information to Bidders.

END OF SECTION

	Description of Work	Unit	Measure	Unit Cost	Total Cost
A.	**General Construction**				
1	Mobilization/Demobilization	1	LS		
2	Construction Staking	1	LS		
3	Clearing/Grubbing	10	AC		
4	Silt Fence	14,000	LF		
5	Vibration Monitoring per SCDOT Requirements - Refer to Specifications and Drawings	1	LS		
6	Grassing	10	AC		
7	Landscaping/Trail replacement allowance	1	LS		
8	Miscellaneous Sediment & Erosion Control (including rock ditch checks, silt fence rock outlets, ditch crossings)	1	LS		
9	Rip Rap	150	TN		
10	Turf Reinforcement Mats for bank stabilization	500	SY		
11	Sewer Main & Manhole Testing	1	LS		
12	As-built Survey Drawings	1	LS		
				General Construction Subtotal	
B.	**Sewer Construction**				
	Gravity Sewer - Line A (Pipe depth measured to ground surface)				
13	24-inch CL-250 DIP 0-12' deep - Lined with ceramic epoxy or bonded polyethylene including any necessary dewatering & removal of unsuitables, restrained joints and spacers through casings, complete, in-place	550	LF		
14	24-inch CL-250 DIP 12.1-16' deep - Lined with ceramic epoxy or bonded polyethylene including any necessary dewatering & removal of unsuitables, restrained joints and spacers through casings, complete, in-place	1,140	LF		
15	24-inch CL-250 DIP 16.1-20' deep - Lined with ceramic epoxy or bonded polyethylene including any necessary dewatering & removal of unsuitables, restrained joints and spacers through casings, complete, in-place	2,220	LF		
16	24-inch CL-350 DIP 20.1-24' deep - Lined with ceramic epoxy or bonded polyethylene including any necessary dewatering & removal of unsuitables, restrained joints and spacers through casings, complete, in-place	420	LF		
17	8-inch CL-350 DIP 16.1-20' deep - Lined with ceramic epoxy or bonded polyethylene including any necessary dewatering & removal of unsuitables, restrained joints and spacers through casings, complete, in-place	12	LF		
18	48-inch Gravity Jack & Bore including 48" steel casing, minimum 35 KIPS. Including spacers per specificiation and 24-inch CL-200 DIP - Lined with ceramic epoxy or bonded polyethylene, restrained joints and spacers through casings, water tight casing seals, complete, in-place	655	LF		
19	Standard 5' ϕ precast concrete manholes - including any necessary dewatering & removal of unsuitables	310	VF		
20	Standard 6' ϕ precast concrete manholes - including any necessary dewatering & removal of unsuitables	44	VF		

21	Installation of Creek Crossings, as specified, including concrete encasement where specified, performing the work including diverting the creek to install the new sewer, restoring all creek features to pre-construction elevations, installing all soil erosion control devices, and all else required to complete the creek crossings (except rock excavation which is paid separately).	1	LS		
22	Anti-Seep Collar, concrete, including excavation, dewatering, installation, and backfill, complete, per details	4	EA		
23	Coring and tie in to existing manhole at STA 0+00 with 24-inch gravity line as shown on C2.1 to include cost of connections, bypass pumping, complete, in-service	1	LS		
24	Coring and tie in to existing manhole at STA 4+90 with 8-inch gravity line as shown on C2.1 to include cost of connections, bypass pumping, complete, in-service	1	LS		
25	Coring and tie in to existing manhole at STA 50+04 with 24-inch gravity line as shown on C2.4 to include cost of connections, bypass pumping, complete, in-service	1	LS		
26	Frame with Watertight Cover	15	EA		
27	Abandonment of approximately 500 LF of existing 8" gravity sewer (fill with flowable fill per specifications)	7	CY		
28	Manhole Vents to 2' above the 100-year floodplain - Per drawings, complete, in service.	4	EA		
	Gravity Sewer - Line B, Line C, and Line E (Pipe depth measured to ground surface)				
29	24-inch CL-250 DIP 0-12' deep - Lined with ceramic epoxy or bonded polyethylene including any necessary dewatering & removal of unsuitables, restrained joints and spacers through casings, complete, in-place	620	LF		
30	24-inch CL-250 DIP 12.1-16' deep - Lined with ceramic epoxy or bonded polyethylene including any necessary dewatering & removal of unsuitables, restrained joints and spacers through casings, complete, in-place	395	LF		
31	24-inch CL-250 DIP 16.1-20' deep - Lined with ceramic epoxy or bonded polyethylene including any necessary dewatering & removal of unsuitables, restrained joints and spacers through casings, complete, in-place	760	LF		
32	24-inch CL-350 DIP 20.1-24' deep - Lined with ceramic epoxy or bonded polyethylene including any necessary dewatering & removal of unsuitables, restrained joints and spacers through casings, complete, in-place	140	LF		
33	18-inch CL-250 DIP 0-12' deep - Lined with ceramic epoxy or bonded polyethylene including any necessary dewatering & removal of unsuitables, restrained joints and spacers through casings, complete, in-place	400	LF		
34	18-inch CL-250 DIP 12.1-16' deep - Lined with ceramic epoxy or bonded polyethylene including any necessary dewatering & removal of unsuitables, restrained joints and spacers through casings, complete, in-place	630	LF		
35	18-inch CL-250 DIP 16.1-20' deep - Lined with ceramic epoxy or bonded polyethylene including any necessary dewatering & removal of unsuitables, restrained joints and spacers through casings, complete, in-place	535	LF		
36	18-inch CL-350 DIP 20.1-24' deep - Lined with ceramic epoxy or bonded polyethylene including any necessary dewatering & removal of unsuitables, restrained joints and spacers through casings, complete, in-place	235	LF		

37	12-inch CL-350 DIP 14.1-18' deep - Lined with ceramic epoxy or bonded polyethylene including any necessary dewatering & removal of unsuitables, restrained joints and spacers through casings, complete, in-place	93	LF		
38	36-inch Gravity Jack & Bore including 36" steel casing, minimum 35 KIPS. Including spacers per specificiation and 18-inch CL-250 DIP - Lined with ceramic epoxy or bonded polyethylene, restrained joints and spacers through casings, water tight casing seals with vent pipes at both ends, complete, in-place	168	LF		
39	Standard 5' ϕ precast concete manholes - including any necessary dewatering & removal of unsuitables	193	VF		
40	Standard 6' ϕ precast concrete manholes - including any necessary dewatering & removal of unsuitables	17	VF		
41	Installation of new doghouse manhole MH-E01 (5' ϕ) on the existing 10-inch gravity line as shown on C2.8 to include cost of connections, bypass pumping, complete, in-service	2	EA		
42	Coring and tie in to existing manhole at Line C STA 18+71 with 24-inch gravity line as shown on C2.9 to include cost of connections, bypass pumping, complete, in-service				
43	Frame with Watertight Cover	8	EA		
44	Abandonment of 140 LF of existing 10" gravity sewer inside Norfolk Southern R/W (fill with flowable fill per specification)	3	CY		
45	Abandonment of existing manholes per drawings	7	EA		
46	Manhole Vents to 2' above the 100-year floodplain - Per drawings, complete, in service.	1	EA		
				Sewer Construction Subtotal	

C.	**Miscellaneous Contingencies**				
47	Removal & disposal of unsuitable soils	1,500	CY		
48	Trench rock excavation, complete, as specified	2,000	CY		
49	Additional Stone bedding (Allowance)	2,000	TN		
50	2" HMA Surface Course Type C per SCDOT, installed, compacted, and tested (Convention Center Drive)	2,320	SY		
51	6" Macadam Base Course per SCDOT Section 305, installed, compacted, and tested (Convention Center Drive)	757	TN		
				Miscellaneous Contingencies Subtotal	
				Total Bid (A+B+C)	

00 43 13 BID BOND

STATE OF SOUTH CAROLINA
COUNTY OF YORK

KNOW ALL MEN BY THESE PRESENTS, that _____

as Principal, and _____, as Surety, a Corporation chartered and existing under the laws of the State of _____ _____, with its principal offices in the City of_____, and authorized to do business in the State of South Carolina are held and firmly bound unto the OWNER, _____ _____ in the penal Sum of _____ _____Dollars ($_____) lawful money of the United States, for the payment of which sum will and truly to be made, we bind ourselves, our heirs, executors, administrators, and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Principal has submitted to the OWNER the accompanying bid, dated _____***, 20***___, for:

New Heritage Gravity Sewer – Phase 2

NOW, THEREFORE,

A. If said Bid shall be rejected, or

B. If the principal shall not withdraw said Bid within twenty-four (24) hours after date of opening of the same, and shall within ten (10) days after the prescribed forms are presented to him for signature, enter into a written contract with the OWNER in accordance with the Bid as accepted, and give bonds with good and sufficient surety or sureties, as may be required, for the faithful performance and proper fulfillment of such contract, then the above obligations shall be void and of no effect, otherwise to remain in full force and effect.

C. In the event of the withdrawal of said Bid within the period specified, or the failure to enter into such contract and give such bonds within the time specified, if the principal shall pay the OWNER the difference between the amount specified in said bid and the amount for which the OWNER may procure the required work and supplies, if the latter amount be in excess of the former, then the above obligations shall be void and of no effect, otherwise to remain in full force and effect.

IN WITNESS WHEREOF, the above bounded parties have executed this instrument under their several seals, this ____ day of _____, A.D., *20___,* the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

WITNESS: (If Sole Ownership or Partnership, two (2) Witnesses required).
(If Corporation, Secretary only will attest and affix seal).

WITNESSES: PRINCIPAL:

_____ _____
Name of Firm

_____ _____
Signature of Authorized Officer
(Affix Seal)

_____
Title

_____
Business Address

_____
City State

WITNESS: SURETY:

_____ _____
Corporate Surety

_____
(Affix Attorney-in-Fact Seal)

_____
Business Address

_____
City State

_____
Name of Local Insurance Agency

CERTIFICATES AS TO CORPORATE PRINCIPAL

I, _____, certify that I am the Secretary of the Corporation named as Principal in the within bond; that _____who signed the said bond on behalf of the principal, was then _____ of said corporation; that I know his signature, and his signature hereto is genuine; and that said bond was duly signed, sealed, and attested for and in behalf of said corporation by authority of its governing body.

_____
(Corporate Secretary Seal)

STATE OF SOUTH CAROLINA
COUNTY OF YORK

Before me, a Notary Public duly commissioned, qualified and acting, personally appeared _____ _____to me well known, who being by me first duly sworn upon oath, says that he is the Attorney-in-Fact, for the _____ and that he has been authorized by ___ _____ to execute the foregoing bond on behalf of the Contractor named therein in favor of the OWNER, the _____.

Subscribed and sworn to before me this ____ day of_____, *20*___, A.D.

(Attach Power of Attorney
to original Bid Bond)

_____
Notary Public
State of South Carolina-at-Large

My Commission Expires:_____

END OF SECTION

00 45 19 NON-COLLUSION AFFIDAVIT

State of _____)

County of _____)

_____, being first duly sworn, deposes and says that:

(1) He is _____ of _____, the Bidder
Title Company Name
that has submitted the attached Bid;

(2) He is fully informed respecting the preparation and contents of the attached Bid and of all pertinent circumstances respecting such Bid;

(3) Such Bid is genuine and is not a sham Bid;

(4) Neither the said Bidder nor any of its officers, partners, owners, agents, representatives, employees or parties in interest, including this affiant, has in any way colluded, conspired, connived or agreed, directly or indirectly with any other Bidder, firm, or person to submit a collusive or sham Bid in connection with the Contract for which the attached Bid has been submitted or to refrain from bidding in connection with such Contract, or has in any manner, directly or indirectly, sought by agreement or collusion or communication or conference with any other Bidder, firm or person to fix the price or prices in the attached Bid or of any other Bidder, or to fix any overhead, profit or cost element of the Bid price or the Bid price of any other bidder, or to secure through any collusion, conspiracy, conveyance or unlawful agreement any advantage against the OWNER or any person interested in the proposed contract;

(5) The price or prices quoted in the attached Bid are fair and proper and are not tainted by any collusion, conspiracy, connivance or unlawful agreement on the part of the Bidder or any of its agents, representatives, owners, employees, or parties in interest, including this affidavit.

(Signed) _____

_____
(Title)

Subscribed and sworn to before me

this ____ day of _____, 20_____

_____
(Title)

My commission expires _____

00 51 00 NOTICE OF AWARD

TO: _____ FROM: York County Engineering

_____ P.O. Box 148

6 York, SC 29745

PROJECT TITLE: New Heritage Gravity Sewer – Phase 2

PROJECT DESCRIPTION
The Owner has considered the Bid submitted by you for the above described work in response to its Advertisement for Bids dated _____and Information for Bidders.

You are hereby notified that your Bid has been accepted for items in the amount of
(_____).

You are required by the Information for Bidders to execute the Agreement and furnish the required Contractor's Performance Bond, Payment Bond and certificates of insurance within ten (10) calendar days from the date of this Notice to you.

If you fail to execute said Agreement and to furnish said Bonds within ten (10) days from the date of this Notice, said Owner will be entitled to consider all your rights arising out of the Owner's acceptance of your Bid as abandoned and as forfeiture of your Bid Bond. The Owner will be entitled to such other rights as may be granted by law.

You are required to return an acknowledged copy of this Notice of Award to the Owner.

Dated this ____ day of _____ .

On behalf of the York County Council

By: _____

Title: County Engineer

ACCEPTANCE OF NOTICE

Receipt of the above Notice of Award is hereby acknowledged

By:_____

Title:_____

This _____day of _____,*20*___.

00 52 00 AGREEMENT

THIS AGREEMENT, made and entered into this _____ day of _____, *20__* A.D., by and between the York County Government, party of the first part (hereinafter sometimes called the "OWNER"), and _____, party of the second part (hereinafter sometimes called the "CONTRACTOR").

WITNESSETH: That the parties hereto, for the consideration hereinafter set forth, mutually agree as follows:

1. SCOPE OF THE WORK

1.1. The CONTRACTOR shall furnish all labor, materials, equipment, machinery, tools, apparatus, and transportation and perform all of the Work shown on the Drawings and described in the Specifications entitled:

New Heritage Gravity Sewer – Phase 2

as prepared by Michael Baker International, Inc. and issued by York County Engineering Department acting as, and in the Contract Documents entitled the ENGINEER, and shall do everything required by this Contract and the other Contract Documents.

2. THE CONTRACT SUM

2.1. The OWNER shall pay to the CONTRACTOR for the faithful performance of the Contract, in lawful money of the United States, and subject to addition and deductions as provided in the Contract Documents, a total sum as follows:

Based upon the prices shown in the Bid heretofore submitted to the OWNER by the CONTRACTOR, a copy of said Proposal being a part of these Contract Documents, the aggregate amount of this Contract (obtained from either the lump sum price, the application of unit prices to the quantities shown in the Bid, or the combination of both) being the sum of

_____
($_____).

3. COMMENCEMENT AND COMPLETION OF WORK

3.1. The CONTRACTOR shall commence Work and the Contract Time will commence to run on the date fixed in the Notice to Proceed.

3.2. The CONTRACTOR shall prosecute the Work with faithfulness and diligence and shall be completed and ready for final payment within ***300 Calendar*** days after commencement date fixed in the Notice to Proceed.

4. CONTRACTOR'S ACCEPTANCE OF CONDITIONS

4.1. The CONTRACTOR hereby agrees that, by virtue of submitting a completed Bid including his declarations therein of full satisfaction, knowledge and understanding of the Contract Documents, site conditions (surface and subsurface) and all other conditions affecting the Work, he assumes full responsibility for performance of the Work as required under this Contract. It is expressly agreed that under no circumstances, conditions or situations shall this Contract be more strongly construed against the OWNER than against the CONTRACTOR and his Surety.

4.2. It is understood and agreed that the passing, approval and/or acceptance of any part of the Work or material by the OWNER, ENGINEER, or by any agent or representative, as being in compliance with the terms of this Contract and/or of the Contract Documents, shall not operate as a waiver by the OWNER of strict compliance with the terms of this Contract, and/or the Contract Documents covering said Work; and the OWNER may require the CONTRACTOR and/or his surety to repair, replace, restore and/or make to comply strictly and in all things with this Contract and the Contract Documents any and all of said Work and/or materials which within a period of two years from and after the date of the acceptance of any such Work or material, are found to be defective or to fail in any way to comply with this Contract or with the Contract Documents. This provision shall not apply to materials or equipment normally expected to deteriorate or wear out and become subject to normal repair and replacement before their condition is discovered. Failure on the part of the CONTRACTOR and/or his Surety, immediately after notice to either, to repair or replace any such defective materials and workmanship shall entitle the OWNER, if it sees fit, to replace or repair the same and recover the reasonable cost of such replacement and/or repair from the CONTRACTOR and/or his surety, who shall in any event be jointly and severally liable to the OWNER for all damage, loss and expense caused to the OWNER by reason of the CONTRACTOR's breach of this Contract and/or his failure to comply strictly and in all things with this Contract.

5. LIQUIDATED DAMAGES

5.1. It is mutually agreed that time is of the essence of this Contract and should the CONTRACTOR fail to complete the work within the specified time, or any authorized extension thereof, there shall be deducted from the compensation otherwise to be paid to the CONTRACTOR, and the OWNER will retain the amount of *Five Hundred Dollars ($500.00)* per calendar day as fixed, agreed, and liquidated damages for each calendar day elapsing beyond the specified time for substantial completion or any authorized extension thereof, which sum shall represent the actual damages which the OWNER will have sustained by failure of the CONTRACTOR to complete the work within the specified time. After substantial completion, if the CONTRACTOR shall neglect, refuse, or fail to complete the remaining Work within the Contract Time or any proper extension thereof granted by OWNER, Contractor shall pay OWNER *Five Hundred Dollars ($500.00)* for each calendar day that expires after the date specified for Final Completion and readiness for final payment until the work is complete and ready for final payment. It being further agreed that said sum is not a penalty, but is the stipulated amount of damages sustained by the OWNER in the event of such default by the CONTRACTOR.

5.2. For the purposes of this Article, the day of final acceptance of the Work shall be considered a day of delay, and the scheduled day of completion of the work shall be considered a day scheduled for production.

6. PARTIAL AND FINAL PAYMENTS

6.1. In accordance with the provisions fully set forth in the General Conditions, and subject to additions and deductions as provided, the OWNER shall pay the CONTRACTOR as follows:

6.1.1. Within 30 days after receipt by the OWNER of the CONTRACTOR's request for partial payment, the OWNER shall make partial payments to the CONTRACTOR, on the basis of the estimate of Work as approved by the ENGINEER, for work performed during the preceding calendar month, less ten percent (10%) of the amount of such estimate which is to be retained by the OWNER until all Work has been performed strictly in accordance with this Agreement and until such Work has been accepted by the OWNER.

6.1.2. Upon submission by the CONTRACTOR of evidence satisfactory to the OWNER that all payrolls, material bills and other costs incurred by the CONTRACTOR in connection with the construction of the Work have been paid in full, including all retainage to subcontractors on the project, and also after all guarantees that may be required in the

specifications have been furnished and are found acceptable by the OWNER, final payment on account of this Agreement shall be made within sixty (60) days after completion by the CONTRACTOR of all Work covered by this Agreement and acceptance of such Work by the OWNER.

6.1.3. Retainage will be released in full at Final Completion.

7. ADDITIONAL BOND

7.1. It is further mutually agreed between the parties hereto that if, at any time after the execution of this Agreement and the Performance and Payment Bonds hereto attached for its faithful performance, the OWNER shall deem the surety or sureties upon such bonds to be unsatisfactory, or if, for any reason, such bond(s) ceases to be adequate to cover the performance of the Work, the CONTRACTOR shall, at his expense, and within three days after the receipt of notice from the OWNER to do so, furnish an additional bond or bonds, in such form and amount, and with such sureties as shall be satisfactory to the OWNER. In such event, no further payment to the CONTRACTOR shall be deemed due under this Agreement until such new or additional security for the faithful performance of the Work shall be furnished in manner and form satisfactory to the OWNER.

8. CONTRACT DOCUMENTS

8.1. The Contract Documents, as stated in the Instructions to Bidders, including this Project Manual and General Conditions, and the accompanying Contract Drawings, shall form the Contract and are as fully a part of this Contract as if herein repeated.

IN WITNESS WHEREOF the parties hereto have executed this Agreement on the day and date first above written in three (3) counterparts, each of which shall, without proof or accounting for the other counterparts, be deemed an original Contract.*

Owner	Contractor
By:_____	By:_____
[Corporate Seal]	[Corporate Seal]
Attest:_____	Attest:_____
Address for giving notices:	Address for giving notices:
	License No._____
	Agent for service of process:_____

(*) In the event that the CONTRACTOR is a Corporation, a certificate of resolution of the Board of Directors of the Corporation, authorizing the officer who signs the Contract to do so in its behalf shall be completed and submitted with this form.

END OF SECTION

00 55 00 NOTICE TO PROCEED

Date: _____

To: _____

_____

_____

Project:

New Heritage Gravity Sewer – Phase 2

You are hereby notified to commence work in accordance with the Agreement dated _____ on or before _____, and you are to complete the work within 330 consecutive calendar days thereafter. The date of completion of all work is therefore _____.

On behalf of the

YORK COUNTY GOVERNMENT

By: _____

Title: _____

ACCEPTANCE OF NOTICE

Receipt of the above Notice to Proceed is hereby acknowledged by _____, this the ____day of _____, ***20___***.

By: _____

Title: _____

00 61 13.13 PERFORMANCE AND INDEMNITY BOND

STATE OF SOUTH CAROLINA
COUNTY OF YORK

KNOW ALL MEN BY THESE PRESENTS that _____ _____ as Principal, hereinafter called Contractor, and _____ _____as Surety, hereinafter called Surety, are held and firmly bound unto the York County Government, as Obligee, hereinafter called owner, in the amount of _____ _____Dollars ($_____) for the payment whereof Contractor and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, Contractor has by written agreement dated_____, *20___*, entered into a Contract with Owner for:

New Heritage Gravity Sewer – Phase 2

in accordance with Drawings and Specifications prepared by York County Engineering Department, ENGINEER, which Contract is by reference made a part hereof and is hereinafter referred to as the Contract.

NOW, THEREFORE, THE CONDITIONS OF THIS OBLIGATION ARE SUCH, that, if the Principal shall in all respects promptly and faithfully perform and comply with the terms and conditions of said Contract and his obligations thereunder and shall indemnify the OWNER and the ENGINEER and save either or all of them harmless against and from all costs, expenses and damages arising from the performance of said Contract or the repair of any work thereunder, then this obligation shall be void; otherwise, this Bond shall remain in full force and effect, in accordance with the following terms and conditions:

A. The Principal and Surety jointly and severally agree to pay the OWNER any difference between the sum to which the said Principal would be entitled on the completion of the Contract, and that sum which the OWNER may be obliged to pay for the completion of said work by Contract or otherwise, and any damages, direct or indirect or consequential, which the said OWNER may sustain on account of such work, or on account of the failure of said CONTRACTOR to properly and in all things, keep and execute all of the provisions of said Contract.

B. And this Bond shall remain in full force and effect for a period of one (1) year from the date of final payment of the project by the OWNER and shall provide that the CONTRACTOR guarantees to repair or replace for said period of one (1) year all work performed and materials and equipment furnished that were not performed or furnished according to the terms of the Contract, and shall make good, defects thereof which have become apparent before the expiration of said period of two (1) year. If any part of the project, in the judgment of the OWNER, for the reasons above stated needs to be replaced, repaired or made good during that time, the OWNER shall so notify the CONTRACTOR in writing. If the CONTRACTOR refuses or neglects to do such work within five (5) days from the date of service of such Notice, the OWNER shall have the work done by others and the cost thereof shall be paid by the CONTRACTOR or his Surety.

C. And the said Surety, for value received hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the work to be performed thereunder or the specifications accompanying the same shall in any way affect its obligations on this bond, and it does hereby waive Notice of any change, extension of time, alteration or addition to the terms of the Contract or to the Work or to the Specifications.

D. The surety represents and warrants to the OWNER that they have a minimum Best's Key Rating Guide General Policyholder's Rating of "A –" and Financial Category of "Class VIII".

IN WITNESS WHEREOF, the above bounded parties executed this instrument under their several seals, this ____ day of _____ *20___*, A.D., the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

WITNESS: (If Sole Ownership or Partnership, two (2) Witnesses required).
(If Corporation, Secretary only will attest and affix seal).

PRINCIPAL:

_____

_____
Signature of Authorized Officer
(Affix Seal)

WITNESSES:

_____ _____
Title

_____ _____
Business Address

_____
City State

SURETY:

WITNESS:

_____
Corporate Surety

_____ _____
Attorney-in-Fact (Affix Seal)

_____
Business Address

_____
City State

_____
Name of Local Insurance Agency

CERTIFICATES AS TO CORPORATE PRINCIPAL

I, _____, certify that I am the Secretary of the Corporation named as Principal in the within bond; that _____ who signed the said bond on behalf of the Principal, was then _____ of said Corporation; that I know his signature, and his signature hereto is genuine; and that said bond was duly signed, sealed, and attested for and in behalf of said Corporation by authority of its governing body.

_____
Secretary

Corporate
Seal

STATE OF SOUTH CAROLINA

COUNTY OF YORK

Before me, a Notary Public, duly commissioned, qualified and acting, personally appeared _____ _____ to me well known, who being by me first duly sworn upon oath, says that he is the Attorney-in-Fact, for the _____ _____ and that he has been authorized by _____ _____ to execute the foregoing bond on behalf of the Contractor named therein in favor of the_____.

Subscribed and sworn to before me this . day of _____, *20*___, A.D.

(Attach Power of Attorney)

_____
Notary Public
State of South Carolina-at-Large

My Commission Expires:

END OF SECTION

00 61 13.16 PAYMENT BOND

STATE OF SOUTH CAROLINA
COUNTY OF YORK

KNOW ALL MEN BY THESE PRESENTS that _____ _____ as Principal, hereinafter called CONTRACTOR, and _____ as Surety, hereinafter called Surety, are held and firmly bound unto the York County Government, as Obligee, hereinafter called OWNER, in the amount of _____ _____Dollars($_____) for the payment whereof CONTRACTOR and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, CONTRACTOR has by written agreement dated_____, *20__*, entered into a Contract with OWNER for:

New Heritage Gravity Sewer – Phase 2

in accordance with Drawings and Specifications prepared by York County Engineering Department, ENGINEER, which Contract is by reference made a part hereof and is hereinafter referred to as the Contract.

NOW, THEREFORE, THE CONDITIONS OF THIS OBLIGATION ARE SUCH, that, if the Principal shall promptly make payments to all claimants, as herein below defined, then this obligation shall be void; otherwise, this Bond shall remain in full force and effect, subject to the following terms and conditions:

A. A claimant is defined as any person supplying the Principal with labor, material and supplies, used directly or indirectly by the said Principal or any subcontractor in the prosecution of the work provided for in said Contract.

B. The above named Principal and Surety hereby jointly and severally agree with the OWNER that every claimant as herein defined, who has not been paid in full before the expiration of a period of ninety (90) days after performance of the labor or after complete delivery of materials and supplies by such claimant, may sue on this Bond for the use of such claimant, prosecute the suit to final judgment for such sum or sums as may be justly due claimant, and have execution thereon. The OWNER shall not be liable for the payment of any costs or expenses of any such suit.

C. No suit or action shall be commenced hereunder by any claimant:

1. Unless claimant, other than one having a direct contract with the Principal, shall within forty-five (45) days after beginning to furnish labor, materials or supplies for the prosecution of the work, furnish the Principal with a notice that he intends to look to this bond for protection.

2. Unless claimant, other than one having a direct contract with the Principal, shall within ninety (90) days after such claimant's performance of the labor or complete delivery of materials and supplies, deliver to the Principal written notice of the

performance of such labor or delivery of such material and supplies and the nonpayment therefore.

3. After the expiration of one (1) year from the performance of the labor or completion of delivery of the materials and supplies; it being understood, however, that if any limitation embodied in this Bond is prohibited by any law controlling the construction hereof such limitations shall be deemed to be amended so as to be equal to the minimum period of limitation permitted by such law.

4. Other than in a state court of competent jurisdiction in and for the county or other political subdivision of the state in which the project, or any part thereof, is situated, or in the United States District Court for the district in which the project, or any part thereof, is situated, and not elsewhere.

D. The Principal and the Surety jointly and severally, shall repay the OWNER any sum which the OWNER may be compelled to pay because of any lien for labor or materials furnished for any work included in or provided by said Contract.

E. The Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration of or addition to the terms of the Contract or to the work to be performed thereunder or the Specifications applicable thereto shall in any way affect its obligations on this Bond, and the Surety hereby waives notice of any such change, extension of time, alterations of or addition to the terms of the Contract, or to the work or to the Specifications.

F. The Surety represents and warrants to the Owner that they have a minimum Best's Key Rating Guide General Policyholder's rating of "A –“ and Financial Category of "Class VIII".

IN WITNESS WHEREOF, the above bounded parties executed this instrument under their several seals, this _____ day of _____ *20___*, A.D., the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

WITNESS: (If Sole Ownership or Partnership, two (2) Witnesses required).
(If Corporation, Secretary only will attest and affix seal).

PRINCIPAL:

_____

_____
Signature of Authorized Officer
(Affix Seal)

WITNESSES:

_____ _____
Title

_____ _____
Business Address

_____
City State

SURETY:

WITNESS:

_____
Corporate Surety

_____ _____
Attorney-in-Fact
(Affix Seal)

_____
Business Address

_____
City State

_____
Name of Local Insurance Agency

CERTIFICATES AS TO CORPORATE PRINCIPAL

I, _____, certify that I am the Secretary of the Corporation named as Principal in the within bond; that _____ who signed the said bond on behalf of the Principal, was then _____ of said Corporation; that I know his signature, and his signature hereto is genuine; and that said bond was duly signed, sealed, and attested for and in behalf of said Corporation by authority of its governing body.

_____

Secretary

Corporate
Seal

STATE OF SOUTH CAROLINA

COUNTY OF YORK

Before me, a Notary Public, duly commissioned, qualified and acting, personally appeared _____ to me well known, who being by me first duly sworn upon oath, says that he is the Attorney-in-Fact, for the _____ _____ and that he has been authorized by _____ to execute the foregoing bond on behalf of the CONTRACTOR named therein in favor of the_____.

Subscribed and sworn to before me this ____ day of _____, *20___*, A.D.

(Attach Power of Attorney)

_____
Notary Public
State of South Carolina-at-Large

My Commission Expires: _____

END OF SECTION

00 61 33 CONTRACT CHANGE ORDER

CHANGE ORDER NO:___

PROJECT: New Heritage Gravity Sewer – Phase 2

DATE OF ISSUANCE:

DESCRIPTION OF CHANGE:

_____

_____

_____

CONTRACT AMOUNT		CONTRACT TIME (Calendar Days)	
Original	$ 0	Original Durations	0 Days
Previous Change Orders (Add/Deduct)	$ 0	Previous Change Order (Add/Deduct)	0 Days
This Change Order (Add/Deduct)	$ 0	This Change Order (Add/Deduct)	0 Days
Revised Contract Amount	$ 0	Revised Contract Time	0 Days
		REVISED CONTRACT COMPLETION DATE IS:	

OWNER	CONTRACTOR	ENGINEER

_____

Attest

00 62 16 CERTIFICATE OF INSURANCE
(May also use applicable Accord form)

THIS IS TO CERTIFY THAT THE _____
Insurance Company

Address _____

Of _____
has issued policies of insurance, as described below and identified by a policy number, to the insured named below; and to certify that such policies are in full force and effect at this time. It is agreed that none of these policies will be cancelled or changed so as to affect the interest(s) of the York County Government (hereinafter sometimes called the OWNER) until thirty (30) days after written notice of such cancellation or change has been delivered to the ENGINEER.

Insured: _____

Address: _____

Status of Insured
_____ Corporation _____ Partnership _____ Individual

Insured: _____

Description of Work: _____

_____

_____

INSURANCE POLICIES IN FORCE

Forms of Coverage	Policy Number	Expiration Date
*Worker's Comp./Employers' Liability	_____	_____
**Comprehensive Auto Liability	_____	_____
***Excess Liability	_____	_____
Other (Please specify type)	_____	_____

POLICY INCLUDES COVERAGE FOR:		YES	NO
1.	Additional Insured: OWNER and ENGINEER	_____	_____
2.	*Liability under the United States Longshore-men's and Harbor Workers' Compensation Act.	_____	_____
3.	**All owned, hired, or nonowned automotive equipment used in connection with work done for the Owner.		
4.	Contractual Liability	_____	_____
5.	Damage caused by explosion, collapse or structural injury, and damage to underground utilities.	_____	_____
6.	Products/Completed Operations	_____	_____
7.	Owners and Contractors Protective Liability	_____	_____
8.	Personal Injury Liability	_____	_____
9.	***Excess Liability applies excess of:		
	(a) Employers' Liability	_____	_____
	(b) Comprehensive General Liability	_____	_____
	(c) Comprehensive Automobile Liability	_____	_____

Types of Coverage	Forms of Coverage	Minimum Limits of Liability	
Workers' Compensation	Bodily Injury	$ 1,000,000	Statutory
Employers' Liability	Bodily Injury	$ 500,000	Each Accident
	Disease	$ 500,000	Each Person
	Disease	$ 500,000	Policy Limit
Comprehensive Auto Liability	Combined Single Limit BI/PD	$ 1,000,000	Each Accident
Comprehensive General Liability	Bodily Injury	$ 1,000,000	Each Occurrence
		$ 5,000,000	Aggregate

The Insurance Company hereby agrees to deliver, within ten (10) days, two (2) copies of the above policies to the Engineer when so requested.

NOTE: Entries on this certificate are limited to the Authorized Agent or Insurance Company Representative.

Date_____ (SEAL) _____
Insurance Company

Issued at_____
Authorized Representative

Insurance Agent or Company

- Send original and one copy to:

York County Engineering
Post Office Box 148
6 South Congress Street
York, South Carolina 29745

END OF SECTION

00 62 76 APPLICATION FOR PAYMENT No.

Date: _____ Contractor: _____

Project: _____

Project Number: _____ For Period _____ To _____

Total value of work completed to date (see attached sheet)	$ _____
Total value of materials stored for project (see attached sheet)	$ _____
SUB TOTAL	$ _____
LESS _____ %RETAINED	$ _____
TOTAL	$ _____
LESS PREVIOUS PAYMENTS	$ _____
Other Changes, additions, or deductions (see attached sheet)	$ _____
TOTAL AMOUNT DUE THIS PAYMENT	**$ _____**

Previous Payments

1. _____	**4.** _____	**7.** _____	**10.** _____
2. _____	**5.** _____	**8.** _____	**11.** _____
3. _____	**6.** _____	**9.** _____	**12.** _____

Submitted By:
I hereby certify to the best of the Contractor's knowledge, information and belief, the Work covered by this Application for Payment has been completed in accordance with the Contract Documents, and that all amounts have been paid by the Contractor for Work which previous Applications for Payment were issued and payments received from the Owner, that current payment shown herein is now due.

Contractor: _____

Signed By: _____

Date: _____

Notarized: _____
(affix seal)
My Commission Expires: _____

Recommended By:
Architect/Engineer: _____ Date: _____

Certified Amount: $ _____

The Certified amount is payable only to the Contractor named herein. Issuance, payment, and acceptance of payment are without prejudice to any rights of the Owner or Contractor under this Contract.

Accepted By:
Owner: _____ Date: _____

00 65 19 RELEASE AND WAIVER OF CLAIM BY PRIME CONTRACTOR

Know all men by these presents that the undersigned, _____of _____ _____first being duly sworn, states that all payrolls, materials bills, sales tax, privilege tax or license, old age benefits tax, state and federal unemployment insurance, and other liabilities incurred for use in the performance of the contract for the ***New Heritage Gravity Sewer – Phase 2*** located in Ft. Mill, South Carolina have been paid in full and waives any and all claims and releases York County Government (York County, South Carolina) from any rights or claims for debts due and owing by virtue of the furnishing of any material or supplies or any lien thereon.

_____
(Name of Company)

By: _____

Its: _____

Sworn to before me
this _____day of _____, 20 _____.

_____

Notary Public for _____

My Commission expires: _____

00 72 00 GENERAL CONDITIONS

1. DEFINITIONS

1.1. Whenever used in any of the Contract Documents, the following meanings shall be given to the terms herein defined:

1.1.1. *Addendum* or *Addenda* - Written or graphic instruments issued prior to the opening of Bids which clarify, correct or change the Bidding Requirements or the Contract Documents.

1.1.2. *Agreement* - The written contract between OWNER and CONTRACTOR covering the Work to be performed; other Contract Documents are attached to the Agreement and made a part thereof as provided therein.

1.1.3. *Application for Payment* - The form accepted by ENGINEER which is to be used by CONTRACTOR in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

1.1.4. *Bid* - The offer or proposal of the bidder on the prescribed Bid Form setting forth the prices for the Work to be performed.

1.1.5. *Bidder* - One who submits a Bid directly to OWNER, as distinct from sub-bidder, who submits a Bid to a Bidder.

1.1.6. *Bidding Documents* - The Invitation for Bids, Information to Bidders, the Bid Form, and the proposed Contract Documents (including all Addenda issued prior to receipt of Bids).

1.1.7. *Bonds* - Performance and Indemnity and Payment Bonds and other instruments of security.

1.1.8. *Change Order* - A document recommended by ENGINEER, which is signed by CONTRACTOR and OWNER and authorizes an addition, deletion or revision in the Work, or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.

1.1.9. *Contract Documents* - Executed Agreement, Addenda (if any), Invitation for Bids, Information to Bidders, Signed Copy of Bid, Bid Guarantee, Statement of Bidder's Qualifications, Performance and Indemnity Bond, Payment Bond, Certification of Insurance, General Conditions, Supplemental Conditions (if any), Special Conditions (if any), Technical Specifications, and Drawings.

1.1.10. *Contract Price* - The moneys payable by OWNER for completion of the Work in accordance with the Contract Documents.

1.1.11. *Contract Times* - The numbers of days or the dates stated in the Agreement: (i) to achieve Substantial Completion, and (ii) to complete the work so that it is ready for final payment as evidenced by ENGINEER's written records.

1.1.12. *CONTRACTOR* - The person, firm, or corporation entering into Contract with the OWNER to construct and install the improvements embraced in this Contract.

1.1.13. *Defective* - An adjective which when modifying the word Work refers to Work that is unsatisfactory, faulty or deficient, in that it does not conform to the Contract Documents, or does not meet the requirements of any inspection, reference standard, test or approval referred to in the Contract Documents, or had been damaged prior to ENGINEER's recommendation or final payment.

1.1.14. *Drawings* - The construction drawings which graphically show the scope, extent, and character of the Work to be furnished and performed by the CONTRACTOR and which have been prepared or approved by ENGINEER and are referred to in the Contract Documents.

1.1.15. *ENGINEER* – The person, firm or corporation serving the OWNER with Engineering services, his successors, or any other person or persons, employed by said OWNER for the purpose of directing or having charge of the work embraced in this Contract.

1.1.16. *Laws and Regulations; Laws or Regulations* – Any and all applicable laws, rules, regulations, ordinances codes and orders of any and all governmental bodies, agencies, authorities and courts having jurisdiction.

1.1.17. *Liens* - Liens, charges, security interests or encumbrances upon project funds, real property or personal property.

1.1.18. *Local Government* - York County, South Carolina, within which the Project Areas are situated.

1.1.19. *Milestone* - A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.

1.1.20. *Notice of Award* - The written notice by OWNER to the apparent successful Bidder stating that upon compliance by the apparent successful Bidder with the conditions precedent enumerated therein, within the time specified, OWNER will sign and deliver the agreement.

1.1.21. *Notice to Proceed* - A written notice given by OWNER to CONTRACTOR (with a copy to ENGINEER) fixing the date on which the Contract Times will commence to run and on which CONTRACTOR shall start to perform, CONTRACTOR's obligations under the Contract Documents.

1.1.22. O*WNER* - The York County Government, which is authorized to undertake this Contract.

1.1.23. *Partial Utilization* - Use by OWNER of a substantially completed part of the Work for the purpose for which it is intended (or a related purpose) prior to Substantial Completion of all the Work.

1.1.24. *Project* - The total construction of which the Work to be provided under the Contract Documents may be the whole, or a part as indicated elsewhere in the Contract Documents.

1.1.25. *Project Area* - The area within which are the specified limits of the improvements to be constructed in whole or in part under this Contract.

1.1.26. *Project Manual* – The bound documentary information prepared for bidding and constructing the Work. A listing of the contents of the Project Manual, which may be bound in one or more volumes, is contained in the table(s) of contents.

1.1.27. *Resident Project Representative* – The authorized representative of ENGINEER who may be assigned to the Site or any part thereof.

1.1.28. *Samples* - Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

1.1.29. *Site* – Lands or areas indicated in the Contract Documents as being furnished by OWNER upon which the Work is to be performed, including rights-of-way and easements for access thereto, and such other lands furnished by OWNER which are designated for the use of the CONTRACTOR.

1.1.30. *Shop Drawings* - All drawings, diagrams, illustrations, schedules and other data or information which are specifically prepared or assembled by or for CONTRACTOR and submitted by CONTRACTOR to illustrate some portion of the Work.

1.1.31. *Special Conditions* - The part of the Contract Documents that amends or supplements the Technical Specifications.

1.1.32. *Subcontractor* - An individual, firm or corporation having a direct contract with CONTRACTOR or with any other Subcontractor for the performance of a part of the Work at the site.

1.1.33. *Substantial Completion* - The Work (or specified part thereof) has progressed to the point where, in the opinion of ENGINEER as evidenced by ENGINEER's definitive certification of Substantial Completion, it is sufficiently complete, in accordance with the Contract Documents, so that the Work (or specified part) can be utilized for the purposes for which it is intended; or if no such certificate is issued, when the Work is complete and ready for final payment as evidenced by ENGINEER's written recommendation of final payment. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.

1.1.34. *Successful Bidder* - The lowest, qualified, responsible and responsive Bidder to whom OWNER (on the basis of OWNER's evaluation as hereinafter provided) makes an award.

1.1.35. *Supplier* – A manufacturer, fabricator, supplier, distributor, material man or vendor having a direct contract with CONTRACTOR or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by CONTRACTOR or any Subcontractor.

1.1.36. *Supplemental Conditions* - The part of the Contract Documents that amends or supplements these General Conditions.

1.1.37. *Technical Specifications* - The part of the Contract Documents that describes, outlines, and stipulates: the quality of materials, equipment and systems to be furnished; the quality of workmanship required; and the methods to be used in carrying out the construction work to be performed under this Contract.

1.1.38. *Underground Facilities* - All pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels or other such facilities or attachments, and any encasements containing such facilities which have been installed underground to furnish any of the following services or materials: electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, sewage and drainage removal, traffic or other control systems, or water.

1.1.39. *Unit Price Work* - Work to be paid for on the basis of unit prices.

1.1.40. *Work* - The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract Documents. Work includes and is the result of performing or furnishing and incorporating materials and equipment into the construction, and furnishing, installing and incorporating all materials and equipment into such construction, all as required by the Contract Documents..

1.2 Other technical terms not specifically defined within the Contract Documents shall have the meanings given in AIA Document "Glossary of Construction Industry Terms," current edition. Technical terms not defined as above and used to describe items of the Work, and which so applied have a well-known technical or trade meaning, shall be deemed to have such recognized meaning.

2. CONTRACTOR'S OBLIGATIONS

2.1. All work shall be done in strict accordance with the Contract Documents. Observations, construction reviews, tests, recommendations or approvals by the ENGINEER or persons other than the CONTRACTOR, shall in no way relieve the CONTRACTOR of his obligations to complete all work in accordance with the Contract Documents. All work shall be done under the direct supervision of the CONTRACTOR. The CONTRACTOR shall be responsible for construction means, methods, techniques, and procedures, and for providing a safe place for the performance of the work by the CONTRACTOR, Subcontractors, suppliers, and their employees and for access, use, work, or occupancy by all authorized persons.

3. LANDS BY CONTRACTOR

3.1. OWNER shall furnish the Site. OWNER shall notify CONTRACTOR of any encumbrances or restrictions not of general application, but specifically related to the use of the Site with which the CONTRACTOR must comply in performing work.

3.2. Any land and access thereto not specifically shown to be furnished by the OWNER that may be required for temporary construction facilities or for storage of materials and equipment shall be provided by the CONTRACTOR with no liability to the OWNER. The CONTRACTOR shall confine his apparatus and storage to such additional areas as he may provide at his expense.

3.3. The CONTRACTOR shall not enter upon private property for any purpose without obtaining permission, and he shall be responsible for the preservation of all public property, trees, monuments, structures and improvements, along and adjacent to the street and/or right-of-way, and shall use every precaution necessary to prevent damage or injury thereto. He shall use suitable precautions to prevent damage to pipes, conduits, and other underground structures, and shall protect carefully from disturbance or damage all monuments and property marks until an authorized agent has witnessed or otherwise referenced their location and shall not remove them until directed.

4. SURVEYS BY CONTRACTOR

4.1. Based upon the Construction Documents and any additional information provided by the OWNER, the CONTRACTOR shall develop and make all detailed surveys necessary for construction, including working points, lines and elevations.

5. PUBLIC UTILITIES

5.1. The elevation and location of all public utilities shown on the Drawings were taken from existing public records. It shall be the duty of the CONTRACTOR to make final and exact determination of the location and extent of all utilities and he will be liable for any expense resulting from damage to them.

6. SUPERINTENDENT

6.1. A qualified superintendent, who is acceptable to the OWNER, shall be maintained on the Work and shall give efficient supervision to the Work until its completion. The superintendent shall have full authority to act in behalf of the CONTRACTOR, and all instruction given to the superintendent shall be considered as given to the CONTRACTOR. It shall be the responsibility of this CONTRACTOR's superintendent to coordinate the Work of all the Subcontractors. The superintendent shall be present on the site at all times required to perform adequate supervision and coordination.

7. SUBCONTRACTORS

7.1. At the time set forth in the Contract Documents or when requested by the OWNER, the CONTRACTOR shall submit in writing for review of the OWNER the names of the Subcontractors proposed for the work. Subcontractors may not be changed except at the request or with the approval of the OWNER. The CONTRACTOR is responsible to the OWNER for the acts and deficiencies of his Subcontractors, and of their direct and indirect employees, to the same extent as he is responsible for the acts and deficiencies of his employees. The Contract Documents shall not be construed as creating any contractual relation between any Subcontractor and the OWNER. The CONTRACTOR shall bind every Subcontractor by the terms of the Contract Documents.

8. ASSIGNMENTS

8.1. The CONTRACTOR shall not assign the whole or any part of this Contract or any moneys due or to become due hereunder without written consent of the OWNER. In case the CONTRACTOR assigns all or any part of any moneys due or to become due under this Contract, the instrument of assignment shall contain a clause substantially to the effect that it is agreed that the right of the assignee in and to any moneys due or to become due to the CONTRACTOR shall be subject to prior claims of all persons, firms, and corporations for services rendered or materials supplied for the performance of the work called for in this Contract.

9. MUTUAL RESPONSIBILITY OF CONTRACTORS

9.1. If through acts of neglect on the part of the CONTRACTOR, any other CONTRACTOR or any Subcontractor shall suffer loss or damage on the work, the CONTRACTOR agrees to settle with such other CONTRACTOR or Subcontractor by agreement or arbitration if such other CONTRACTOR or Subcontractor will so settle. If such other CONTRACTOR or Subcontractor shall assert any claim against the OWNER on account of any damage alleged to have been sustained, the OWNER shall notify the CONTRACTOR, who shall indemnify and save harmless the OWNER against any such claim.

10. ORAL AGREEMENTS

10.1. No oral order, objection, claim or notice by any party to the others shall affect or modify any of the terms or obligations contained in any of the Contract Documents, and none of the provisions of the Contract Documents shall be held to be waived or modified by reason of any act whatsoever, other than by a definitely agreed waiver or modification thereof in writing, and no evidence shall be introduced in any proceeding of any other waiver or modification.

11. MATERIALS, SERVICE AND FACILITIES

11.1. It is understood that except as otherwise specifically stated in the Contract Documents, the CONTRACTOR shall provide and pay for all materials, labor, tools, equipment, water, gas, light, power, transportation, superintendence, taxes, insurance, temporary construction of every nature, and all other services and facilities of every nature whatsoever necessary to execute, complete, and deliver the work within the specified time.

11.2. Any work necessary to be performed after regular working hours, on Sundays or Legal Holidays, shall be performed without additional expense to the OWNER.

12. MATERIALS AND EQUIPMENT

The materials and equipment installed in the work shall meet the requirements of the Contract Documents and no materials or equipment shall be ordered until reviewed by the ENGINEER. The CONTRACTOR shall furnish all materials and equipment not otherwise specifically indicated or provided by the OWNER.

The CONTRACTOR shall guarantee all materials and equipment he provides in accordance with Section 16 of these GENERAL CONDITIONS.

12.1. Substitutions: In order to establish standards of Quality, the ENGINEER has, in the detailed Specifications, referred to certain products by name and catalog number without consideration of possible substitute or “or equal” items. This procedure is not to be construed as eliminating from competition other products of equal or better quality by other manufacturers where fully suitable in design.

12.1.1. Whenever it is indicated in the Drawings or specified in the specifications that a substitute or “or-equal” item of material or equipment may be furnished or used by the CONTRACTOR, application for such acceptance will not be considered by the ENGINEER until after the Effective Date of the agreement. The CONTRACTOR shall furnish the complete list of proposed desired substitutions, together with such engineering and catalog data as the ENGINEER may require. All proposals for substitutions shall be submitted in writing by the General Contractor and not by individual trades or material suppliers. The ENGINEER will review proposed substitutions and make his recommendations in writing within reasonable time.

12.1.2. The CONTRACTOR shall abide by the ENGINEER's recommendation when proposed substitute materials or items of equipment are not recommended for installation and shall furnish the specified material or item of equipment in such case.

12.2. Space Requirements: It shall be the responsibility of the CONTRACTOR to ensure that materials and equipment to be furnished fit the space available. He shall make necessary field measurements to ascertain space requirements, including those for connections, and shall order such sizes and shapes of equipment that the final installation shall suit the true intent and meaning of the Contract Documents.

12.3. Arrangement: Where equipment requiring different arrangement of connections from those shown is approved, it shall be the responsibility of the CONTRACTOR to install the equipment to operate properly, and in harmony with the intent of the work required by such arrangement.

12.4. Unacceptable Materials and Equipment: Materials and equipment which do not conform to the requirements of the Contract Documents, or are not equal to samples reviewed by the ENGINEER, or are in any way unsatisfactory or unsuited to the purpose for which they are intended, shall not be furnished nor installed.

12.5. Storage: Materials and equipment shall be so stored as to ensure the preservation of their quality and fitness for the work. When considered necessary, they shall be placed on wooden platforms or other hard, clean surfaces, and not on the ground and/or they shall be placed under cover. Stored materials and equipment shall be located so as to facilitate prompt inspection. Private property shall not be used for storage purposes without the written permission of the property owner or leasee. Materials, equipment, construction machinery, fuel, and oils shall not be stored or parked within the drip-line of any trees in or adjacent to the project site or additional off-site easements and right-of-ways.

12.6. Manufacturer's Directions: Manufactured articles, materials and equipment shall be applied, installed, connected, erected, used, cleaned, and conditioned as directed by the manufacturer.

13. INSPECTION AND TESTING OF MATERIALS

13.1. Unless otherwise specifically provided for in the specifications, the inspection and testing of material and finished articles to be incorporated in the work at the site shall be made by bureaus, laboratories, or agencies approved by the OWNER. The cost of such inspection and testing shall be paid by the CONTRACTOR. The CONTRACTOR shall furnish evidence satisfactory to the OWNER that the material and finished articles have passed the required tests prior to the incorporation of such materials and finished articles in the work. The CONTRACTOR shall promptly segregate and remove rejected material and finished articles from the site of the work.

14. SAMPLES

14.1. All samples called for in the Specifications or required by the ENGINEER shall be furnished by the CONTRACTOR and shall be submitted to the ENGINEER for his review. Samples shall be furnished so as not to delay fabrication, allowing the ENGINEER reasonable time for the consideration of the samples submitted.

14.1.1. Samples for Tests: CONTRACTOR shall furnish such samples of material as may be required for examination and test. All samples of materials for tests shall be taken according to standard methods or as provided in the Contract Documents.

14.1.2. CONTRACTOR's Guaranty: All samples shall be submitted by the CONTRACTOR with a covering letter indicating that such samples are recommended by the CONTRACTOR for the service intended and that the CONTRACTOR's Guaranty will fully apply.

14.1.3. All materials, equipment and workmanship shall be in accordance with samples guaranteed by the CONTRACTOR and reviewed by the ENGINEER.

15. SHOP DRAWINGS

15.1. The CONTRACTOR shall provide shop drawings, setting schedules and such other drawings as may be necessary for the prosecution of the work in the shop and in the field as required by the Drawings, Specifications or the ENGINEER's instructions. Deviations from the Drawings and Specifications shall be called to the attention of the ENGINEER at the time of the first submission of shop drawings and other drawings for consideration. The ENGINEER's review of any drawings shall not release the CONTRACTOR from responsibility for such deviations. Shop drawings shall be submitted according to a schedule prepared jointly by the CONTRACTOR and the ENGINEER.

15.1.1. CONTRACTOR's Certification: When submitted for the ENGINEER's review, shop drawings shall bear the CONTRACTOR's certification that he has reviewed, checked and approved the shop drawings, that they are in harmony with the requirements of the Project and with the provisions of the Contract Documents, and that he has verified all field measurements and construction criteria, materials, catalog numbers and similar data. CONTRACTOR shall also certify that the work represented by the shop drawings is recommended by the CONTRACTOR and the CONTRACTOR's Guaranty will fully apply.

16. GUARANTY

16.1. The CONTRACTOR shall guarantee all materials and equipment furnished and work performed for a period of two years from the date of final payment of the work.

16.1.1. The Performance and Indemnity Bond shall remain in full force and effect during the guaranty period.

16.1.2. Correction of faulty work after final payment shall be as provided in Paragraph 41.

17. INSURANCE

17.1. The CONTRACTOR shall not commence any work until he obtains, at his own expense, all required insurance. Such insurance must have the approval of the OWNER as to the limit, form, and amount. The CONTRACTOR will not permit any Subcontractor to commence work on this project until such Subcontractor has complied with the same insurance requirements.

Types: The types of insurance the CONTRACTOR is required to obtain

and maintain for the full period of the Contract will be: Workmen's Compensation Insurance, Automobile and Comprehensive General Liability Insurance as detailed in the following portions of this specification.

17.1.2. Evidence: As evidence of specified insurance coverage, the OWNER may, in lieu of actual policies, accept certificates issued by the insurance carrier showing such policies in force for the specified period. Each policy or certificate will bear an endorsement or statement waiving right of cancellation or reduction in coverage within ten days' notice in writing to be delivered by registered mail to the OWNER. Should any policy be cancelled before final payment by the OWNER to the CONTRACTOR and the CONTRACTOR fails immediately to procure other insurance as specified, the OWNER reserves the right to procure such insurance and to deduct the cost thereof from any sum due the CONTRACTOR under this Contract.

17.1.3. Adequacy of Performance: Any insurance bearing on adequacy of performance shall be maintained after completion of the project for the full guaranty period. Should such insurance be cancelled before the end of the guaranty period and the CONTRACTOR fails immediately to procure other insurance as specified, the OWNER reserves the right to procure such insurance and to charge the cost thereof to the CONTRACTOR.

17.1.4. Payment of Damages: Nothing contained in these insurance requirements is to be construed as limiting the extent of the CONTRACTOR's responsibility for payment of damages resulting from his operations under this Contract.

18. WORKMEN'S COMPENSATION INSURANCE

18.1. Before the Agreement between the OWNER and the CONTRACTOR is entered into, the CONTRACTOR shall submit written evidence that he and all Subcontractors have obtained, for the period of the Contract, full Workman's Compensation Insurance coverage for all persons whom they employ or may employ in carrying out the work under this Contract. This insurance shall be in strict accordance with the requirements and statutory limits of the most current and applicable South Carolina Workman's Compensation Insurance Laws.

19. COMPREHENSIVE GENERAL LIABILITY AND AUTOMOBILE INSURANCE

19.1. Before commencement of the work, the CONTRACTOR shall submit written evidence that he and all his Subcontractors have obtained for the period of the Contract, full Comprehensive General Liability Insurance and automobile coverage. This coverage shall provide for both bodily injury and property damage.

19.1.1. Comprehensive General Liability Insurance shall include coverage for bodily injury, sickness or disease, death, or property damage arising directly or indirectly out of or in connection with the performance of work under this Contract, and shall provide for a combined single limit of not less than one million ($1,000,000) dollars for all damages arising out of bodily injury, sickness or disease, death, or property damage for each occurrence.

19.1.2. Automobile insurance shall include coverage for bodily injury and property damage arising directly or indirectly out of or in connection with the performance of work under this Contract, and shall provide for a combined single limit of not less than one million ($1,000,000) dollars for all damages arising out of bodily injury or property damage for each occurrence.

19.1.3. Indemnity: Included in such insurance will be contractual coverage sufficiently broad to insure the provisions of Paragraph 20.

20. INDEMNITY

20.1. The CONTRACTOR shall hold harmless, indemnify and defend the OWNER, it's successors and assigns, the ENGINEER, their consultants, and each of their officers and employees and agents, from any and all liability claims, losses or damage arising or alleged to arise from the performance of the work described herein, but not including the sole negligence of the OWNER or the ENGINEER.

21. PATENTS AND ROYALTIES

21.1. If any design, device, material or process covered by letters, patent or copyright is used by the CONTRACTOR, he shall provide for such use by legal agreement with the OWNER of the patent or a duly authorized licensee of such OWNER, and shall save harmless the OWNER, and the ENGINEER, from any and all loss or expense on account thereof, including its use by the OWNER.

22. PERMITS

22.1. All permits and licenses necessary for the prosecution of the work shall be secured and paid for by the CONTRACTOR. This shall include all Business Licenses required by the Local Government.

23. LAWS TO BE OBSERVED

23.1. The CONTRACTOR shall give all notices and comply with all Federal, State and local laws, ordinances and regulations in any manner affecting the conduct of the work, and all such orders and decrees as exist, or may be enacted by bodies or tribunals having any jurisdiction or authority over the work, and shall indemnify and save harmless the OWNER its successors and assigns, the ENGINEER, their consultants, and each of their officers and employees and agents against any claim or liability arising from, or based on, the violation of any such law, ordinance, regulation, order or decree, whether by himself or his employees.

24. WARNING SIGNS AND BARRICADES

24.1. The CONTRACTOR shall provide adequate signs, barricades, and watchmen and take all necessary precautions for the protection of the work and the safety of the public.

25. PUBLIC CONVENIENCE

25.1. The CONTRACTOR shall at all times so conduct his work as to ensure the least possible obstruction to traffic and inconvenience to the general public and the residents in the vicinity of the work, and to ensure the protection of persons and property. No road or street shall be closed to the public except with permission of the proper authorities. Fire hydrants on or adjacent to the work shall be kept accessible to fire-fighting equipment at all times. Temporary provisions shall be made by the CONTRACTOR to ensure the use of sidewalks and the proper functioning of all gutters, sewer inlets, drainage ditches, and irrigation ditches, which shall not be obstructed.

26. SAFETY

26.1. The CONTRACTOR shall be solely and completely responsible for the conditions of the job site, including safety of all persons and property affected directly or indirectly by his operation during the performance of the work. This requirement will not be limited to normal working hours but will apply continuously 24 hours per day until written acceptance of the work by the OWNER and shall not be limited to normal working hours.

26.2. The ENGINEER's construction reviews of the CONTRACTOR's performance is not intended to include review of the adequacy of the CONTRACTOR's safety measures in, on, or near the construction site.

27. NOTICE TO PROCEED

27.1. Following the execution of the Contract by the OWNER and the CONTRACTOR, written Notice to Proceed with the work shall be given by the OWNER to the CONTRACTOR. The CONTRACTOR shall begin and shall prosecute the work regularly and uninterruptedly thereafter (except as provided for herein) with such force as to secure the completion of the work within the Contract Time.

28. TIME FOR COMPLETION AND LIQUIDATED DAMAGES

28.1. It is hereby understood and mutually agreed, by and between the CONTRACTOR and the OWNER, that the date of beginning and the time for completion as specified in the Contract of the work to be done hereunder are ESSENTIAL CONDITIONS of this Contract; and it is further mutually understood and agreed that the work embraced in this Contract shall be commenced on a date to be specified in the Notice to Proceed.

28.2. The CONTRACTOR agrees that said work shall proceed regularly, diligently, and uninterruptedly at such rate of progress as will ensure full completion thereof within the time specified. It is expressly understood and agreed, by and between the CONTRACTOR and the OWNER, that the time for the completion of the work described herein is a reasonable time for the completion of the same, taking into consideration the average climatic range and usual industrial conditions prevailing in this locality.

28.3. If said CONTRACTOR shall neglect, fail, or refuse to complete the work within the time herein specified, or any proper extension thereof granted by the OWNER, then the CONTRACTOR does hereby agree, as a part consideration for the awarding of this Contract, to pay to the OWNER the amount specified in the Contract, not as a penalty but as liquidated damages for such breach of contract as hereinafter set forth, for each and every calendar day that the CONTRACTOR shall be in default after the time stipulated in the Contract for completing the work.

28.4. The said amount is fixed and agreed upon by and between the CONTRACTOR and the OWNER because of the impracticability and extreme difficulty of fixing and ascertaining the actual damages the OWNER would in such event sustain, and said amount is agreed to be the amount of damages which the OWNER would sustain and said amount shall be retained from time to time by the OWNER from current periodical estimates.

28.5. It is further agreed that time is of the essence of each and every portion of this Contract and of the Specifications wherein a definite and certain length of time is fixed for the performance of any act whatsoever; and where under the Contract an additional time is allowed for the completion of any work, the new time limit fixed by such extension shall be of the essence of this Contract. PROVIDED, that the CONTRACTOR shall not be charged with liquidated damages or any excess cost when the delay in completion of the work is due to the following:

28.5.1. Any preference, priority or allocation order duly issued by the Federal or State Government.

28.5.2. Unforeseeable cause beyond the control and without the fault or negligence of the CONTRACTOR, including, but not restricted to, acts of God, or of the public enemy, acts of the OWNER, acts of another CONTRACTOR in the performance of a contract with the OWNER, fires, flood, epidemics, quarantine restrictions, strikes, freight embargoes and unusually severe weather; and

28.5.3. Any delays of Subcontractors or suppliers occasioned by any of the causes specified in subsection 28.5.1. and 28.5.2. of this article:

PROVIDED, FURTHER, that the CONTRACTOR shall, within 10 days from the beginning of such delay, unless the OWNER shall grant a further period of time prior to the date of final settlement of the contract, notify the OWNER, in writing, of the causes of the delay, who shall ascertain the

facts and extent of the delay and notify the CONTRACTOR within a reasonable time of its decision in the matter, and grant such extension of time as the OWNER shall deem equitable and just.

29. CONSTRUCTION SCHEDULE AND PERIODIC ESTIMATES

29.1. Immediately after execution and delivery of the contract, and before the first partial payment is made, the CONTRACTOR shall deliver to the OWNER an estimated construction progress schedule in a form satisfactory to the OWNER, showing the proposed dates of commencement and completion of each of the various subdivisions of work required under the Contract Documents.

30. EXTENSION OF CONTRACT TIME

30.1. A delay beyond the CONTRACTOR's control occasioned by an Act of God, by act or omission on the part of the OWNER or by strikes, lockouts, fire, etc., may entitle the CONTRACTOR to any extension of time in which to complete the work as agreed by the OWNER, provided, however, that the CONTRACTOR shall immediately give written notice to the OWNER of the cause of such delay.

30.2. Act of God shall mean an earthquake, flood, cyclone, or other cataclysmic phenomenon. Storms of normal intensity for the locality shall not be construed as an Act of God and no reparation shall be made to the CONTRACTOR for damages to the work resulting there from.

31. EXTRA WORK

31.1. New and unforeseen items of work found to be necessary, and which cannot be covered by any item or combination of items for which there is a Contract price, shall be classed as Extra Work. It shall be the responsibility of the CONTRACTOR to identify necessary work items classed as Extra Work and for which no previous contract price has been arranged and advise the ENGINEER and the OWNER of the need for the aforesaid necessary Extra Work. The CONTRACTOR shall do such Extra Work and furnish such materials as may be required for the proper completion or construction of the whole work contemplated, upon written order from the OWNER as approved by the ENGINEER. In the absence of such written order, no claim for Extra Work shall be considered.

31.2. Extra Work shall be performed in accordance with these Contract Documents where applicable and work not covered by such shall be done in accordance with the best construction practice and in a workmanlike manner.

31.3. Extra Work required in an emergency to protect life and property shall be performed by the CONTRACTOR as required.

32. CLEANING UP

32.1. The CONTRACTOR shall at all times, keep the premises clean and shall remove from the OWNER's property, and from all public and private property, temporary structures, rubbish, waste materials resulting from his operation or caused by his employees, and all surplus materials, leaving the site smooth, clean and true to line and grade and in the same condition as existed prior to the work performed by the CONTRACTOR or his Subcontractors and as approved by the OWNER. Failure to maintain a clean project site or to complete clean-up of the project site at the completion of the work shall be cause for the OWNER to perform the necessary clean-up and the costs thereof shall be charged to the CONTRACTOR.

33. REQUEST FOR PAYMENT

33.1. The CONTRACTOR may submit to the OWNER periodically, but not more than once each month, a Request for Payment for work done and materials delivered to and stored on the site. The

CONTRACTOR shall furnish the OWNER all reasonable information required for obtaining the necessary data relative to the progress and execution of the work. Payment for materials stored on the site will be conditioned upon evidence submitted to establish the OWNER's title to such materials. Each Request for Payment shall be computed on the basis of work completed on all items listed in the Detailed Breakdown of Contract (or on unit prices, as the case may be), less 10 percent to be retained until final completion and acceptance of the work and less previous payments.

34. ENGINEER'S ACTION ON REQUEST FOR PAYMENT

34.1. All CONTRACTOR's Requests for Payment shall be referred to the ENGINEER for his review and, within a reasonable period, the ENGINEER shall:

34.1.1. Recommend payment by the OWNER of the Request for Payment as submitted.

34.1.2. Recommend payment by the OWNER of such other amount as the ENGINEER shall consider as due the CONTRACTOR, informing the OWNER and the CONTRACTOR in writing of his reasons for recommending the amended amount.

34.1.3. Recommend to the OWNER that payment of the Request for Payment be withheld, informing the CONTRACTOR and the OWNER in writing of his reasons, for so recommending.

35. OWNER'S ACTION ON REQUEST FOR PAYMENT

35.1. Within thirty days after receipt of a Request for Payment from the CONTRACTOR, the OWNER shall:

35.1.1. Pay the Request for Payment as recommended by the ENGINEER.

35.1.2. Pay such other amount, in accordance with Paragraph 36, as he shall decide is due the CONTRACTOR, informing the CONTRACTOR and the ENGINEER in writing of this reasons for paying the amended amount.

35.1.3. Withhold payment in accordance with Paragraph 36, informing the CONTRACTOR and the ENGINEER of his reasons for withholding payment.

36. OWNER'S RIGHT TO WITHHOLD PAYMENT OF A REQUEST FOR PAYMENT

36.1. The OWNER may withhold payment, in whole or in part, of a Request for Payment to the extent necessary to protect himself from loss on account of any of the following:

36.1.1. Defective work.

36.1.2. Evidence indicating the probable filing of claims by other parties against the CONTRACTOR that may adversely affect the OWNER.

36.1.3. Failure of the CONTRACTOR to make payments due to Subcontractors, material suppliers, or employees.

36.1.4. Damage to another CONTRACTOR.

37. PAYMENT FOR EXTRA WORK

37.1. Written notice of claims for payment for Extra Work shall be given by the CONTRACTOR within ten days after receipt of instructions from the OWNER to proceed with the Extra Work and also before any work is commenced, except in emergency endangering life or property. No claim shall be valid

unless so made. In all cases, the CONTRACTOR's itemized estimate sheets showing all labor and material shall be submitted to the OWNER. The OWNER's order for Extra Work shall specify any extension of the Contract Time and one of the following methods of payment:

37.1.1. Unit prices or combination of unit prices which formed the basis of the original Contract.

37.1.2. A lump sum based on the CONTRACTOR's estimate and accepted by the OWNER.

37.1.3. Actual cost plus 15 percent for overhead and profit. Actual costs are defined as follows:

37.1.3.1. Labor costs, including time of foreman while engaged directly upon extra work.

37.1.3.2. Labor insurance and taxes.

37.1.3.3. Materials and supplies actually used on the work.

37.1.3.4. Associated General Contractors of America standard rental rates on each piece of equipment having a value in excess of $50.00. Equipment and tools of lesser value are considered "small tools" and, as such, are considered to be part of overhead.

38. ACCEPTANCE AND FINAL PAYMENT

38.1. When the CONTRACTOR has completed the work in accordance with the terms of the Contract Documents, he shall certify completion of the work to the OWNER and submit a final Request for Payment, which shall be the Contract Amount plus all approved additions, less all approved deductions and less previous payments made. The CONTRACTOR shall furnish evidence that he has fully paid all debts for labor, materials, and equipment incurred in connection with the work, and upon acceptance by the OWNER, the OWNER will release the CONTRACTOR except as to the conditions of the Performance and Indemnity Bond and the Labor and Material Payment Bond, any legal rights of the OWNER, required guaranties, and Correction of Faulty Work after Final Payment, and will pay the CONTRACTOR's final Request of Payment. The CONTRACTOR shall allow sufficient time between the time of completion of the work and approval of the final Request for Payment for the ENGINEER to assemble and check the necessary data.

38.1.1. Release of Liens: The CONTRACTOR shall deliver to the OWNER a complete release of all liens arising out of this Contract before the retained percentage or before the final Request for Payment is paid. If any liens remains unsatisfied after all payments are made, the CONTRACTOR shall refund to the OWNER such amounts as the OWNER may have been compelled to pay in discharging such liens including all costs and a reasonable attorney's fees.

39. OWNER'S RIGHT TO TERMINATE AGREEMENT

39.1. The OWNER shall have the right to terminate his agreement with the CONTRACTOR after giving ten days' written notice of termination to the CONTRACTOR in the event of any default by the CONTRACTOR.

39.1.1 Default by CONTRACTOR: It shall be considered a default by the CONTRACTOR whenever he shall:

39.1.1.1. Declare bankruptcy, become insolvent, or assign his assets for the benefit of his creditors.

39.1.1.2. Disregard or violate provisions of the Contract Documents or fail to prosecute the work according to the agreed Schedule of Completion, including extensions thereof.

39.1.1.3. Fail to provide a qualified superintendent, competent workmen or Subcontractors, or proper materials, or fail to make prompt payment thereof.

39.1.2. Completion by the OWNER: In the event of termination of the Agreement by the OWNER because of default by the CONTRACTOR, the OWNER may take possession of the work and of all materials and equipment thereon and may finish the work by whatever method and means he may select.

40. TERMINATION OF CONTRACTOR'S RESPONSIBILITY

40.1. The Contract will be considered complete when all work has been finished and the project accepted in writing by the OWNER. The CONTRACTOR's responsibility shall then cease, except as set forth in his Performance and Indemnity Bond, as provided in Paragraph 16, Guaranty, and as provided in Paragraph 41, Correction of Faulty Work After Final Payment.

41 CORRECTION OF FAULTY WORK AFTER FINAL PAYMENT

41.1. The making of the final payment by the OWNER to the CONTRACTOR shall not relieve the CONTRACTOR of responsibility for faulty materials or workmanship. The CONTRACTOR shall promptly replace any such defects, as determined by the ENGINEER, discovered within two years from the date of final payment of the work.

42. INSPECTION

42.1. The authorized representatives of the ENGINEER and OWNER shall be permitted to inspect all materials, workmanship, and other relevant project records and data. Materials and workmanship will be subject to the approval of the OWNER and/or his representative.

43. CORRECTION OF WORK

43.1. All work, all materials, whether incorporated in the work or not, all processes of manufacture, and all methods of construction shall be, at all times and places, subject to the inspection of the ENGINEER who shall be the final judge of the quality and suitability of the work, materials, process of manufacturer, and methods of construction for the purposes for which they are used. Should they fail to meet his approval, they shall be forthwith reconstructed, made good, replaced and/or corrected, as the case may be, by the CONTRACTOR at his own expense. Rejected material shall immediately be removed from the site. If, in the opinion of the ENGINEER, it is undesirable to replace any defective or damaged materials or to reconstruct or correct any portion of the work injured or not performed in accordance with the Contract hereunder shall be reduced by such amount as in the judgment of the ENGINEER shall be equitable.

44. SUBSURFACE CONDITIONS FOUND DIFFERENT

44.1. Should the CONTRACTOR encounter subsurface and/or latent conditions at the site materially differing from those shown on the Plans or indicated in the Specifications, he shall immediately give notice to the ENGINEER of such conditions before they are disturbed. The ENGINEER will thereupon promptly investigate the conditions, and if he finds and so determines that they materially differ from those shown on the Plans or indicated in the Specifications, he will at once make such changes in the Plans and/or Specifications, as he may find necessary. Any increase or decrease of cost resulting from such changes are to be adjusted in the manner provided in Paragraph 37 of the General Conditions.

45. CONTRACT SECURITY

45.1. The CONTRACTOR shall furnish a Performance Indemnity Bond and Payment Bond (forms attached) in an amount at least equal to 100% of the contract prices as security for the faithful performance of this Contract, as the security for the payment of all persons performing labor on the

project under this Contract, and furnishing materials in connection with this Contract. The Performance and Indemnity Bond and the Payment Bond may be in one or in separate instruments in accordance with local law. Before final acceptance, each bond must be approved by the OWNER.

46. DISPUTE RESOLUTION

46.1 OWNER and CONTRACTOR agree to negotiate all disputes between them in good faith prior to exercising their rights under law.

46.2 Any claim, dispute or other matter in question arising from or related to this Agreement or the performance or breach thereof, which cannot be resolved through direct discussions between parties shall be subject to mediation as a condition precedent to the institution of legal or equitable proceedings by either party, and only after both parties have completed the mediation process.

46.3 Through mediation, CONTRACTOR and OWNER shall endeavor to resolve claims, disputes, or other matters in question between them by mediation in an informal process in which a third-party mediator facilitates discussion between the parties. The parties may designate a mediator mutually agreeable to both CONTRACTOR and OWNER to conduct the mediation. If the parties are unable to agree upon a mediator, mediation shall be conducted in accordance with the mediation provision of the South Carolina Circuit Court Alternative Dispute Resolution Rules. The mediation shall be conducted in York County, South Carolina. A request for mediation shall be filed in writing with the other party to this Agreement, and legal or equitable proceedings shall be stayed pending mediation for a period of sixty (60) days from the date of the request for mediation is filed, unless stayed for a longer period of time by agreement of the parties or court order. The cost of a third-party mediator will be shared equally by the parties.

46.4 If the parties reach an agreement during the mediation process, they shall reduce the agreement to writing and sign it with their attorneys, if any. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

46.5 In any action or proceedings to enforce or interpret any provision of this Agreement, or where any provision herein is validity asserted as a defense, each Party shall bear its own attorney fees, costs, and expenses.

END OF SECTION

00 73 00 SUPPLEMENTARY CONDITIONS

PART 1 GENERAL

1.01 SUMMARY

A. These Supplementary Conditions amend and supplement the General Conditions defined in Document 00 72 00 - General Conditions and other provisions of Contract Documents as indicated below. Provisions that are not so amended or supplemented remain in full force and effect.

B. The terms used in these Supplementary Conditions that are defined in the General Conditions have the meanings assigned to them in the General Conditions.

1.02 RELATED SECTIONS

A. Section 00 50 00 - Contracting Forms and Supplements.

B. Section 01 42 16 - Definitions.

1.03 REFERENCE STANDARDS

A. AIA A503 - Guide for Supplementary Conditions 2017.

B. AIA A511 - Guide for Supplementary Conditions. 1999.

C. EJCDC C-800 - Guide to the Preparation of Supplementary Conditions 2013.

1.04 MODIFICATIONS TO GENERAL CONDITIONS

A. **Contractor's Obligations** – Add the following sections:

2.2 *Reporting Discrepancies:*

1. *Contractor's Review of Contract Documents Before Starting Work*: Before undertaking each part of the Work, Contractor shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy which Contractor discovers, or has actual knowledge of, and shall obtain a written interpretation or clarification from Engineer before proceeding with any Work affected thereby.

2. *Contractor's Review of Contract Documents During Performance of Work*: If, during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation , (b) any standard, specification, manual, or code, or (c) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 6.16.A) until an amendment or supplement to the Contract Documents has been issued.

3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

2.3 Resolving Discrepancies:

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Contract Documents and:

a. the provisions of any standard, specification, manual, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference in the Contract Documents); or

b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

47.1 Electronic Data – Add Electronic Data Section:

1. Unless otherwise stated in the Supplementary Conditions, the data furnished by Owner or Engineer to Contractor, or by Contractor to Owner or Engineer, that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.

2. Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data's creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 60 days, after which the receiving party shall be deemed to have accepted the data thus transferred. Any errors detected within the 60-day acceptance period will be corrected by the transferring party.

3. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

01 10 00 SUMMARY

PART 1 GENERAL

1.01 **PROJECT**

A. The Project consists of the construction of a gravity sewer interceptor consisting of approximately 6,900 LF of 24-inch gravity sewers, 1,875 LF of 18-inch gravity sewers and approximately 36 related sewer manholes. Additionally, the project includes 650-LF of 48” gravity jack and bore and 150-LF of 36” gravity jack and bore. Included with the construction are all necessary appurtenances necessary for construction, including any necessary bypass pumping for gravity sewer construction.

B. The jack and bore operations at Line A from STA 29+52 to STA 36+09 shall be executed at the beginning of the project, prior to installation of any downstream gravity sewer piping.

1.02 **CONTRACT DESCRIPTION**

A. Contract Type: A single prime contract based on a Stipulated Price as described in Document 005200 - Agreement Form.

1.03 **ALTERATIONS WORK**

A. Scope of demolition and removal work is specified in the York County Standard Specifications and Construction Drawings.

1.04 **OWNER OCCUPANCY**

A. Owner intends to occupy the Project upon Final Completion.

B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.

C. Schedule the Work to accommodate Owner occupancy.

1.05 **SPECIFICATION SECTIONS APPLICABLE TO ALL CONTRACTS**

A. Unless otherwise noted, all provisions of the sections listed below apply to all contracts. Specific items of work listed under individual contract descriptions constitute exceptions.

B. Section 012000 - Price and Payment Procedures.

C. Section 012200 - Unit Prices.

D. Section 013216 - Construction Progress Schedule.

END OF SECTION

01 20 00 PRICE AND PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedures for preparation and submittal of applications for progress payments.

1.02 RELATED REQUIREMENTS

A. Section 00 52 00 - Agreement Form: Contract Sum, retainages, payment period, monetary values of unit prices.

B. Section 00 72 00 - General Conditions: Additional requirements for progress payments, final payment, changes in the Work.

1.03 SCHEDULE OF VALUES

A. Use Schedule of Values Form: 00 41 00 - Bid Form.

B. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit draft to Engineer for approval.

C. Forms filled out by hand will not be accepted.

1.04 APPLICATIONS FOR PROGRESS PAYMENTS

A. Payment Period: Submit at intervals stipulated in the Agreement.

B. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to Engineer for approval.

C. Forms filled out by hand will not be accepted.

D. Execute certification by signature of authorized officer.

E. Submit one electronic and three hard-copies of each Application for Payment.

1.05 APPLICATION FOR FINAL PAYMENT

A. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Sum, previous payments, and sum remaining due.

B. Application for Final Payment will not be considered until the following has been accomplished:

1. All closeout procedures specified in Section 01 70 00.

END OF SECTION

01 22 00 UNIT PRICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Measurement and payment criteria applicable to Work performed under a unit price payment method.

1.02 RELATED REQUIREMENTS

A. Document 00 21 13 - Instructions to Bidders: Instructions for preparation of pricing for Unit Prices.

B. Section 01 20 00 - Price and Payment Procedures: Additional payment and modification procedures.

1.03 COSTS INCLUDED

A. Unit Prices included on the Bid Form shall include full compensation for all required labor, products, tools, equipment, plant, transportation, services and incidentals; erection, application or installation of an item of the Work; overhead and profit.

1.04 UNIT QUANTITIES SPECIFIED

A. Quantities indicated in the Bid Form are for bidding and contract purposes only. Quantities and measurements of actual Work will determine the payment amount.

1.05 MEASUREMENT OF QUANTITIES

A. Measurement methods delineated in the individual specification sections complement the criteria of this section. In the event of conflict, the requirements of the individual specification section govern.

B. Take all measurements and compute quantities. Measurements and quantities will be verified by Engineer.

C. Assist by providing necessary equipment, workers, and survey personnel as required.

1.06 PAYMENT

A. Payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities of Work that is incorporated in or made necessary by the Work and accepted by the Engineer, multiplied by the unit price.

B. Payment will not be made for any of the following:

1. Products wasted or disposed of in a manner that is not acceptable.
2. Products determined as unacceptable before or after placement.
3. Products not completely unloaded from the transporting vehicle.
4. Products placed beyond the lines and levels of the required Work.
5. Products remaining on hand after completion of the Work.
6. Loading, hauling, and disposing of rejected Products.

1.07 DEFECT ASSESSMENT

A. Replace Work, or portions of the Work, not complying with specified requirements.

B. If, in the opinion of Engineer, it is not practical to remove and replace the Work, Engineer will direct one of the following remedies:

1. The defective Work may remain, but the unit price will be adjusted to a new unit price at the discretion of Engineer.

C. If, in the opinion of Owner, it is not practical to remove and replace the Work, Owner will direct one of the following remedies:

1. The defective Work may remain, but the unit price will be adjusted to a new unit price at the discretion of Owner.

D. The individual specification sections may modify these options or may identify a specific formula or percentage price reduction.

E. The authority of Engineer to assess the defect and identify payment adjustment is final.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

01 25 00 SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedural requirements for proposed substitutions.

1.02 RELATED REQUIREMENTS

A. Section 01 22 00 - Unit Prices, for additional unit price requirements.

1.03 REFERENCE STANDARDS

A. CSI/CSC Form 1.5C - Substitution Request (During the Bidding/Negotiating Stage) Current Edition.

B. CSI/CSC Form 13.1A - Substitution Request (After the Bidding/Negotiating Phase) Current Edition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. A Substitution Request for products, assemblies, materials and equipment constitutes a representation that the submitter:

1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
2. Agrees to provide the same warranty for the substitution as for the specified product.
3. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
4. Waives claims for additional costs or time extension that may subsequently become apparent.

B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.

C. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.

1. No specific form is required. Contractor's Substitution Request documentation must include the following:
    a. Project Information:
        1) Official project name and number, and any additional required identifiers established in Contract Documents.
    b. Substitution Request Information:
    c. Attached Comparative Data: Provide point-by-point, side-by-side comparison addressing essential attributes specified, as appropriate and relevant for the item:
    d. Impact of Substitution:

D. Limit each request to a single proposed substitution item.

3.02 **RESOLUTION**

A. Engineer may request additional information and documentation prior to rendering a decision. Provide this data in an expeditious manner.

B. Engineer will notify Contractor in writing of decision to accept or reject request.

3.03 **ACCEPTANCE**

A. Accepted substitutions change the work of the Project. They will be documented and incorporated into work of the project by Change Order, Construction Change Directive, Supplementary Instructions, or similar instruments provided for in the Conditions of the Contract.

3.04 **CLOSEOUT ACTIVITIES**

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

END OF SECTION

SECTION 01 26 20
WEATHER DELAYS

PART 1 - GENERAL

1.01 EXTENSIONS OF CONTRACT TIME

A. If the basis exists for an extension of time in accordance with paragraph 8.3 of the Conditions, an extension of time on the basis of weather may be granted only for the number of Weather Delay Days in excess of the number of days listed as the Standard Baseline for that month.

1.02 STANDARD BASELINE FOR AVERAGE CLIMATIC RANGE

A. The Owner has reviewed weather data available from the National Oceanic and Atmospheric Administration and determined a Standard Baseline of average climatic range for the State of South Carolina.

B. Standard Baseline shall be regarded as the normal and anticipatable number of calendar days for each month during which construction activity shall be expected to be prevented and suspended by cause of adverse weather. Suspension of construction activity for the number of days each month as listed in the Standard Baseline is included in the Work and is not eligible for extension of Contract Time.

C. Standard Baseline is as follows:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10	9	8	8	8	11	12	11	7	7	8	9

1.03 ADVERSE WEATHER and WEATHER DELAY DAYS

A. Adverse Weather is defined as the occurrence of one or more of the following conditions which prevents exterior construction activity or access to the site within twenty-four (24) hours:

1. precipitation (rain, snow, or ice) in excess of one-tenth inch (0.10") liquid measure
2. temperatures which do not rise above 32 degrees F by 10:00 a.m.
3. temperatures which do not rise above that specified for the day's construction activity by 10:00 a.m., if any is specified
4. sustained wind in excess of twenty-five (25) m.p.h.
5. standing snow in excess of one inch (1.00")

B. Adverse Weather may include, if appropriate, "dry-out" or "mud" days:

1. for rain days above the standard baseline;
2. only if there is a hindrance to site access or sitework, such as excavation, backfill, and footings; and,
3. at a rate no greater than 1 make-up day for each day or consecutive days of rain beyond the standard baseline that total 1.0 inch or more, liquid measure, unless specifically recommended otherwise by the Designer.

C. A Weather Delay Day may be counted if adverse weather prevents work on the project for fifty percent (50%) or more of the contractor's scheduled work day, including a weekend day or holiday if Contractor has scheduled construction activity that day.

1.04 DOCUMENTATION and SUBMITTALS

A. WEATHER DELAY REPORT:

1. Use a copy of Section 01 26 25 as a Weather Delay Report, indicating for each calendar month the days on which construction activity affecting the critical path of the Work was prevented by weather conditions.

2. In the column for the cause, indicate measurement of precipitation, temperature, wind, or other influencing factors.

3. Describe the construction activity that was scheduled, on the critical path, and delayed.

4. At the end of the month, add up the number of days delay, subtract the baseline number given in this Section, and show the resulting claimable days in excess of baseline.

5. Submit a copy of the completed report with the next application for payment. Reports submitted with applications for payment do not constitute a claim or preliminary claim for extension of time.

B. When making a claim for a time extension based on weather delay(s):

1. Submit a copy of all reports completed since the last month for which a time extension was previously claim, or the commencement of Work if no previous claim, through the last month for which delay is being claimed. Claims for time extension based upon weather delays are unjustified if a submitted report does not corroborate the claim or if no report was submitted when it was required with an application for payment.

2. Submit daily jobsite work logs showing which and to what extent construction activities have been affected by weather on a monthly basis.

3. Submit actual weather data to support claim for time extension obtained from nearest NOAA weather station or other independently verified source approved by Designer at beginning of project.

4. Organize claim and documentation to facilitate evaluation on a basis of calendar month periods, and submit in accordance with the procedures for Claims established in Article 15 of the Conditions, and the applicable General Requirements.

5. If an extension of the Contract Time is appropriate, it shall be implemented in accordance with the provisions of Article 7 of the Conditions, and the applicable General Requirements.

END OF SECTION

01 26 25 WEATHER DELAY REPORT

Project Number and Project Name	Month and Year reported below

Date	weather condition causing delay	Work scheduled on critical path for this day that was delayed
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
	Total number of days this month with delay due to weather	
	Baseline number from Section 01 26 20	
	Total – Baseline = claimable days	

01 30 00 ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General administrative requirements.

B. Electronic document submittal service.

C. Preconstruction meeting.

D. Progress meetings.

E. Construction progress schedule.

F. Contractor's daily reports.

G. Progress photographs.

H. Submittals for review, information and project closeout.

I. Submittal procedures.

1.02 RELATED REQUIREMENTS

A. Section 00 72 00 - General Conditions: Dates for applications for payment.

B. Section 00 73 00 - Supplementary Conditions: Duties of the Construction Manager.

C. Section 01 70 00 - Execution and Closeout Requirements: Additional coordination requirements.

1.03 GENERAL ADMINISTRATIVE REQUIREMENTS

A. Comply with requirements of Section 01 70 00 - Execution and Closeout Requirements for coordination of execution of administrative tasks with timing of construction activities.

B. Make the following types of submittals to Engineer:

1. Requests for Interpretation (RFI).
2. Requests for substitution.
3. Shop drawings, product data, and samples.
4. Test and inspection reports.
5. Design data.
6. Manufacturer's instructions and field reports.
7. Applications for payment and change order requests.
8. Progress schedules.
9. Coordination drawings.
10. Correction Punch List and Final Correction Punch List for Substantial Completion.
11. Closeout submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRECONSTRUCTION MEETING

A. Schedule meeting after Notice of Award.

B. Engineer will schedule a meeting after Notice of Award.

C. Attendance Required:

1. Owner.
2. Engineer.
3. Contractor.
4. York County Stormwater Inspector.

D. Agenda:

1. Execution of Owner-Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
3. Distribution of Contract Documents.
4. Submission of list of subcontractors, list of products, schedule of values, and progress schedule.
5. Designation of personnel representing the parties to Contract.
6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
7. Scheduling.

E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Engineer, Owner, participants, and those affected by decisions made.

3.02 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the work at maximum monthly intervals.

B. Engineer will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.

C. Attendance Required:

1. Contractor.
2. Owner.
3. Engineer.
4. Contractor's superintendent.
5. Major subcontractors.
6. Boring Subcontractor if active.

D. Agenda:

1. Review meeting summary of previous meetings.
2. Review of work progress.
3. Field observations, problems, and decisions.

4. Identification of problems that impede, or will impede, planned progress.
5. Review of submittals schedule and status of submittals.
6. Maintenance of progress schedule.
7. Corrective measures to regain projected schedules.
8. Planned progress during succeeding work period.
9. Maintenance of quality and work standards.
10. Effect of proposed changes on progress schedule and coordination.
11. Other business relating to work.

E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Engineer, Owner, participants, and those affected by decisions made.

3.03 **CONSTRUCTION PROGRESS SCHEDULE - SEE SECTION 01 32 16**

A. Within 10 days after date of the Agreement, submit preliminary schedule defining planned operations for the first 60 days of work, with a general outline for remainder of work.

B. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.

1. Include written certification that major subcontractors have reviewed and accepted proposed schedule.

3.04 **DAILY CONSTRUCTION REPORTS**

A. Include only factual information. Do not include personal remarks or opinions regarding operations and/or personnel.

B. In addition to transmitting electronically a copy to Owner and Engineer, submit two printed copies at weekly intervals.

1. Submit in format acceptable to Owner.

C. Prepare a daily construction report recording the following information concerning events at Project site and project progress:

1. Date.
2. High and low temperatures, and general weather conditions.
3. List of subcontractors at Project site.
4. Major equipment at Project site.
5. Material deliveries.
6. Safety, environmental, or industrial relations incidents.
7. Meetings and significant decisions.
8. Unusual events (submit a separate special report).
9. Stoppages, delays, shortages, and losses. Include comparison between scheduled work activities (in Contractor's most recently updated and published schedule) and actual activities. Explain differences, if any. Note days or periods when no work was in progress and explain the reasons why.
10. Testing and/or inspections performed.

11. Signature of Contractor's authorized representative.

3.05 PROGRESS PHOTOGRAPHS

A. Submit photographs with each application for payment, taken not more than 3 days prior to submission of application for payment.

B. Submit new photographs at least once a month, within 3 days after being taken.

C. Photography Type: Digital; electronic files.

D. Provide photographs of site and construction throughout progress of work produced by an experienced photographer, acceptable to Engineer.

E. In addition to periodic, recurring views, take photographs of each of the following events:

1. Completion of site clearing.
2. Excavations in progress.
3. Final completion, minimum of ten (10) photos.

F. Take photographs as evidence of existing project conditions as follows:

1. Exterior views: All structures adjacent to construction.

G. Views:

1. Provide non-aerial photographs from four cardinal views at each specified time, until date of Substantial Completion.
2. Consult with Engineer for instructions on views required.
3. Provide factual presentation.
4. Provide correct exposure and focus, high resolution and sharpness, maximum depth of field, and minimum distortion.

H. Digital Photographs: 24 bit color, minimum resolution of 1024 by 768, in JPG format; provide files unaltered by photo editing software.

1. Delivery Medium: Via email.
2. File Naming: Include project identification, date and time of view, and view identification.
3. PDF File: Assemble all photos into printable pages in PDF format, with 2 to 3 photos per page, each photo labeled with file name; one PDF file per submittal.
4. Hard Copy: Printed hardcopy (grayscale) of PDF file and point of view sketch.

3.06 SUBMITTALS FOR REVIEW

A. When the following are specified in individual sections, submit them for review:

1. Product data.
2. Shop drawings.
3. Samples for selection.
4. Samples for verification.

B. Submit to Engineer for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.

C. Samples will be reviewed for aesthetic, color, or finish selection.

D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 78 00 - Closeout Submittals.

3.07 SUBMITTALS FOR INFORMATION

A. When the following are specified in individual sections, submit them for information:

1. Design data.
2. Certificates.
3. Test reports.
4. Inspection reports.
5. Manufacturer's instructions.
6. Manufacturer's field reports.
7. Other types indicated.

B. Submit to Owner.

3.08 SUBMITTALS FOR PROJECT CLOSEOUT

A. Submit Correction Punch List for Substantial Completion.

B. Submit Final Correction Punch List for Substantial Completion.

C. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 01 78 00 - Closeout Submittals:

1. Project record documents.
2. Operation and maintenance data.
3. Warranties.
4. Bonds.
5. Other types as indicated.

D. Submit for Owner's benefit during and after project completion.

3.09 SUBMITTAL PROCEDURES

A. General Requirements:

1. Use a single transmittal for related items.

3.10 SUBMITTAL REVIEW

A. Submittals for Review: Engineer will review each submittal, and approve, or take other appropriate action.

B. Submittals for Information: Engineer will acknowledge receipt and review. See below for actions to be taken.

C. Engineer's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.

D. Engineer's and consultants' actions on items submitted for review:

1. Authorizing purchasing, fabrication, delivery, and installation:

a. "Approved", or language with same legal meaning.

b. "Approved as Noted, Resubmission not required", or language with same legal meaning.

1) At Contractor's option, submit corrected item, with review notations acknowledged and incorporated.

c. "Approved as Noted, Resubmit for Record", or language with same legal meaning.

2. Not Authorizing fabrication, delivery, and installation:

E. Engineer's and consultants' actions on items submitted for information:

1. Items for which no action was taken:

a. "Received" - to notify the Contractor that the submittal has been received for record only.

2. Items for which action was taken:

a. "Reviewed" - no further action is required from Contractor.

END OF SECTION

01 32 16 CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.01 **SECTION INCLUDES**

A. Construction progress schedule, bar chart type.

1.02 **SUBMITTALS**

A. Within 10 days after date of Agreement, submit preliminary schedule.

1.03 **QUALITY ASSURANCE**

A. Scheduler: Contractor's personnel or specialist Consultant specializing in CPM scheduling with one years minimum experience in scheduling construction work of a complexity comparable to this Project, and having use of computer facilities capable of delivering a detailed graphic printout within 48 hours of request.

1.04 **SCHEDULE FORMAT**

A. Listings: In chronological order according to the start date for each activity. Identify each activity with the applicable specification section number.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 **BAR CHARTS**

A. Include a separate bar for each major portion of Work or operation.

B. Identify the first work day of each week.

END OF SECTION

01 40 00 QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Submittals.

B. Quality assurance.

C. Testing and inspection agencies and services.

D. Control of installation.

E. Defect Assessment.

1.02 RELATED REQUIREMENTS

A. Document 00 72 00 - General Conditions: Inspections and approvals required by public authorities.

B. Section 01 30 00 - Administrative Requirements: Submittal procedures.

1.03 REFERENCE STANDARDS

A. ASTM C1021 - Standard Practice for Laboratories Engaged in Testing of Building Sealants 2008 (Reapproved 2014).

B. ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation 2017.

C. ASTM C1093 - Standard Practice for Accreditation of Testing Agencies for Masonry 2015a, with Editorial Revision (2016).

D. ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction 2012a.

E. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection 2018.

F. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing 2015.

G. ASTM E699 - Standard Specification for Agencies Involved in Testing, Quality Assurance, and Evaluating of Manufactured Building Components 2016.

H. IAS AC89 - Accreditation Criteria for Testing Laboratories 2017.

1.04 DEFINITIONS

A. Contractor's Quality Control Plan: Contractor's management plan for executing the Contract for Construction.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Test Reports: After each test/inspection, promptly submit two copies of report to Engineer and to Contractor.

1. Include:

a. Date issued.

b. Project title and number.

c. Name of inspector.

d. Date and time of sampling or inspection.

e. Identification of product and specifications section.

f. Location in the Project.

g. Type of test/inspection.

h. Date of test/inspection.

i. Results of test/inspection.

j. Compliance with Contract Documents.

k. When requested by Engineer, provide interpretation of results.

2. Test report submittals are for Engineer's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.

1.06 **QUALITY ASSURANCE**

A. Testing Agency Qualifications:

1. Prior to start of work, submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.

B. Contractor's Quality Control (CQC) Plan:

1. Prior to start of work, submit a comprehensive plan describing how contract deliverables will be produced. Tailor CQC plan to specific requirements of the project. Include the following information:

a. Management Structure: Identify personnel responsible for quality. Include a chart showing lines of authority.

1) Include qualifications (in resume form), duties, responsibilities of each person assigned to CQC function.

b. Management Approach: Define, describe, and include in the plan specific methodologies used in executing the work.

1.07 **TESTING AND INSPECTION AGENCIES AND SERVICES**

A. Contractor shall employ and pay for services of an independent testing agency to perform other specified testing.

B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

C. Contractor Employed Agency:

1. Testing agency: Comply with requirements of ASTM E329, ASTM E543, ASTM E699, ASTM C1021, ASTM C1077, ASTM C1093 and ASTM D3740.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. Comply with manufacturers' instructions, including each step, in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Have work performed by persons qualified to produce required and specified quality.

F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.02 TESTING AND INSPECTION

A. Testing Agency Duties:

1. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
2. Perform specified sampling and testing of products in accordance with specified standards.
3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
4. Promptly notify Engineer and Contractor of observed irregularities or non-compliance of Work or products.
5. Perform additional tests and inspections required by Engineer.
6. Submit reports of all tests/inspections specified.

B. Limits on Testing/Inspection Agency Authority:

1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
2. Agency may not approve or accept any portion of the Work.
3. Agency may not assume any duties of Contractor.
4. Agency has no authority to stop the Work.

C. Contractor Responsibilities:

1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
2. Cooperate with laboratory personnel and provide access to the Work and to manufacturers' facilities.
3. Provide incidental labor and facilities:
    a. To provide access to Work to be tested/inspected.

b. To obtain and handle samples at the site or at source of Products to be tested/inspected.

c. To facilitate tests/inspections.

d. To provide storage and curing of test samples.

4. Notify Engineer and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.

5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.

6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.

D. Re-testing required because of non-compliance with specified requirements shall be performed by the same agency on instructions by Engineer.

E. Re-testing required because of non-compliance with specified requirements shall be paid for by Contractor.

3.03 **DEFECT ASSESSMENT**

A. Replace Work or portions of the Work not complying with specified requirements.

END OF SECTION

01 50 00 TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 **SECTION INCLUDES**

A. Dewatering - Refer to Construction Drawings for additional requirements

B. Waste removal facilities and services.

1.02 **DEWATERING**

A. Provide temporary means and methods for dewatering all temporary facilities and controls.

B. Maintain temporary facilities in operable condition.

1.03 **WASTE REMOVAL**

A. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.

B. Provide containers with lids. Remove trash from site periodically.

C. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

01 57 13 TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 **SECTION INCLUDES**

A. Prevention of erosion due to construction activities.

B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.

C. Restoration of areas eroded due to insufficient preventive measures.

D. Performance bond.

E. Compensation of Owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.02 **RELATED REQUIREMENTS**

A. Section 31 10 00 - Site Clearing: Limits on clearing; disposition of vegetative clearing debris.

1.03 **REFERENCE STANDARDS**

A. ASTM D4355/D4355M - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus 2014.

B. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity. 1999a (Reapproved 2014).

C. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles 2011.

D. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles 2015a.

E. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile 2016.

F. ASTM D4873 - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples 2002 (Reapproved 2009).

G. South Carolina Department of Environmental Control (SCDHEC) National Pollutant Discharge Elimination System (NPDES), Construction General Permit (SRC100000), Current Edition.

H. SCDHEC BMP Manual, Current Edition

1.04 **PERFORMANCE REQUIREMENTS**

A. Comply with York County Land Disturbance Permit conditions, the Comprehensive Storm Water Pollution Prevention Plan (C-SWPPP), and the SCDHEC Construction General Permit (CGP).

B. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish all documentation required to obtain applicable permits.

C. Provide to Owner a Performance Bond covering erosion and sedimentation preventive measures only, in an amount equal to 100 percent of the cost of erosion and sedimentation control work.

D. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.

1. Control movement of sediment and soil from temporary stockpiles of soil.

2. Prevent development of ruts due to equipment and vehicular traffic.

3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

E. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.

1. Prevent windblown soil from leaving the project site.

2. Prevent tracking of mud onto public roads outside site.

3. Prevent mud and sediment from flowing onto sidewalks and pavements.

4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

F. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.

1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.

2. If sediment basins are used as temporary preventive measures, pump dry and remove deposited sediment after each storm.

G. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.

1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.

H. Open Water: Prevent standing water that could become stagnant.

I. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

1.05 **SUBMITTALS**

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Certificate: Mill certificate for silt fence fabric attesting that fabric and factory seams comply with specified requirements, signed by legally authorized official of manufacturer; indicate actual minimum average roll values; identify fabric by roll identification numbers.

C. Inspection Reports: Submit report of each inspection; identify each preventive measure, indicate condition, and specify maintenance or repair required and accomplished.

PART 2 PRODUCTS

2.01 **MATERIALS**

A. Grass Seed For Temporary Cover: In accordance with the Construction Drawings and SCDHEC BMP Field Manual, latest edition

B. Silt Fence Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:

1. Average Opening Size: 30 U.S. Std. Sieve (0.600 mm), maximum, when tested in accordance with ASTM D4751.
2. Permittivity: 0.05 sec^-1, minimum, when tested in accordance with ASTM D4491.
3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355/D4355M after 500 hours exposure.
4. Tensile Strength: 100 pounds-force (450 N), minimum, in cross-machine direction; 124 pounds-force (550 N), minimum, in machine direction; when tested in accordance with ASTM D4632/D4632M.
5. Elongation: 15 to 30 percent, when tested in accordance with ASTM D4632/D4632M.
6. Tear Strength: 55 pounds-force (245 N), minimum, when tested in accordance with ASTM D4533.
7. Color: Manufacturer's standard, with embedment and fastener lines preprinted.

C. Silt Fence Posts: One of the following, minimum 5 feet (1500 mm) long:
1. Steel U- or T-section, with minimum mass of 1.33 pound per linear foot (1.98 kg per linear m).

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.03 INSTALLATION

A. Silt Fences:
1. Store and handle fabric in accordance with ASTM D4873.
2. Where slope gradient is less than 3:1 or barriers will be in place less than 6 months, use nominal 16 inch (405 mm) high barriers with minimum 36 inch (905 mm) long posts spaced at 6 feet (1830 mm) maximum, with fabric embedded at least 4 inches (100 mm) in ground.
3. Where slope gradient is steeper than 3:1 or barriers will be in place over 6 months, use nominal 28 inch (710 mm) high barriers, minimum 48 inch (1220 mm) long posts spaced at 6 feet (1830 mm) maximum, with fabric embedded at least 6 inches (150 mm) in ground.
4. Where slope gradient is steeper than 3:1 and vertical height of slope between barriers is more than 20 feet (6 m), use nominal 32 inch (810 mm) high barriers with woven wire reinforcement and steel posts spaced at 4 feet (1220 mm) maximum, with fabric embedded at least 6 inches (150 mm) in ground.
5. Install with top of fabric at nominal height and embedment as specified.
6. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches (460 mm), with extra post.

7. Fasten fabric to steel posts using wire, nylon cord, or integral pockets.
8. Wherever runoff will flow around end of barrier or over the top, provide temporary splash pad or other outlet protection; at such outlets in the run of the barrier, make barrier not more than 12 inches (300 mm) high with post spacing not more than 4 feet (1220 mm).

B. Temporary Seeding:

1. When hydraulic seeder is used, seedbed preparation is not required.
2. When surface soil has been sealed by rainfall or consists of smooth undisturbed cut slopes, and conventional or manual seeding is to be used, prepare seedbed by scarifying sufficiently to allow seed to lodge and germinate.
3. If temporary mulching was used on planting area but not removed, apply nitrogen fertilizer at 1 pound per 1000 sq ft (0.5 kg per 100 sq m).
4. On soils of very low fertility, apply 10-10-10 fertilizer at rate of 12 to 16 pounds per 1000 sq ft (6 to 8 kg per 100 sq m).
5. Incorporate fertilizer into soil before seeding.
6. Apply seed uniformly; if using drill or cultipacker seeders place seed 1/2 to 1 inch (12 to 25 mm) deep.
7. Irrigate as required to thoroughly wet soil to depth that will ensure germination, without causing runoff or erosion.
8. Repeat irrigation as required until grass is established.

3.04 **MAINTENANCE**

A. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches (13 mm) or more rainfall at the project site, and daily during prolonged rainfall.

B. Repair deficiencies immediately.

C. Silt Fences:

1. Promptly replace fabric that deteriorates unless need for fence has passed.
2. Remove silt deposits that exceed one-third of the height of the fence.
3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.

D. Clean out temporary sediment control structures weekly and relocate soil on site.

E. Place sediment in appropriate locations on site; do not remove from site.

3.05 **CLEAN UP**

A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Engineer.

B. Clean out temporary sediment control structures that are to remain as permanent measures.

C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

END OF SECTION

01 78 00 CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Project Record Documents.

B. Warranties and bonds.

1.02 RELATED REQUIREMENTS

A. Section 00 72 00 - General Conditions and 007300 - Supplementary Conditions: Performance bond and labor and material payment bonds, warranty, and correction of work.

B. Section 01 30 00 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.

C. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.

B. Warranties and Bonds:

1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.

2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.

3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:

1. Drawings.

2. Addenda.

3. C-SWPPP and associated Inspection Records

4. Change Orders and other modifications to the Contract.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:

1. Field changes of dimension and detail.

2. Details not on original Contract drawings.

3.02 **WARRANTIES AND BONDS**

A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.

B. Verify that documents are in proper form, contain full information, and are notarized.

C. Co-execute submittals when required.

D. Retain warranties and bonds until time specified for submittal.

END OF SECTION

31 12 00 SITE CLEARING & PREPARATION

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Removal of surface debris.
B. Removal of paving, curbs, and gutters.
C. Removal of trees, shrubs, and other plant life.
D. Topsoil excavation.

1.2 REGULATORY REQUIREMENTS

A. Conform to applicable code for environmental requirements, disposal of debris, burning debris on site, and use of herbicides.
B. Coordinate clearing Work with utility companies.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Provide tree protection materials as detailed on the construction drawings.

PART 3 – EXECUTION

3.1 PREPARATION

A. Verify existing plant life designated to remain is tagged or identified.
B. Identify a waste area and salvage area for placing removed materials.

3.2 PROTECTION

A. Trees within the permanent easement shall be removed. Trees located within the temporary easement shall be saved unless previously approved by the engineer. All trees not to be removed will be protected from injury to their roots and to their top to a distance three feet beyond the drip-line and no grading, trenching, pruning, or storage of materials may go in this area except as provided by an Owner's representative stakeout. Contractor will pay a penalty for any tree removed from the site that has not been deemed applicable for removal as specified above. Contractor also will pay for any tree that dies due to damage during construction that was not deemed applicable for removal as specified above. This applies to all trees on site whether or not they are shown on the plans.
B. Contractor shall not be held accountable for damages to trees resulting from placement of fill or removal of soils where such action is required by the contract documents. Any tree, the trunk of which is within 10 feet of any footing or trench, shall be exempt from these penalties except Contractor shall exercise all reasonable precautions to preserve even these trees. Contractor agrees to pay fines as established below in the event he or any of his subcontractors causes loss or removal of trees designated to be saved under provisions of this contract.

The fines are as follows:

Caliper	Fine
1" - 2"	$ 150.00
2" - 3"	200.00
3" - 4"	250.00
4" - 5"	400.00
5” - 6"	500.00
6” - 7"	600.00
7” - 8"	750.00
8” - 11"	1,500.00
12" - 20"	2,000.00
21" & larger	$ 2,500.00

C. Trees shall be graded by Owner’s representative as to variety, condition, and site importance, with above figures acting as a maximum fine. Lowest assessment amount shall be no less than one-half of the above fine figures.

D. Protect bench marks, survey control points, and existing structures from damage or displacement.

E. Protect all remaining utilities.

F. Clearing operations shall be conducted to prevent damage by falling trees to trees left standing, to existing structures and installations, and to those under construction, and to provide for the safety of employees and others.

3.3 CLEARING

A. Clear areas required for access to site and execution of work. Clearing shall consist of felling and cutting trees into sections, and satisfactory disposal of trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within area to be cleared. Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be removed completely from the site, except such trees and vegetation as may be indicated or directed to be left standing. Trees designated to be left standing within cleared areas shall be trimmed of dead branches 1-1/2 inch or more in diameter. Limbs and branches to be trimmed shall be neatly cut close to the trunk of the tree or main branches. Cuts more than 1-1/2 inches in diameter shall be painted with an accepted treewound paint. Trees and vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations, by the erection of timber barriers or by such other means as circumstances require. Such barriers must be placed and be checked by the OWNER before construction observations can proceed (See 3.2). Clearing shall also include removal and disposal of structures obtruding, encroaching upon, or otherwise obstructing the work.

3.4 REMOVAL

A. Where indicated or directed, trees and stumps shall be removed from areas outside those areas designated for clearing and grubbing. Work shall include felling of such trees and removal of their stumps and roots. Trees shall be disposed of as hereinafter specified.

B. Remove debris, rock, and other extracted plant life from site.

C. Partially remove paving, curbs, and gutters; as indicated. Neatly saw cut edges at right angle to surface.

3.5 DISPOSAL

A. Disposal of trees, branches, snags, brush, stumps, etc., resulting from clearing and grubbing shall be the Contractor’s responsibility and shall be disposed of by burning,

removal from site, or a combination of both. All costs in connection with disposing of materials will be at the Contractor's expense. Material disposed of by burning shall be burned in a manner avoiding all hazards, such as damage to existing structures, construction in progress, trees, and vegetation. Contractor shall be responsible for compliance with all local and State laws and regulations relative to the building of fires. Disposal by burning shall be kept under constant attendance until fires have burned out or extinguished. All liability of any nature resulting from disposal of cleared and grubbed material shall become the Contractor's responsibility. Disposal of all materials cleared and grubbed will be in accordance with rules and regulations of the State of South Carolina. No material will be burned unless directed to do so by the OWNER. Contractor shall obtain a permit to burn on site from local fire department, before beginning the work.

3.6 GRUBBING

A. Grubbing shall consist of removal and disposal of stumps, roots larger than one inch in diameter, and matted roots from designated grubbing areas. This material, together with logs and other organic or metallic debris not suitable for building of pavement subgrade or building pads, shall be excavated and removed to a depth of not less than 18 inches below original surface level of the ground in embankment areas and not less than 2 feet below finished earth surface in excavated areas. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform to original adjacent ground.

END OF SECTION

31 23 16.26 ROCK EXCAVATION

PART 1 – GENERAL

1.1 RELATED SECTIONS

A. Section 31 12 00 – Site Clearing

1.2 SCOPE

This specification covers the rock excavation requirements for the installation of water main, reuse water mains, sanitary sewers, force main, manholes, valve vaults/chambers, and associated appurtenances.

1.3 DEFINITIONS

A. Common Excavation: Excavation of all material that can be excavated, transported, and unloaded using heaving ripping or that can be excavated and dumped into place or loaded onto hauling equipment by excavator equipped with attachments (shovel, bucket, backhoe, dragline, or clam shell) appropriate to the material type, character, and nature of the materials.

B. Rock Excavation: Removal of all hard, compacted, or cemented materials that require blasting or the use of pneumatic table/hammering and in the opinion of the Engineer is incapable of being loosened with a track- type tractor with mounted heavy ripper equipment. The excavation and removal of isolated bounders or rock fragments larger than 1 cubic yard encountered in materials otherwise conforming to the definition of common excavation shall be classified as rock excavation. The presence of isolated boulders or solid rock fragments smaller than 1 cubic yard or isolated in nature is not in itself sufficient cause to change the classification of the surrounding material.

For the purpose of these classifications, the following definitions shall apply:

Heavy Ripping equipment is a rear-mounted, heavy duty, single-tooth, ripping attachment mounted on a track type tractor with a minimum mass of 35 tons and having a power rating of at least 250 flywheel horsepower unless otherwise specified.

Hydraulic Hammer equipment is an additional wheeled or tracked excavator necessary for hydraulic fracturing of rock. The ripper is to be attached to the tractor in the most efficient parallelogram type recommended by the tractor/ripper manufacturer. The ripper and tractor must be in good class condition and operated by experienced personnel.

Isolated Boulder and Solid Rock shall be defined as solid boulders or pieces of rock exceeding 1 cubic yard in volume and shall have not less than 3,000 psi of unconfined compressive strength (USC), and the production rate is less than 50 cubic yards per hour for continuous four hours using a minimum 300 HP excavator or ripper at full capacity.

Unclassified excavation is defined as the excavation of all materials encountered, including rock materials, regardless of their nature or the manner in which they are removed.

1.4 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized over excavation.

1.6 WEATHER LIMITATIONS

A. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.7 SEQUENCING AND SCHEDULING

A. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 02110, Site Clearing, prior to excavating.

B. Excavation Support: When performing trench excavation in excess of 5 feet in depth, comply with Occupational Safety and Health Administration's (OSHA) trench safety standards, 29 CFR, s. 1926.650, Subpart P, “Excavation, Trenching, and Shoring”, and all subsequent revisions or updates adopted by the Department of Labor and Employment Security. Ensure that trench boxes are wide enough to accommodate compaction and density testing. The excavation support system shall be designed by a professional Engineer registered in the State of South Carolina, other than the project Engineer of Record.

PART 2 – PRODUCTS – NOT USED

PART 3 – EXECUTION

3.1 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.

B. Surface water runoff should be prevented from entering trenches by temporary berms, swales, or other diversion methods.

C. Where rock is encountered in trenches, excavated to remove boulders and stones to provide a minimum of six inches clearance between the rock and any part of the pipe or manhole.

D. Where rock is encountered in trenches for pipelines, excavate to the minimum depth with will provide clearance below the pipe barrel of eight inches for pipe 21 inches in diameter and small and 12 inches for larger pipe, valves, and manholes. Remove boulders and stones to provide a minimum of six inches clearance between the rock and any part of the pipe, manhole or accessory.

3.2 UNCLASSIFIED EXCAVATION

A. Excavation is unclassified except for rock excavation as defined in 1.3 of this section. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.3 TRENCH WIDTH

A. Minimum Width of Trenches: Excavate trenches for pipes to the elevation of the bottom of the pipe or sub-base as specified on the Drawings. The width should be sufficient to provide adequate working room for pipe installation and connections.
B. Wherever the prescribed maximum trench width is exceeded, the Contractor shall use the next higher Class or Type of bedding and haunching as shown on the Drawings for the full trench width as actually cut. The excessive trench width may be due to unstable trench walls, inadequate or improperly placed bracing and sheeting which caused sloughing, accidental over- excavation, necessitate by the size of the Contractor's tamping and compaction equipment, or other reasons beyond the control of the Owner or Engineer. Do not intentionally over- excavate without prior authorization of Engineer.

3.4 EMBANKMENT AND CUT SLOPES

A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.
B. Remove stones and rock that exceed 3-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.
C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

3.5 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.
B. Confine stockpiles to within easements, rights-of-way, and accepted work areas. Do not obstruct roads or streets.
C. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.
D. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.6 USE OF EXCAVATED MATERIAL

A. Suitable material from the specified excavations may be used in the construction of required earthfill or rockfill. The suitability of material for specific purposes is determined by the engineer.

3.7 DISPOSAL OF SPOIL

A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, offsite.
B. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 02110, Site Clearing, for clearing and grubbing debris.

3.8 BLASTING – SEE YORK COUNTY STANDARD SPECIFICATIONS

3.9 OVEREXCAVATION

A. Overexcavation in rock

1. The space below grade for pipe lines shall be backfilled to the proper grade with

compacted layers of stone bedding or sand backfill conforming to the requirements specified herein for backfill. Where pipe sewers are constructed on concrete cradles, rock shall be excavated to the bottom of the cradle as shown on the Drawings.

2. Rock under structures shall be excavated to lines and grades shown on the Drawings. Unless specified otherwise, where rock excavation has been carried below grade, the contractor shall backfill to grade with Class B concrete at his own expense.
3. Where rock foundation is obtained at grade for over 50% of the area of any one structure, the portion of the foundation that is not rock shall be excavated below grade to reach a satisfactory foundation of rock. The portion below grade shall be backfilled with Class B Concrete made of materials and mix design by Engineer.
4. Where rock foundation is obtained at grade for less than 50% of any one structure and satisfactory rock cannot be found over the remaining area by reasonable additional excavation, the rock shall be removed for a depth of 12 inches below grade and the space below grade shall be backfilled to the proper grade with compacted layers of crushed rock conforming to the requirements specified herein for backfill.
5. Rock excavation for all structure and adjacent trenched under this Contract and any other rock excavation directed by the Engineer shall be completed before the construction of any structure is stated in the vicinity.
6. Over excavation in Earth is excavation in earth beyond the specified lines and grades shall be corrected by filling the resulting voids with approved, compacted earth fill. The exception to this is that if the earth is to become the subgrade for riprap, rockfill, sand or gravel bedding, or drain fill, the voids may be filled with material conforming to the specifications for the riprap, rockfill, bedding, or drain fill. Before correcting an overexcavation condition, the contractor shall review the planned corrective action with the engineer and obtain acceptance of the corrective measures.

END OF SECTION

31 23 23.33 FLOWABLE FILL

PART 1 – GENERAL

1.1 SCOPE

A. The work covered by this section consists of furnishing all material, equipment, and performing all labor for the manufacturing, transporting, and placing of flowable fill. The material shall be placed as shown on the contract drawings.

1.2 RELATED SECTIONS

A. None

1.3 REFERENCES (LATEST REVISION)

A. ASTM C 33 – Concrete Aggregates
B. ASTM C 94 – Ready-Mixed Concrete
C. ASTM C 150 – Portland Cement
D. ASTM C 618 – Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

PART 2 – PRODUCTS

2.1 MATERIALS

A. General – Flowable fill shall be composed of fine aggregate (sand), cementitious materials (Portland cement plus fly ash), and water.
B. Fine Aggregate – Fine aggregate shall conform to the quality and gradation requirements of ASTM C 33 for fine aggregate.
C. Portland cement – Portland cement shall conform to the requirements of ASTM C 150, Type I.
D. Fly Ash – Fly ash shall conform to the requirements of ASTM C 618, Class F.
E. Mixing Water – Mixing water shall conform to the requirements of ASTM C 94.

2.2 PROPORTIONING

A. The intended proportioning of materials for excavatable pipe flowable fill per cubic yard shall be as follows:

Type I Portland Cement	100 pounds
Fly Ash	300 pounds
Fine Aggregate (SSD)*	2,600 pounds
Water	584 pounds (70 gallons)
Air**	15-35%
28-day Compressive Strength**	300 psi maximum

*Saturated Surface Dry
**The requirements for air, 28-day compressive strength, and unit weight are for laboratory design only and are not jobsite acceptable requirements.

The amount of water may be adjusted to provide for a workable mix during placement.

The Contractor may direct minor modification of the mix proportioning to suit local conditions and materials.

PART 3 – EXECUTION

3.1 PLACEMENT

A. The flowable fill may be placed by direct discharge from the truck, by pumping or by other approved methods. It shall be placed as shown on the contract drawings.

CAUTION: Fluidized flowable fill is a heavy material and during placement (prior to seating) will exert a high fluid pressure against the pipe and any forms or wall used to contain the fill. Unless the pipe is anchored down or held in place in some manner, the placement of the flowable fill will cause the pipe to float or shift. The Contractor shall be responsible for anchoring or securing the pipe so the line and grade is maintained during placement and setting of the flowable fill.

To avoid displacing the pipe, placements have been made by placing the flowable fill in small incremental depths with the time interval between placements sufficient in length to allow initial "setting" of the prior placement. However, the Engineer in no way endorses or recommends this method. Should this method be utilized, the Contractor shall be responsible for developing a procedure that will ensure maintenance during placement and setting.

The ends of the flowable fill will require blocking with wood or metal forms, bags of soil, or other suitable means.

The flowable fill will tend to bleed water to the surface. The blocking of the ends of the flowable fill shall be accomplished in such manner so as not to prevent the runoff of the bleeding water.

Placement of flowable fill shall start only when weather conditions are favorable. The temperature shall be at least 35° F and rising. Mixing and placing shall stop when the temperature is 38° F and falling. Placement shall be performed when it is not raining, and shall be as continuous an operation as is practicable.

The completed flowable fill shall not be subjected to any load and shall remain undisturbed by construction activities for at least 24 hours after placement.

Cover trenches as necessary with accepted material by Engineer.

END OF SECTION

31 37 00 RIP-RAP

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Material placed as bank protection and erosion control.

1.2 RELATED SECTIONS

A. None

1.3 ALLOWABLE TOLERANCES

A. Depth of rip-rap blanket as shown on the drawings and in these specifications is a minimum depth.

1.4 REFERENCES (LATEST REVISION)

A. ASTM C 150 – Portland Cement.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Stone Rip-Rap: Shall be hard quarry or field stone of such quality the pieces will not disintegrate on exposure to water, sunlight or weather. Stone shall be solid and non-friable and range in weight from a minimum of 25 pounds to a maximum of 150 pounds. At least 50 percent of the stone pieces shall weigh more than 60 pounds. The stone pieces shall have a minimum dimension of 12 inches. Documents indicating stone analysis, source and other pertinent data (i.e. - filter fabric) shall be submitted for review by the Engineer prior to delivery.

B. Sand-Cement Bag Rip-Rap:
   1. Bags: Shall be of cotton, burlap, or fiber-reinforced paper capable of containing the sand-cement mixture without leakage during handling and placing. Bags previously used for any purpose shall not be used. Capacity shall be not less than 0.75 cubic foot nor more than two cubic feet.
   2. Cement: Portland cement shall be Type I meeting requirements of ASTM C 150. Cement which has been damaged, or which is partially set, lumpy, or caked shall not be used.
   3. Fine Aggregate: Shall be composed of hard, durable particles, free from injurious amounts of organic impurities and shall contain, in the material passing the No. 10 sieve, not more than 7 percent clay, and not more than 20 percent passing the No. 200 sieve.

C. Filter Fabric: Shall be a woven fabric of monofilament and multifilament yarn equivalent to Mirafi FW700. Fabric shall be finished so the filaments will retain their relative position with respect to each other. Fabric shall contain stabilizers and/or inhibitors added to make filaments resistant to deterioration due to ultraviolet and/or heat exposure. Fabric shall be free of flaws, rips, holes or defects.

2.2 PRODUCT REVIEW

A. Contractor shall provide the Engineer with a complete description of all products before ordering. Engineer will review all products before they are ordered.

PART 3 – EXECUTION

3.1 PREPARATION

A. The surface to receive rip-rap shall be prepared to a relatively smooth condition free of obstruction, depressions, debris, rises, and soft or low-density pockets of material. Contours and elevations on construction drawings are to the surface of rip-rap material.

3.2 PLACEMENT

A. Filter fabric shall be placed with the long dimension running up slope. The strips shall be placed to provide a minimum width of one foot of overlap for each joint. Fabric shall be anchored in place with securing pins of the type recommended by fabric manufacturer. Pins shall be placed on or within 3 inches of the over-lap. Place fabric so upstream strip will overlap the downstream strip. Fabric shall be placed loosely to give and avoid stretching and tearing during placement of the stones.

B. Minimum depth or thickness of stone blanket shall be 12 inches with no under tolerance. Stones shall be dropped no more than three feet during construction. Placing shall begin at bottom of slope. Provide a toe trench if required as detailed on the construction drawings. Entire mass of stone shall be placed to conform with lines, grades, and thickness shown on the plans. Rip-rap shall be placed to its full course thickness at one operation and in such a manner as to avoid displacing the underlying material. Placing of rip-rap in layers, or by dumping into chutes, or by similar methods likely to cause segregation, will not be permitted.

Larger stones shall be well distributed and the entire mass of stone shall conform to gradation specified. All material used in rip-rap protection shall be placed and distributed so there will be no large accumulations of either the larger or smaller sizes of stone.

It is the intent of these specifications to produce a fairly compact rip-rap protection in which all sizes of material are placed in their proper proportions. Hand placing or rearranging of individual stones by mechanical equipment may be required to secure the results specified.

C. Sand-Cement Bag Rip-Rap: Bags shall be uniformly filled. Bagged rip-rap shall be placed by hand with tied ends facing the same direction, with close, broken joints. After placing, bags shall be rammed or packed against one another to produce the required thickness and form a consolidated mass. The top of each bag shall not vary more than 3 inches above or below required plane. When directed by the Engineer or required by construction drawings, header courses shall be placed.

END OF SECTION

TECHNICAL SPECIFICATIONS FOR

NEW HERITAGE GRAVITY SEWER PHASE 2

PREPARED FOR:
YORK COUNTY WATER & SEWER

PREPARED BY:
MICHAEL BAKER INTERNATIONAL, INC.
MBI CONTROL #166622

OCTOBER 2020

I. MATERIAL SPECIFICATIONS

Unless superseded or modified by the construction documents, all materials, apparatus, supplies, methods of manufacture, and construction shall conform to the following specifications: Current National material standards and addenda (ASTM, ANSI, etc.) shall be used.

A. Pipe

1. PVC (Poly Vinyl Chloride) Pressure Sewer Pipe: Unless amended on the construction drawings or elsewhere in these specifications, the following shall apply:

   a. 2" and 3" : Must be PVC 1120 in accordance with ASTM D-2241: PC315 with a SDR of 13.5 or less for C-900.

   b. 4" through 12": Must be PVC 1120 in accordance with ASTM D-1785 or ASTM D-2241, AWWA C900, DR-14.

   c. 14" through 48": Must be Polyvinyl Chloride Pipe (PVC) large diameter sewer pipe with a minimum pipe stiffness of 46 PSI in accordance with ASTM Specification F-679.

   d. Pipe joining shall be push-on elastomeric joints only and joints shall be manufactured in accordance with ASTM Specification D-3212. The pipe shall be furnished with integral bells and with gaskets that are permanently installed at the factory. The pipe shall be furnished in nominal lengths of 20 feet. PVC sewer pipe shall be green or white in color.

   e. PVC pipe shall contain the markings required by ASTM D-3034 or F-679 as applicable. The manufacturer shall submit certification that the pipe has been tested in accordance with ASTM D-3034 or F-679 as applicable and has been found to meet all requirements. Test samples shall be as selected by the manufacturer or testing laboratory unless stipulated elsewhere in the construction documents.

   f. Fittings shall be in accordance with ASTM D-3034, F-679, and/or D-3212 as applicable, with stiffness and wall thickness equal to or greater than the pipe. Adapters shall be provided to join different materials.

2. PVC Profile Gravity Sewer Pipe: Unless amended on the construction drawings or elsewhere in the specifications, the following shall apply:

   a. 8" through 24": Must be SDR 35 manufactured in accordance with

~~the requirements of ASTM D 3034 for diameters from 4"-15", and ASTM F for diameters from 18"-24".~~

~~b. The pipe shall be produced with integral bell and spigot end construction with elastomeric seals and shall conform to all requirements of ASTM D- 3212. Joining shall be by rubber gaskets that conform in all respects to the physical requirements specified by ASTM F 477 for low head applications. The lubricant used for assembly shall be as recommended by the manufacturer and shall have no detrimental effect on either the pipe or the rubber gasket.~~

~~c. The average nominal inside diameter and manufacturing tolerance shall be as listed for stiffness Series 46 in Table 1A for open profile pipe and Table 1B for closed profile pipe of ASTM F-794. The pipe shall be furnished in nominal lengths of 20 feet and shall contain all markings required by ASTM F-794.~~

~~d. One sample of each size pipe specified, from the production runs for this project, shall be tested in accordance with the requirements of ASTM F- 794. The manufacturer shall furnish certification that the pipe was manufactured, sampled, tested and inspection in accordance with and has been found to meet the requirements of ASTM F-794 in all aspects.~~

~~e. Fittings shall be in accordance with ASTM F-794, D-3212, and/or D-3034 as applicable, with stiffness and was thickness equal to or greater than the pipe. Adapters shall be provided to joint different materials.~~

3. Ductile Iron Gravity Sewer Pipe: Unless amended on the construction drawings or elsewhere in these specifications, the following shall apply:

~~a. Ductile iron pipe shall conform to the requirements of AWWA Standard C-151 and shall have a cement-mortar lining of standard thickness in accordance with AWWA C-104. Ductile iron pipe used in force main applications shall have an interior coating of Protecto 401 Ceramic Epoxy, Sewper Coat as manufactured by LaFarge Calcium Aluminates, American Polybond lining or approved equal.~~

~~b. All ductile iron pipe shall be furnished with push-on joints in accordance with AWWA C-111.~~

~~c. 12-inch and smaller diameter (push-on joint) pipe shall be minimum pressure class 350 (PC350). 16-inch and larger diameter pipe shall be minimum pressure class 250 (PC250). Also, the pipe class selection for 12-inch and larger diameter pipe shall be based on the~~

~~installation conditions. This pipe class shall be as shown on the plans and/or elsewhere in the specifications.~~

~~d. Fittings shall be in accordance with AWWA C-110 or AWWA C-153 and shall have a cement mortar lining in accordance with AWWA C-104.~~

~~e. Ductile iron pipe exterior is to be Bituminous Coated a minimum of 1mm thick.~~

~~f. Flanged Pipe (if required) is to be thickness Class 53.~~

~~4. Steel Pipe - (Aerial Creek Crossings): Unless amended on the construction drawings or elsewhere in these specifications, the following shall apply:~~

~~a. High Strength Steel Pipe shall be welded or seamless, manufactured in accordance with ASTM A-53 for Welded and Seamless Steel Pipe (1/8- inch to 26-inch inclusive) and/or ASTM A-139 for Welded Straight-Seam Steel Pipe (4-inch to 92-inch inclusive).~~

~~b. All steel shall be Grade "B" only, with minimum yield strength of 35,000 PSI. Thickness shall be 0.250" unless otherwise specified or shown on the plans.~~

~~c. The pipe shall be produced in a single continuous length. Welding of two or more individual pieces together end to end shall not be permitted. Spiral-seam pipe shall not be permitted.~~

~~d. All steel pipe shall receive one (1) of the following shop applied linings on the inside of pipe barrel:~~

~~(i) Coal tar lining 3/32-inch minimum thickness in accordance with AWWA 203.~~

~~(ii) Coal tar epoxy lining 24 mils (dry) minimum dry film thickness and shall be Koppers' No. 300M, Americoat No. 78, Carboline- Carbomastic No. 14 or approved equal.~~

~~e. The outside of steel pipe and complete couplings shall receive one coat of Koppers 300M coal tar epoxy - 16 mils minimum dry film thickness - or approved equal. The coal tar epoxy coat shall be shop applied to the pipe,and field applied to the couplings. Damage to exterior shop applied coatings shall be repaired with the same coating used by the manufacturer and applied as recommended by the manufacturer.~~

~~f. Pipe ends shall have tolerances within the limits required for approved couplings. Pipe shall also be furnished with plain right-~~

angle ends with all burrs removed from the ends. Steel mechanical transition couplings shall be as follows:

1. Steel Pipe to Steel Pipe:

(i) 30-inch and smaller pipe sizes shall have a center ring length of seven (7) inches.

(ii) 36-inch and larger pipe sizes shall have a center ring length of ten (10) inches.

(iii) Couplings shall be as manufactured by Dresser Industries - Style 38 Straight Coupling, or approved equal. Center ring, glands, bolts, and nuts shall receive one shop coat of primer.

2. Steel Pipe to Ductile Iron Pipe:

(i) 8-inch and smaller pipe sizes shall have a center ring length of five (5) inches.

(ii) 10-inch through 20-inch pipe sizes shall have a center ring length of seven (7) inches.

(iii) 24-inch and larger pipe sizes shall have a center ring length of ten (10) inches.

(iv) Couplings shall be as manufactured by Dresser Industries
- Style 62 Transition Coupling, or approved equal. Center ring, glands, bolts, and nuts shall receive one shop coat of primer.

(v) Couplings shall receive field applied protective coatings as specified for steel pipe.

5. 4-Inch Sanitary Sewer Laterals: Unless amended on the construction drawings or elsewhere in these specifications, the following shall apply:

a. All 4-inch laterals shall be SDR 35 PVC, Schedule 40 PVC or Ductile Iron (PC350) Pipe. SDR 35 PVC and ductile iron laterals shall be as hereinbefore specified.

b. 4-inch laterals must connect perpendicular to the mainline when possible.

c. Schedule 40 PVC: Schedule 40 PVC laterals shall be in accordance

~~with ASTM D-2665, NSF 14, and D-1785. Fittings shall be socket type in accordance with ASTM D-2466. Joining shall be through solvent cement in accordance with ASTM D-2564.~~

~~d. Cleanouts constructed of SCH 40 PVC shall be provided at the roadway right-of-way or easement line (as applicable).~~

6. 6-inch Sanitary Sewer Laterals: Unless amended on the construction drawings or elsewhere in these specifications, the following shall apply:

   a. All 6-inch laterals shall be Ductile Iron Pipe, SDR 35 Polyvinyl Chloride Pipe, or Schedule 40 PVC Pipe as hereinbefore specified.

   b. 6-inch laterals must connect perpendicular to the mainline when possible.

7. Couplings/Saddles: Unless amended on the construction drawings or elsewhere in these specifications, the following shall apply:

   a. Couplings used to join various types of 12-inch and smaller pipe shall be elastomeric PVC sleeve couplings with stainless steel compression bands and stainless steel shear rings as manufactured by Mission Clay Products, Fernco, Logan Clay Products, or approved equal.

   b. Couplings for 12-inch and smaller pipe may also be elastomeric PVC with internally molded rigid fiberglass insert and stainless steel bands as manufactured by DFW Plastics or approved equal. The coupling shall provide a water and/or gas tight connection.

   c. Couplings for 15-inch and larger pipe shall be submitted to the Owner Engineer for approval.

   d. Saddles for lateral connections shall be ABS Plastic, PVC, Elastomeric PVC, or approved equivalent. Saddles shall be connected to VCP using epoxy sealant. Saddles shall be connected to PVC pipe using a flat or profile gasket, as applicable to the type of pipe, and at least two stainless steel bands around the pipe and saddle. The lateral shall be connected to the saddle with a compression gasket, solvent weld adapter, and/or stainless steel band, as applicable.

B. Manholes

All sewer manholes shall be constructed or precast concrete sections in conformance with the following specifications and York County Government

Engineering ~~Water & Sewer~~ Department Standard Detail Drawings. Special cast in place manhole structures shall be as shown on the ***drawings*** ~~plans~~ and shall comply with the various other applicable sections in the specifications.

Manholes will be furnished with the following clear inside diameters according to the sewer main diameter unless amended by the ***drawings*** ~~Plans~~ or other project documents:

8" to 18" pipe	4' Manhole
21" to 36" pipe	5' Manhole
42" to 54" pipe	6' Manhole
54" and larger	8' Manhole

The manhole diameter for a given pipe size may be increased from that shown above for applications where the angle between the influent and effluent pipe precludes proper installation of the pipe connections in the standard size manhole.

Manholes shall be furnished with pre-cast bottom slabs and flexible watertight boots for 15-inch and smaller pipe. The boots shall be cast in as integral parts of the base or installed in cored openings with stainless steel compression bands, and shall conform to ASTM C-923. Manholes for 18-inch and larger pipe may be furnished with precast bottom slabs and flexible boots, flexible seals, or concrete collars. The flexible seals shall be A-Lok or Contour Seal. Flexible connectors shall conform to ASTM C-923.
The concrete collars shall be according to the applicable Standard Detail. Manholes to be placed over existing pipelines shall be furnished with "doghouse" openings cast in the bottom section allowing it to be set over the existing pipe. A concrete base and invert shall be poured around the bottom section and the pipe according to the applicable Standard Detail.

Shop drawings, which show dimensions, openings for pipe, reinforcing steel dimensions and layout and other essential details shall be submitted for approval.

1. Precast Reinforced Concrete Manhole Sections: All precast reinforced concrete manholes shall conform to York County Government ***Engineering*** ~~Water & Sewer~~ Department Standard Detail drawings and to ASTM C-478. The following minimum standards shall also apply:

   A. Wall thickness shall be a minimum of 1/12th of the inside diameter of the manhole with a minimum thickness of five (5") inches.

   B. Base sections shall be cast monolithically or have a waterstop cast in the cold joint between the walls and the base slab.

   C. Cone sections shall normally be eccentric with the inside face of one side vertical and flush with the inside face of the barrel

section. Eccentric cones with bolt down frame and cover shall have a minimum vertical height, as measured from the top of the cone to the bottom of the bell, of 32 inches. Eccentric cones without bolt down frame and cover to be installed flush to finish grade may have a minimum vertical height of 24- inches. Concentric cones with a vertical height of 20-inches may be used on manholes less than five (5') feet deep (4' diameter manhole only). Transition cone sections may be provided for an eccentric transition from a 60-inch riser to a 48-inch cone section to be placed directly beneath the 48-inch cone.

D. Transition slabs may be placed a minimum of five (5) feet above the invert shelf for six (6) feet and larger diameter manholes where the slab will be buried. Flat top slabs may be used in six (6) feet and larger diameter manholes, unless the manhole is located within pavement or maintained lawns.

E. Joints between sections shall be manufactured in accordance with ASTM C-443. Joints may be sealed with rubber gaskets in accordance with ASTM C-443 or with butyl rubber sealants conforming to Federal Specifications SS-S-210A and AASHTO — 198, Type B.

F. All markings required by ASTM C-478 shall be clearly stamped on the inside of each section.

G. Aggregate shall be sound, crushed, angular granitic stone only, substantially in accordance with ASTM C-33, except that the requirement for gradation in that standard shall not apply. Smooth or rounded stone (river rock) shall not be acceptable.

H. The cement shall be Type II with a maximum Tricalcium Aluminate ($3CaOAI_2O_3$) content 8%.

In lieu of Type II cement and grantic aggregate, precast manhole sections may be furnished of Type III cement with calcareous (limestone) aggregate. The manufacturer will submit lab tests certifying the amount of Alkalinity (minimum 78%) present in the complete mix.

I. Manhole riser sections, transition slabs, flat top slabs, and cone sections shall be designed for H-20 loadings.

J. The manufacturer shall furnish the ***Owner*** ~~Engineer~~ with test results on compression and absorption for one section in every twenty-five sections poured, and certification from cement manufacturer and aggregate supplier certifying chemical content.

The ***Owner*** ~~Engineer~~ reserves the right to pick random sections for the required testing.

2. Steps: Manhole steps will be furnished in accordance with Standard Details, ASTM C-478 and current OSHA regulations. In addition to the testing requirements of ASTM C-478 each step installed in precast manholes will be tested to resist a 1000 lb. pullout. The manhole manufacturer will furnish certification of each test with each shipment showing manhole location, date of test, and results.

3. Watertight Manhole Covers: Watertight manhole covers required where the top elevations are lower than the 100 year flood elevation.

~~4. Manhole Diameter: Manholes shall have a minimum inside diameter of 4 feet for invert depths of 19 feet or less. Manholes with invert depths of 20 feet or greater shall be a minimum of 5 feet in diameter. The minimum access diameter shall be 22 inches.~~

C. MISCELLANEOUS STEEL

~~1. Steel Pier Material: Steel piles, cross braces, cradles, etc., shall consist of structural steel shapes of the section required on the Plans and Details. The steel shall conform to specifications for Steel for Bridges and Buildings, ASTM A-36.~~

~~All bolts and nuts will conform to ASTM A-325 for 7/8 inch and to ASTM A-490 for 1-inch and larger.~~

~~The Contractor shall handle and store steel members above ground on platforms, skids, or other supports. Members shall be free of dirt, grease, and other foreign material and protected against corrosion.~~

~~Coal tar epoxy coating Koppers' No. 300M, Amercoat No. 78, Carboline-Carbomastic No. 14 or approved equal shall be applied to all specified surfaces of the steel pier.~~

~~Welding Electrodes shall conform to the following:~~

~~Shielded Metal-Arc: AWS A5.1 or AWS 5.5, E70XX~~
~~Submerged-Arc: AWS A5.17, F70X-EXXX~~
~~Gas Metal-Arc: AWS A5.18, E70S-X or E7OU-1~~
~~Flux Cored-Arc: AWS A5.20, E70T-X (except 2 and 3)~~

2. Steel Encasement Pipe: Steel pipe shall be welded or seamless, smooth wall or spiral weld, consisting of Grade "B" steel as specified in ASTM - 139.

Minimum yield strength shall be 35,000 PSI; and pipe thickness shall be as specified for each individual job.

All pipe shall be furnished with beveled ends prepared for field welding of circumferential joints. All burrs at pipe ends shall be removed.

Encasement pipe must be approved by the appropriate controlling agency (SCDOT, Railway Corporation, etc.) and the County's Engineering department prior to ordering.

~~3. Structural Steel Tunnel Liner Plates: The tunnel liner plates shall be either the four (4) flange type (as approved for use within SCDOT right-of-way) or the lap seam type (as approved for use within railroad rights-of-way) fabricated to permit assembly of a continuous steel support system as the tunnel is excavated. Tunnel liner plates shall be fabricated from hot rolled, carbon steel sheets or plates conforming to the specifications of ASTM A-569.~~

~~The tunnel liner shall be designed in accordance with the requirements of Section 16-Division I and constructed to conform to Section 25-Division II of the current or interim AASHTO Standard Specifications for Highway Bridges.~~

~~Liner plates shall be galvanized in accordance with AASTO M167 and fully bituminously coated in accordance with AASHTO M190. All hardware necessary to the tunneling operation shall be hot-dip galvanized in accordance with ASTM A-153 prior to bituminous coating application. Hardware shall conform to ASTM Specification A-307, Grade A.~~

~~The minimum mechanical properties of the flat steel plate before cold forming used for the design of the tunnel liner shall be:~~

~~A. Minimum Tensile Strength of Liner Plates: 42,000 PSI~~
~~B. Minimum Yield Strength of Liner Plates: 28,000 PSI~~
~~C. Steel Liner Plates must be approved by the appropriate controlling agency (SCDOT, Railway Corporation, etc.) and the County's Engineering~~

~~department prior to ordering. Gauge or thickness of liner plates will be as noted on the plans and elsewhere in the specifications.~~
~~D. Elongation, 2-inches = 30 percent~~
~~E. The moment of inertia shall be 0.042 inches to the 4th power per inch of width for four flange 12 guage liner plate.~~

4. Steel Vent Pipe: Unless otherwise specified, steel vents shall be Schedule 40 five- inch (5") diameter steel pipe, consisting of Grade "B" steel as

specified in ASTM A-139.

All steel shall be Grade "B", with a minimum yield strength of 35,000 PSI.

The steel pipe shall have an inside coal tar lining 3/32 inch minimum thickness in accordance with AWWA C-203 or a coal tar epoxy lining conforming to that required for steel (aerial creek crossing) pipe.

Outside surface of pipe shall be sand or grit blasted to commercial standard and have one (1) coat of zinc chromate primer applied in accordance with Federal Specification TT-86a.

Pipe shall be furnished with two (2) evenly applied coats of rust inhibiting enamel paint, either Koppers Glamortex No. 501 Enamel (Olive Green), Southern Coatings Rustaloy No. 0537 Enamel (Garden Green), or equal.

5. Steel Straps and Anchors: All pipe and/or pier straps shall conform to the requirements of ASTM A-36 with a minimum yield strength of 36,000 PSI.

Finished straps and anchors shall be galvanized in accordance with ASTM A-153. The entire strap and all exposed surfaces of anchors and/or bolts (and nuts) shall be fully bituminously coated in accordance with AASHTO —190. Anchor bolts (non-head) shall conform to ASTM A-36 with tension test to be made (as required) on the bolt body or on the bar stock used for making the anchor bolts.
Unless otherwise specified all other fasteners shall conform to ASTM A-307 for carbon steel externally and internally threaded standard fasteners Grade A or B.

D. CONCRETE

1. Portland Cement: All concrete shall conform to the Standard Specifications for READY MIXED CONCRETE, ASTM C-94. An air-entraining admixture, conforming to ASTM C-260, shall be added either Type I, Type II, or Type III Portland Cement. Fly Ash conforming to ASTM C-618 for Class C Fly Ash may be added to the concrete mix but shall not be considered as replacement for more than 10 % of the cement therein (strengths shall not be less than hereinafter required).

Types I, IA, III and IIIA Portland Cement shall only be used for manhole inverts, concrete encasement, concrete blocking, and/or as directed by the ***Owner*** ~~Engineer~~, and shall conform to ASTM C-150.

Types II and IIA Portland Cement shall be used in precast manholes, cast in place manhole structures, reinforced concrete pipe, reinforced concrete

piers and concrete or reinforced concrete rip-rap as directed by the ***Owner*** ~~Engineer~~, and shall conform to ASTM C-150 except that Tricalcium Aluminate ($3CaOAI_2O_3$) content shall not exceed 8%.

2. Aggregates: All aggregates used for concreting shall conform to ASTM C-33 and shall be checked daily for any variances in moisture content. Said variances shall be corrected and/or taken into consideration for each batch.

   A. Coarse Aggregates: Shall be uniformly and evenly graded for each application in accordance with A.C.I. Standard 318. Unless otherwise approved, aggregate shall be sound, crushed, angular granitic stone. Smooth or rounded stone (river rock) shall not be acceptable.

   B. Fine Aggregates: Shall consist of natural sand, manufactured sand or a combination thereof. Fine aggregates shall conform to the sieve analysis as specified in paragraph 4.1 of the standard except that the percent passing a No. 50 sieve shall not exceed 6% and the percent passing a No. 100 sieve shall be 0% as provided for in paragraph 4.2 of the standard.

3. Mix Design: Concrete shall be watertight, resistant to freeze-thaw cycles and moderate sulfate attack, abrasion resistant, workable, and/or finishable. These qualities may be met through the use of admixtures (if and only if approved in the mix design as hereinafter specified) conforming to the appropriate ASTM with the exception of the use of calcium chloride, which shall be limited to no more than 1% by cement weight - thoroughly mixed to insure uniform distribution within the mix. If the concrete is used with reinforcing steel, no calcium chloride will be allowed.

   The Contractor shall assume responsibility for concrete mixture. The concrete shall be proportioned to meet the following requirements: (Note: This mix does not apply “in total” to precast manhole or reinforced concrete pipe).

A.	Compressive Strength	Minimum 3600 PSI
B.	Water-Cement Ration By Weight	Maximum 0.50
C.	Slump	Min. 3" Max. 5"
D.	Air Content (Entrained & Entrapped)	Min. 4% Max. 6%
E.	Coarse Aggregate 3/4"- 1 1/2 (as required by the application)	

   When required by the ***Owner*** ~~Engineer~~, and prior to beginning construction, the Contractor, at his expense, shall obtain from an approved commercial testing laboratory a design for a suitable concrete mix and submit same with his list of materials and material suppliers for approval.

4. Curing Compound: All concrete curing shall conform to the standard specifications for LIQUID MEMBRANE - FORMING COMPOUNDS FOR CURING CONCRETE, ASTM C-309, TYPE 2.

   Curing compounds shall be applied as forms are stripped.

5. Grouts: All grouts shall be of a non-shrink nature (as may be achieved through additives or proportioning) and depending upon application range from plastic to flowable cement water paste. Testing as specified above for concrete may be required for acceptance of grouts to include frequent checks for consistency by a time-of-flow measurement.

   Expansion grouts shall be either Gilco pre-mixed or Supreme non-metallic grout as manufactured by Gifford-Hill and Company, Incorporated, or Embeco 636 grout as manufactured by Master Builders or equal.

   Acceptable range of testing requirements:

Compressive Strength	10,500 to 12,500 PSI
Bond Strength	1,350 to 1,700 PSI
% Expansion	+.025% to +0.75%

   Expansion grouts shall be used only as directed by the ***Owner*** ~~Engineer~~.

   Grouts shall be mixed (if applicable) and placed in accordance with the manufacturer's recommendations, for each specific application.

6. Mortar: Mortar used in sanitary sewer manholes shall be hydraulic cement mortar in accordance with ASTM C-398. Mortar used in water meter vaults and water valve vaults shall be Type M mortar in accordance with ASTM C-270.

E. STONE AND BRICK

1. Granular Bedding Material: All bedding material shall be angular, clean washed crushed stone graded in accordance with Size #57 or #67 in ASTM D-448 for "Standard Sizes of Coarse Aggregate", (SC DOT Standard size #57 or #67).Bedding material will be used only as instructed in the Specifications and/or as specifically directed by the ***Owner*** ~~Engineer~~.

2. Stone Stabilization Material: All stone stabilization material shall be angular, clean washed crushed stone graded in accordance with standard sizes #467 in ASTM D-448, (SC DOT Standard size #467M).

   Stabilization material will be used only as instructed in the specifications and/or as specifically directed by the ***Owner*** ~~Engineer~~.

3. Silt Check Dam Material: Shall be coarse angular, clean washed crushed stone, gravel, or rock, well graded, and ranging in size from 2-inches to 6-inches, (SC DOT stone for erosion control-Class A).

4. Rip-Rap: All rip rap shall consist of clean field stone or rough unhewn quarry stone, resistant to the action of air and water, varying in weight from 25 to 250 pounds with 60% weighing a minimum of 100 pounds each and no more that 5% weighing less than 50 pounds each, (SC DOT Class 2 Rip Rap). Rip-rap will be placed from a minimum of 4.0 feet below the toe of the bank to top of the bank in areas determined by field conditions. Rip-rap thickness shall be 1 1/2 times the diameter of the largest stones used, or as directed by the plans.

5. Brick: All brick used to construct manhole inverts or adjust frames shall be made from clay or shale, shall be solid only and shall be of standard building size. All brick shall meet or exceed the compressive strength and water absorption properties specified in ASTM C-32 for Grade MS brick or in ASTM C-216 and ASTM C-62 for Grade SW brick. All manholes placed within the limits of roadway pavement and sidewalk are to use a minimum of one course of adjusting brick and a maximum as previously called for.

F. FERROUS CASTINGS

1. Special Castings: All cast iron pipe fittings and special castings shall be furnished in weight, classes, and/or special thickness as specified elsewhere. The castings shall conform to ASTM A-126 and shall be manufactured in domestic foundries. Coatings and linings (if applicable) shall be the same as specified for Ductile Iron Pipe.

2. Frames, Covers and Grates: All manhole frames and covers shall conform to ASTM A-48, Class 30 and shall be manufactured in domestic foundries. Dimensions shall conform to the Standard Details.

   Manhole frames and covers shall be furnished with the common contact surfaces between frame and cover machines. Frames and covers shall be Dewey Brothers RCR 2010, Vulcan VM-83, U.S. Foundry or approved equal.

   Where watertight frames and covers are specified, the watertight seal between frame and cover shall be accomplished by means of a rubber gasket. Watertight frames and covers shall be Dewey Brothers RCR 2010W, Vulcan VM 1383, U.S. Foundry or approved equal.

G. TRAFFIC CONTROL DEVICES

All traffic control signs, barrels, barricades, pavement markings, etc., shall conform to the "Manual on Uniform Traffic Control Devices" (MUTCD) published by the U.S.D.O.T. and any supplements to the MUTCD as adopted by S.C.D.O.T.

~~H. EROSION CONTROL~~

~~1. Seed: All seed shall be labeled to show that it meets the current requirements of the South Carolina Seed Law. Seed shall have been tested within the six (6) months immediately preceding its use. Further specifications for each seed item are given below:~~

~~a. Kentucky Fescue #31: Minimum 98% pure live seed; maximum 1% weed seed; minimum 90% germination.~~

~~b. Sericea Lespedeza (Sacrified and Unsacrified): Minimum 98% pure live seed; maximum .50% weed seed; minimum 85% germination. Scarified may include 20% hard seed.~~

~~c. Rye Grass (Annual): Minimum 98% pure live seed; maximum .10% weed seed; minimum 85% germination.~~

~~d. Sudangrass: Minimum 98% pure live seed; maximum .25% weed seed; minimum 85% germination.~~

~~2. Fertilize: All fertilizer for undeveloped areas shall have minimums 5-10-10 analysis or a comparable 1-2-2 ratio. All fertilizer for established lawn areas shall have a minimum 10-10-10 analysis or a comparable 1-1-1 ratio. All fertilizer shall be uniform in composition, dry and free flowing and shall be delivered to the job site in the original unopened containers, each bearing the manufacturer's guaranteed analysis. Any fertilizer, which becomes caked or otherwise damaged,~~

~~will not be accepted. The quality of all fertilizer and all operations in connection with furnishing same, shall comply with the current requirements.~~

~~3. Lime: All lime shall be finely ground limestone (Dolomite) containing not less than 85% total carbonates.~~

~~4. Superphosphate: All superphosphates shall be composed of finely ground phosphate rock, as commonly used for agricultural purposes, containing not less than 20% available phosphoric acid.~~

5. Mulch: All mulch shall be small grain or tame hay. Small grain or tame hay shall be furnished undamaged, air dried, threshed and free of undesirable weed seed.

6. Erosion Control Fabric: Material shall be as specified in the Environmental Protection Section of these specifications per Erosion Control Standard Detail 6.62.

7. Jute Netting or Thatching: All jute shall be of a uniform open plain weave of single jute yarn, 18 inches in width (± 1"). The yarn shall be loosely twisted construction and shall not vary in thickness by more than one-half (½) its normal diameter.

   There shall be 78 warp ends (± 2), per width of netting; 41 weft ends (± 1"), per linear yard; and the weight shall average 1.22 pounds (± 5%) per linear yard of netting. Jute shall be anchored into place in accordance with the manufacturer's requirements. Installation shall only be at the direction of the Engineer.

8. Erosion Control Blanket: Erosion control blankets shall be manufactured from wood fiber, straw, coconut fiber or other degradable material woven into a mat and secured with photo-degradable plastic mesh or biodegradable thread. Blankets shall be installed according to manufacturers recommendations where directed by the Engineer. The following manufacturers area approved. AMXCO- Curlex Blanket, North American Green-SC 150, and HV Excelsior.

9. Gabions: Gabions shall be manufactured from zinc coated steel wire mesh (minimum H-gauge) to form rectangular units. The front, base, back and lid shall be woven into a single unit and the ends and diaphragms shall be factory connected to the base. The individual units shall be installed per the manufacturers instructions and filled with hard durable, clean stone from 4-8 inches inside or as approved by the Engineer.

II. DETAILED SPECIFICATIONS FOR SANITARY SEWER CONSTRUCTION

Unless superseded or modified by a Special Provision, all materials, apparatus, supplies, methods of manufacture, or construction shall conform to the specification for same contained in this Section. The Contractor shall furnish all materials, equipment and labor required to construct the project as outlined in these specifications and accompanying plans.

A. HANDLING AND STORAGE OF MATERIALS

The Contractor shall be responsible for the safe storage of materials furnished by or to ***it*** ~~him~~, and accepted by ***it*** ~~him~~ and intended for the work, until they have been incorporated in the completed project. The interior of all pipe, manholes and other accessories shall be kept free from dirt and foreign materials at all times.

1. Transportation of Materials and Equipment: The Contractor and ***its*** ~~his~~ Suppliers are directed to contact the South Carolina Department of Transportation to verify axle load limits on State maintained roads (and bridges) which would be used for hauling of equipment and materials for this project. The Contractor and ***its*** ~~his~~ Suppliers shall do all that is necessary to satisfy the Department of Transportation requirements and will be responsible for any damage to said roads which may be attributed to this project.

   All materials furnished by the contractor shall be delivered and distributed at the site by the Contractor or ***its*** ~~his~~ material supplier.

2. Loading and Unloading Materials: Ductile iron pipe and cast iron accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. ~~Concrete pipe, clay pipe, and~~ precast manholes will be unloaded with hoists and/or as recommended by the respective manufacturers. Under no circumstances shall such materials by dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground.

3. Responsibility for Materials on Site: In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench. Pedestrian or vehicular traffic shall not be unduly inconvenienced in placing of material along the streets or right-of-way, as applicable.

   The Contractor will string in advance no more than the amount of pipe and material that can be installed within four (4) weeks or less as approved by the ***Owner*** ~~Engineer~~. All the materials shall be placed in

such a manner as not to hinder access, endanger or impede traffic, or create a public nuisance. Materials strung through residential areas (or any area with maintained lawns) shall be placed in such a manner as not to restrict normal maintenance of established lawns, and must either be installed within two (2) weeks or removed to an approved storage yard, as required by the ***Owner*** ~~Engineer~~.

4. Material and Equipment Storage: The Contractor will be responsible for locating and providing storage areas for construction materials and equipment. Unless prior written consent from the owner of the proposed storage area is received by this Department, the Contractor will be required to store all equipment and materials within the limits of the sanitary sewer ***easements***, right-of-way and temporary construction easement provided. The materials and equipment storage shall comply with all local and state ordinances throughout the construction period. Material and equipment may only be stored within road right-of-way if approved by the controlling agency.

   The Contractor shall be responsible for the safeguarding of materials and equipment against fire, theft, and vandalism and shall not hold the ***Owner*** ~~County~~ responsible in any way for the occurrence of same.

5. Care of Coatings and Linings: Pre-cast manholes, pipe and fittings, including rings and covers, steps, straps, etc., shall be so handled that the coating or lining will not be damaged. If, however, any part of the coating or lining is damaged, the repair shall be made by the Contractor at his expense in a manner satisfactory to the ***Owner*** ~~Engineer~~.

B. CONNECTION TO EXISTING SEWERS

Tie-ins to existing activated sewer lines will be allowed when proper precautions are taken to protect the existing main. Tie-ins to existing ***inactive*** ~~unactivated~~ sewer lines not installed under the same contract will not be allowed without written approval from all parties involved (York County, contractors, contract holders, etc.). The Contractor will be required to install watertight masonry plugs in the proposed pipeline at the existing manhole and at the first proposed manhole until all construction is completed and testing begun. If the proposed sewer does not begin at an existing manhole, a straddle type manhole as shown on the Standard Details will be constructed over (and around) the undisturbed existing pipeline and the proposed pipeline plugged as specified. The existing pipeline will not be broken-out and the new invert formed until all testing has been successfully completed. Any connection with 18-inch and smaller pipe at an existing precast ***or cast***-in-place manhole will require the Contractor to core the necessary opening through the manhole wall. Connections to existing manholes with 21-inch and larger pipe may be cored or sawed as approved by the ***Owner*** ~~Engineer~~.

1. Temporary Watertight Plugs: The Contractor shall install temporary watertight plugs in the proposed sewer line at any manhole that is incomplete, at the open end of the pipeline prior to leaving the job site daily and elsewhere as dictated by good engineering and construction practices. All installed pipe shall be backfilled or otherwise securely tied down to prevent flotation in the event water enters or rises in the trench.

   The plugs ~~are~~ installed shall prevent infiltration or the introduction of any foreign material into either the existing or proposed systems.

   The County will not accept any pipeline or manhole, which contains any silt, sedimentation or other foreign material~~, within~~. The Contractor shall at ***its*** ~~his~~ own expense flush, or otherwise cause the line (and manholes) to be cleaned out without any discharge into the existing system.

   Upon completion of all construction, the Contractor will be responsible for the complete removal of all watertight plugs, in the sequence necessary to allow testing and subsequent activation, all under the direction of the ***Owner*** ~~Engineer~~.

2. Scheduling: When the flow of an existing sewer must be interrupted and/or bypassed, the Contractor shall, before beginning any construction, submit a work schedule which will minimize the interruption and/or bypassing of wastewater flow during construction. The schedule must be approved by the appropriate controlling agencies and ***Owner*** ~~Engineer~~ and may require night, holiday, and/or weekend work.

3. Bypass Pumping: If pumping is required, and identical standby pump shall be on site in the event of failure of the primary pump. If, at any time during construction, effluent from the existing sewer is not fully contained by the bypass system, gravity service will be restored by a temporary tie to the new construction and work shall be suspended until the problem is resolved to the satisfaction of the ***Owner*** ~~Engineer~~. The Contractor shall be responsible for any fines levied as a result of effluent reaching the creek. The Contractor will be required to verify his method of handling sewer flows during construction by pumping at peak flows for 1 hour as approved by the ***Owner*** ~~Engineer~~.

C. EXISTING UTILITIES

The Contractor will be required to excavate to determine the precise location of utilities, or other underground obstructions, which are shown on the Construction ***Drawings*** ~~Plans~~. Such location and excavation shall be at least 500 feet ahead of construction or as noted in the Special Provision Section of this document.

All utility owners ***shall*** ~~will~~ be notified ***by Contractor*** prior to excavation as required by the 1985 Underground Damage Prevention Act. Owners who are members of PUPS may be notified in accordance with current PUPS procedures. The York County ***Engineering*** ~~Water/Sewer~~ Department is a PUPS member. The Contractor will be fully responsible for damage to any utilities if the owners have not been properly notified as required by the Underground Damage Prevention Act.

Utility owners may, at their option, have representatives present to supervise excavation in the vicinity of their utilities. The cost of such supervision, if any, shall be borne by the Contractor.

Conflicts with underground utilities may necessitate changes in alignment and/or grade of this construction. All such changes will be approved by the ***Owner*** ~~Engineer~~ before construction proceeds.

When underground obstructions not shown on the Construction Plans are encountered ***and present a conflict with the proposed construction***, the Contractor shall promptly report the conflict to the ***Owner*** ~~Engineer~~ and shall not proceed with construction until the conflict is resolved by the ***Owner*** ~~Engineer~~.

Whenever a sewer main crosses under other utility lines (gas, telephone conduit, storm drain, etc.) there shall be 2 feet clearance between the top of the sewer and the bottom of the affected utility. Stone bedding shall be used from 6-inches below the sewer to 12- inches above the sewer from one foot outside the utility trench. If this clearance is not possible, the sewer line shall be Ductile Iron Pipe one foot outside the utility trench with a minimum length of 10 feet.

Whenever a sewer main crosses over other utility lines (storm drains, gas, encased or capped telephone conduit, etc.) the following will apply:

~~1. For PVC sewer lines - There shall be one foot clearance from the top of the utility to the bottom of the sewer. If this clearance is not possible the sewer line shall be ductile iron pipe from one foot outside the utility trench with a minimum length of 10 feet.~~

D. SEWER LINE/WATER LINE CLEARANCE

When a sewer main or lateral crosses or is parallel to an existing water main, the Contractor shall ***install*** ductile iron pipe (including laterals) for the sewer main as described below.

1. Vertical Separation of Sewer Lines & Water Lines: Whenever it is necessary for a sewer main to cross under a water main with less than 18-inches of vertical separation, the sewer main and water main shall be

constructed of ductile iron pipe, with joints meeting water main standards, for a distance of 10 feet on each side of the point of crossing.

Whenever it is necessary for a sewer main to cross over a water main, the sewer main and water main shall be constructed of ductile iron pipe, with joints meeting water main standards, for a distance of 10 feet on each side of the point of crossing.

2. Horizontal Separation of Sewer Lines and Water Lines: Sewer mains shall be laid at least 10 feet horizontally from existing or proposed water mains unless local conditions or barriers prevent a 10-foot horizontal separation. In that case, the sewer main will be laid in a separate trench, with the elevation of the bottom of the water main at least 18-inches above the top of the sewer. When these conditions are not met, the sewer main and water shall be constructed of Ductile Iron Pipe with joints meeting water main standards.

3. Horizontal Separation of Sewer Lines, Manholes, Pump Stations and Force Mains from Water Wells: Sewer lines, manholes, pump stations and force mains shall be installed at least 100 feet from a public water supply well and at least 20 feet from any other potable water well, as defined in SC DHEC Regulation 61-71; (67.300.A.13).

E. CLEARING

Unless otherwise specified, the entire permanent ***easement*** ~~right-of-way~~ shall be cleared and all stumps, limbs and trash removed and ***legally*** disposed of at an approved location. When the sewer line is installed in undeveloped/non-maintained areas (woods), stumps can be left flush with the ground if they are outside the trench excavation. Stumps must be removed from all maintained areas (yards, lawns, etc.).

Temporary construction easements will be selectively cleared with specimen trees left standing as stipulated in Special Provisions and/or ***easement*** ~~right-of-way~~ agreements. No clearing or grubbing may be performed of rights-of-way except under supervision of the Project Inspector.

Useable timber and/or firewood may be left on adjoining property, off the permanent right-of-way at the request or with the consent of the property owner. Such requests must be in writing and must release the County from any claims for improper disposal of timber.

The Contractor shall abide by all special conditions contained in the ***easement*** ~~right-of-way~~ agreements for this project. When the ***easement*** ~~right-of-way~~ agreement specifies stacking timber or firewood adjacent to the right-of-way, a written release is not required. The Contractorshall verify cut lengths of timber/firewood for such placement and location with property owner.

Fences removed during construction shall be replaced of the same material and to the same condition existing prior to the construction. The Contractor may refer to the "Environmental Protection Section" contained herein for further instructions pursuant to ***easement*** ~~right-of-way~~ treatment.

F. EXCAVATION

All excavations for pipe laying, manholes, piers, drainage ditches, grading and any other excavation required for the proper completion of this contract shall be included herein.

Excavation within street right-of-way shall be backfilled when left unattended for more than 1 hour unless otherwise approved by the controlling agency. Excavations within sewer/water rights-of-way shall be backfilled, fenced or otherwise protected when left unattended for more than 1 hour. Fencing or other protection methods shall be designed to reasonably prevent people and large animals from entering the excavation.

1. Trench Excavation: No more trench (100 ± LF) shall be opened in advance of the pipe laying than is necessary to expedite the work unless prior approval is given by the ***Owner*** ~~Engineer~~. Ground conditions and/or location requirements shall govern the amount of trench open at any one time as determined by the ***Owner*** ~~Engineer~~.

    a. Trench Width: The maximum trench width shall be as indicated for each type of pipe specified. If the actual trench width exceeds the specified width, due to shoring methods, the contractor must obtain approval from the ***Owner*** ~~Engineer~~.

    Trench width shall be measured between faces of cut at the top of the pipe bell. If the Contractor varies from the requirement without prior approval of the ***Owner*** ~~Engineer~~, or if specified trench widths cannot be maintained, improved bedding and/or improved pipe material shall be installed as directed by the ***Owner*** ~~Engineer~~.

    b. Trench Bottom Conformation: The excavation shall be made to the elevations, grades, and lines shown on the Construction Plans unless otherwise approved by the ***Owner*** ~~Engineer~~. The trench bottom shall be excavated slightly above grade and cut down to the pipe grade by hand in the fine grading operation. The trench bottom shall be true and even with bell holes at each joint to provide the barrel of the pipe with soil and/or granular (as applicable) support for its full length. This should prevent joint loading at the bells. If the trench bottom is inadvertently cut

below grade, the Contractor shall fill it to grade with approved material thoroughly tamped.

Pipe depth and/or soil conditions may dictate a granular embedment as specified below. Such bedding shall also be shaped to allow adequate support of the pipe along the full length of the barrel.

If the trench passes either under or over another pipeline or previous excavation, the trench bottom in this area shall be tamped, if necessary, so the disturbed soil has approximately the same supportive strength as the native soil.

2. Excavation for Structures: The excavation shall be made to the lines, grades and elevations shown on the ***drawings*** ~~Plans~~ and Standard Details. The area excavated shall be limited to no more than is necessary to allow the proper installation of the structure as determined by the ***Owner*** ~~Engineer~~. The excavation shall remain open no longer than is necessary to allow the proper and complete installation of the structure.

   a. Structure Pit Bottom Conformation: The pit bottom shall be true and even, and capable of supporting the structure as determined by the ***Owner*** ~~Engineer~~. If the pit bottom is inadvertently cut below grade, the Contractor shall fill it to the proper elevation with approved material capable of continually maintaining adequate supportive strength.

3. Excavation for Bore Pits: The excavation shall be controlled by the limits of the existing ***easements*** ~~rights-of-way~~ and shall not exceed these without prior written approval of the current property owner. The excavation shall be made to the proper elevation, line and grade as required to install the casing pipe as shown on the construction drawings ~~plans~~.

   a. Bore Pit Conformation: The pit bottom shall be true and even with adequate stabilization to maintain proper elevation and grade on the boring rig for the duration of the bore.

~~4. Rock Excavation: Rock excavation shall be defined as solid ledge rock that requires drilling and blasting, sledging, or barring for its removal. Soft, disintegrated rock that can be removed with a pick shall not be classified as solid rock.~~

~~Boulders greater than one cubic yard in volume will also be considered rock excavation. Smaller boulders and soft rock, which in the opinion of the Engineer can be excavated by the use of a power shovel, without undue delay, shall not be classified as rock.~~

~~Rock shall be removed to a depth of six (6) inches below the pipe bell and to the trench widths specified for each size and type of pipe installed. Rock around structures shall be removed to the same twelve (12) inch minimum as measured between vertical planes around the structure, but only to a depth necessary to allow proper installation. Over excavation of rock due to removal methods, or for safety considerations, shall be the Contractor's responsibility.~~

~~When rock removal is necessary for pipeline installation either Type II or Type III bedding shall be installed as specified and directed by the Engineer.~~

~~All blasting shall be conducted in a manner specified elsewhere in these Specifications.~~

5. Piling Excavated Material: All excavated material shall be piled in a manner that will not endanger the work. Excavated material will be piled a safe distance away from the edge of the excavation allowing room for an adequate angle of repose and if shoring, sheeting, and bracing is used to protect the excavation, no material will be piled within three (3) feet of the nearest edge. Sidewalks, driveways, hydrants, valve pit covers, valve boxes, curb stop boxes, existing manholes, fire and police call boxes, or other utility controls shall be unobstructed and accessible until the work is completed. Gutters, catch basins, and natural watercourses shall not be obstructed or silted.

   When working in close proximity with a creek channel or natural watercourse the Contractor shall pile all excavated material on the side of his excavation away from the watercourse.

6. De-watering: The Contractor shall at all times provide and maintain ample means and equipment with which to remove and properly dispose of any and all water entering the excavation or other parts of the work and keep all excavations dry until such time as pipe laying and grading is completed and structures to be built therein are completed.

   No water shall be allowed to rise around the pipe in unbackfilled trenches nor shall it be allowed to rise over masonry until the concrete or mortar has set (minimum 24 hours). All water pumped or drained from the work shall be disposed of in such a manner as to prevent siltation and erosion to adjacent property or other construction. ***Contractor shall employ the use of filter bags or other acceptable means to reduce silt-laden water from discharging from the pumps.***

7. Shoring And Shielding: The Contractor shall comply with OSHA trenching and excavation regulations as revised in Subpart P of Part 1926

in the Federal Register. Shoring and/or shielding systems shall be used as specified in Subpart P to prevent caving of trench banks and to provide a safe excavation.

The Contractor will be responsible for excavation safety and shall designate ***a*** ~~his~~ "competent person" (as defined in Subpart P) for the determination of proper shielding/shoring systems.

If, in the opinion of the ***Owner*** ~~Engineer~~, the trench/excavation is not in compliance with OSHA regulations, the Contractor may be directed to stop work. Continued unsafe conditions will be reported to the appropriate regulatory agency. The Contractor will be responsible for paying all fines resulting from safety violations.

G. PIPE LAYING

The various pipes referred to herein shall be handled, belled up and laid in accordance with the manufacturer's requirements and good ***construction*** ~~engineering~~ practices as defined in the various publications referenced in this document. The following requirements and/or standards of the York County ***Engineering*** ~~Water/Sewer~~ Department shall govern this construction unless exceeded by other regulatory bodies.

1. Construction:

   a. In all instances pipe shall be laid in a workmanlike manner, true to line and grade, with bell ends facing up-grade in the direction of laying.

   b. Sewer pipe is to be laid with a uniform slope between manholes.

   c. Sewers 24 inches or less in diameter shall be laid with straight alignment between manholes.

   d. The internal angle of deflection at manholes must be equal to or greater than 90 degrees.

   ~~e. PVC gravity sewer mains must be installed in accordance with ASTM D- 2321, or latest revision.~~

   ~~f. PVC sewer force mains must be installed in accordance with ASTM D- 2321, or latest revision.~~

   ~~g. Ductile iron force main pipe must be installed in accordance with AWWA C-600.~~

h. ~~Sewer force mains tying into manholes shall enter the manhole a vertical distance of not more than two (2) feet above the flow line of the receiving manhole.~~

2. Pipe Bedding: Unless otherwise specified or noted on the ***drawings*** ~~Plans~~ the following bedding classes are commonly required by this Department.

When granular material embedment is required, the Contractor will follow the layered procedure specified in Type I for soil placement, above the granular bedding, to an elevation one (1) foot above the pipe bell.

~~a. Type I - Shaped Bottom Bedding: The trench bottom shall be shaped so the pipe bears uniformly upon undisturbed native earth. Soil shall then be placed by hand around the pipe and completely under the pipe haunches in uniform layers not to exceeding six (6) inches in depth up to an elevation one (1) foot above the top of the pipe bell.~~

Each layer shall be placed and then carefully and uniformly tamped, so that the pipe is not damaged nor the alignment disturbed.

b. Type II - Granular Material Embedment: The trench bottom shall be undercut a minimum of six (6) inches below the pipe barrel grade and filled with a approved stone to an elevation such that the pipe will be completely and uniformly bedded to a vertical height of one-third the outside diameter of the pipe bell for the pipe's entire length and for the entire width of the ditch. Depending upon soil and ground water conditions, greater depths (undercut) may be required to create a stable condition. Type III granular material embedment shall be used as directed by the ***Owner*** ~~Engineer~~.

c. Type III - Granular Material Embedment: The trench bottom shall be undercut a minimum of six (6) inches below the pipe barrel grade and filled with an approved stone to an elevation such that the pipe will be completely and uniformly bedded to vertical height of one-half the outside diameter of the pipe bell for the pipe's entire length and for the entire width of the ditch. Depending upon soil and ground water conditions, greater depths (undercut) may be required to create a stable condition. Type III granular material embedment shall be used as directed by the ***Owner*** ~~Engineer~~.

d. Stone Stabilization: When the bottom of the trench is not

sufficiently stable to prevent vertical or lateral displacement of the pipe after installation with Type II or Type III bedding, stone stabilization will be required to develop a nonyielding foundation for the bedding and pipe. When such conditions are encountered, the trench will be excavated to a depth determined by the ***Owner*** ~~Engineer~~, and #467 crushed stone will be placed to an elevation six-inches below the bottom of the pipe. The pipe will then be laid with Type II or Type III bedding as directed by the ***Owner*** ~~Engineer~~.

e. Concrete Encasement and Cradles: Shall be as designed for each individual case and will be noted on the Plans and in the Special Provisions when applicable.

3. Installation Depth Limitations: The following are limitations and bedding requirements for supportive strength and shall be adhered to at all times. Granular material embedment may still be required for lesser depths of cover should groundwater and/or soil conditions warrant its use, as determined by the ***Owner*** ~~Engineer~~.

The standard trench widths shall be as shown on the York County Engineering Standards as contained in the Construction Drawings.

~~* The standard trench width for 8"-15" pipe shall be limited to the nominal pipe size plus 30-inches.~~

~~* The standard trench width for 18"-30" pipe shall be limited to the nominal pipe size plus 36-inches.~~

~~* The standard trench width for 36" and larger pipe shall be limited to the nominal pipe size plus 42-inches.~~

Deviations from the standard trench width shall be as approved by the ***Owner*** ~~Engineer~~.

Trench widths must be maintained constant as measured at the top of the pipe. Deviation from the standard trench width will necessitate an increase in the stone bedding around the pipe and/or a change in the type or class of pipe being installed at the Contractor's expense.

All pipes regardless of bedding or pipe type shall require adequate tamping of backfill as specified for Type I, Shaped Bottom Bedding.

~~a. PVC Pipe shall be installed with a minimum of 3.0 feet of cover over the top of the pipe subject to the bedding limitations specified below. When the cover is less than 3.0 feet or greater than the depths shown for Type III Bedding, Ductile Iron Pipe~~

~~must be used.~~

MAXIMUM DEPTH OF COVER			
Size	**~~Type I Bedding~~**	**Type II Bedding**	**Type III Bedding**
8"-15"	**~~10'~~**	**15'**	**18'**

b. Ductile Iron Pipe: Installation of Ductile Iron Pipe shall be installed subject to the bedding limitations specified below, based on a deflection limit of three (3) percent for cement lining. Greater depths of cover may be achieved by using a higher pressure classification and/or using pipe with a flexible lining.

MAXIMUM DEPTH OF COVER - DIP				
Pipe Size	**Pressure Class**	**BEDDING**		
		~~Type I~~	**Type II**	**Type III**
8"	**350**	**~~20'~~**	**34'**	**50'**
10"	**350**	**~~15'~~**	**28'**	**45'**
12"	**350**	**~~15'~~**	**28'**	**44'**
14"	**250**	**~~15'~~**	**23'**	**36'**
16"	**250**	**~~15'~~**	**24'**	**34'**
18"	**250**	**~~14'~~**	**22'**	**31'**
20"	**250**	**~~14'~~**	**22'**	**30'**
24"	**250**	**~~15'~~**	**20'**	**29'**
30"	**250**	**~~15'~~**	**19'**	**27'**
36"	**250**	**~~14'~~**	**18'**	**25'**
42"	**250**	**~~14'~~**	**17'**	**25'**
48"	**250**	**~~13'~~**	**17'**	**24'**

~~c. Poly Vinyl Chloride (PVC) Pipe: PVC pipe shall be installed with a minimum of 3.0 feet of cover and a maximum of 16 feet of cover. When the cover is less than 3.0 feet or more than 16 feet, Ductile Iron Pipe must be used subject to the specified bedding limits. PVC pipe shall be installed in accordance with ASTM D-2321 with the following modifications:~~

~~1. All PVC pipe shall be installed using Type III Granular Embedment. The bedding shall extend from the pipe to the trench wall or to two and one half pipe diameters (OD) on~~

~~each side of the pipe, whichever is less.~~

4. Grade and Line For Pipe: As a minimum, centerline hubs will be set at each manhole and offset stakes set at each manhole, and if required at 100 foot intervals between manholes. Cut sheets will show the vertical distance from the offset stakes to the inlet and outlet pipe invert at each manhole and to the pipe invert at each offset stake. Grade and line may be transferred to "batter boards" set at intervals not to exceed fifty (50) feet. Unless otherwise approved by the ***Owner*** ~~Engineer~~, three (3) batter boards will be in place at all times while pipe laying is in progress. Each joint shall be checked with a grade rod and plumb line with care being taken to keep the string line taut at all times.

   Laser beams may be used to set line and grade when the Contractor provides adequate and accurate equipment for the ***Owner*** ~~Engineer~~ to check his line and grade at each cut stake (lock levels shall not be considered adequate). If laser equipment is used, the grade shall be checked at each manhole ~~and at benchmarks every 500 feet~~. The Contractor shall keep close check of ***the*** ~~his~~ laser for variations in line and grade. No variations between manholes shall be corrected without relaying that portion of line, which has deviated from line or grade unless otherwise approved by the ***Owner*** ~~Engineer~~.

H. LATERAL INSTALLATION

1. ~~4-Inch and~~ 6-Inch Laterals: ~~Four inch and~~ six inch laterals shall be connected to the main with tees as previously specified if the lateral is installed during the construction of the main. ~~Four inch and~~ six inch laterals shall be connected to existing mains with saddles placed in holes cored by an approved coring machine. Saddles and tees shall be as previously specified and as shown on the Standard Details

   Laterals shall be completed to the property line using 22½° bends at the tee or saddle and pipe as previously specified and as shown in these Standard Details. The lateral shall be laid with a minimum slope of 1/8-inch per foot (1%). The end of the lateral will be plugged water/air tight. All tees, saddles and bends shall be completely encased in #67 washed stone. An "S" shall be cut in the curb at the location where lateral crosses under curb.

   In subdivisions constructed without curb, the Contractor will paint an "S" on the edge of pavement at the location where the lateral crosses under the edge of pavement. Markings will be made using green paint.

   All laterals except those serving lots adjacent to in line manholes or upstream from dead-end manholes in cul-de-sacs shall be connected to the sewer main. Laterals connected to manholes shall be laid on a line from the center of the lot to the center of the manhole and shall extend

not more than six inches inside the manhole wall. Manholes in cul-de-sacs shall have a maximum of three (3) laterals. Any in line manhole shall have a maximum of two (2) laterals. The lateral elevation entering the manhole shall match crown to crown with the main entering the manhole and a trough shall be formed for the lateral invert. Laterals that are connected to outfall lines shall enter the manhole at the shelf and an invert shall be formed to carry the lateral flow to the main invert.

The laterals shall be installed with a minimum of four (4) feet of cover at the property line, unless otherwise approved by York County Water/Sewer Department. The depth of the lateral at the property line shall not be greater than five (5) feet unless greater depth of the lateral unit the installation is approved by a York County Water/Sewer Department Inspector.

2. 8-Inch And Larger Laterals: 8-inch and larger diameter laterals shall connect to manholes with the lateral crown level with the crown of the main line pipe, or with outside drops, in accordance with the specifications and standard details for mainline construction. When the lateral is the same diameter as the main line pipe, a drop of 0.2 feet will be provided in the manhole between the invert of the lateral and the invert of the main line pipe. The lateral shall be laid with a minimum slope of 1/8-inch per foot (1%).

I. BACKFILL

All backfill shall be of non-plastic nature free from roots, vegetative matter, waste, construction material, rock larger than ¾ cubic foot, or other objectionable material. Small rock (less than ¾ cubic foot) shall not exceed 10% of the fill material. Rock shall not be placed within 3-feet of the pipeline or within three feet of the finished grade. Rock larger than ¾ cubic foot will not be permitted within the trench. No objectionable or unsuitable material will be allowed in the backfill. Backfill material shall be capable of being tamped by mechanical tamps using relatively low velocity and heavy blows. The material shall have no tendency to flow or behave in a plastic manner under the tamping blows. Material deemed by the ***Owner*** ~~Engineer~~ as unsuitable for backfill purposes shall be removed from the job site before backfilling operations begin.

When the ***Owner*** ~~Engineer~~ determines that the material excavated from the trench is unsuitable for backfill because of the material type or because it contains excessive debris, rock or organics, it shall be removed from the project and replaced with a backfill material approved by the ***Owner*** ~~Engineer~~. When the moisture content of an otherwise suitable material is too high to achieve specified compaction, as determined by a moisture content and density test, the Contractor shall replace the material as necessary to meet backfill requirements. The wet material may be dried to optimum moisture content and used for backfill

in subsequent phases of the project. Should an otherwise suitable material be found too dry to achieve compaction requirements, water may be added to the material to raise the moisture content to optimum.

Borrow material placed at the direction of the ***Owner*** ~~Engineer~~ shall be clean earth at optimum moisture content, concord (pit) gravel or ABC stone.

Backfill shall be accomplished immediately after the pipe is laid. Backfill around pipe and to an elevation of one (1) foot above the pipe bell shall be done only by hand and in layers not exceeding six (6) inches with each and every layer thoroughly tamped. The first three (3) feet of fill shall be completely free of rocks. Successive layers of backfill shall be compacted in place as specified below.

Under no circumstances shall water be permitted to rise in unbackfilled trenches after the pipe has been placed. Should water rise in an unbackfilled ditch after the pipe has been placed, the ***Owner*** ~~Engineer~~ may require the Contractor to remove the pipe, muck the trench and follow the procedure for ~~either Type I or~~ Type II Granular Embedment when relaying the pipe.

1. Backfill of trenches within sewer main ***easements*** ~~rights-of-way~~: Trenches excavated outside existing roadway and railway right-of-way may be backfilled, above the initial one (1) foot, by mechanical means in layers up to twelve (12) inches thick unless otherwise directed by the ***Owner*** ~~Engineer~~.

2. Backfill of trenches within road and railway rights-of-way: Trenches excavated within existing road and railway rights-of-way shall be backfilled in layers not to exceed six (6) inches and each successive layer shall be thoroughly tamped, as specified.

J COMPACTION REQUIREMENTS

Compaction shall be attained by the use of mechanical tamps only. Each layer of backfill shall be placed loose and thoroughly compacted in place. Heavy rollers, vehicles or other equipment shall not be used for compacting pipeline and structure backfill nor allowed to cross over completed work except at points adjudged capable of adequately protecting the pipeline. Pneumatic tamps, gasoline ram type tamps or vibrating tamps with sheepsfoot rollers will be required to meet the specifications of "Mechanical Tamp". Variances shall only be with the explicit approval of the ***Owner*** ~~Engineer~~.

1. Compaction Within Sewer ***Easements*** ~~Rights-of-way~~: Trenches excavated outside existing road and railway rights-of-way shall be backfilled as hereinbefore specified and tamped thoroughly:

1. All material shall have an in-place density of at least 85% of maximum dry density or as approved by the ***Owner*** ~~Engineer~~.

b. Should any public or private roadways, service roads, drives, etc. be encountered during this construction, the Contractor shall at the ***Owner*** ~~Engineer~~'s direction comply with those compaction requirements specified below for work within road and railway rights-of-way.

2. Compaction Within Road and Railway Rights-of-Way: Unless otherwise approved by the controlling agencies, trenches excavated within existing road and railway rights-of-way and all structure excavation regardless of location shall be backfilled as hereinbefore specified and thoroughly tamped.

1 Unless otherwise directed by the ***Owner*** ~~Engineer~~, all material from the bottom of trench to within six (6) inches of the subgrade shall have an in-place density as defined by a standard proctor curve for the material.

b. All material within six (6) inches of the subgrade level shall an in place density of 100% of the maximum dry density.

c. On roadway shoulders, all material shall have an in place density of 95% of the maximum dry density. The Contractor shall remove and replace all material failing to meet these requirements with suitable material. The extent of this removal shall be determined by the ***Owner*** ~~Engineer~~.

K. MANHOLE CONSTRUCTION

All manholes outside street rights-of-way or landscaped areas shall be constructed to a height of two (2) feet above the adjacent ground unless otherwise indicated on the ***drawings*** ~~Plans~~ or by the Special Provisions. Manholes within street rights-of-way or landscaped areas shall have finished rim elevations flush with the pavement or adjacent finished grade.

1. Precast Reinforced Concrete Structures: All precast manhole sections shall conform to the Material Specifications and Standard Details.

Precast manholes shall be treated similar to reinforced concrete pipe for installation. That is, if ground water and/or soil conditions require stabilization for pipe installation comparable measures will be required for precast manhole installation. Under no circumstances will a precast base section be placed on unstable soil as solely determined by the ***Owner*** ~~Engineer~~.

Jointing of precast sections will be done in accordance with the manufactures recommendation, with special attention called to the amount of force used.

All backfill around structures shall be thoroughly tamped in layers as specified for placing backfill.

Regardless of the type manhole construction used, the Contractor will do that which is necessary to stabilize the soil intended to support the structure. A stable condition shall only be adjudged by the Construction ***Owner*** ~~Engineer~~ or his authorized representative. Any cost incurred by the Contractor in stabilizing the area to support a manhole shall be considered incidental to the manhole construction.

2. Outside Drops: When design considerations dictate a large elevation change across a manhole, an outside drop shall be constructed in accordance with the York County Water/Sewer Department Standard Details. Depending on the particular fittings used, elevation differences of 2.0 to 2.5 feet are required to accommodate an outside drop. When there is no sufficient elevation difference to permit construction of an outside drop, the grade of the influent pipe shall be lowered such that the vertical separation of the influent and effluent pipe is 0.2 feet, as measured at the center of the manhole when the grades of both pipes are projected to that point. Outside drops shall not enter the cone section of precast manholes. The influent pipe of an outside drop manhole must be a minimum of 18' ductile iron pipe.

~~3. Inside Drops: When connecting a proposed sewer main to an existing manhole at an elevation significantly higher than the existing invert elevation, and where safety considerations or working space limitations preclude building an outside drop, the connection may be made with an inside drop constructed in conformance with the Standard Details. Inside drops will be used only where shown on the plans or specifically approved by the Engineer. They may not be used in lieu of outside drops shown on the plans. Inside drops shall not enter the manhole in the cone section. Inside drops are not allowed on four (4) feet diameter manholes.~~

4. Installation of Frames And Covers: The frame shall be installed on the manhole with anchor bolts on all manholes that are not flush with the ground. 8-inch tall or 4-inch tall frames may be used for manholes with bolt down frames. These frames shall have four (4) holes in the support flange to permit installation on the cone with anchor bolts. Holes shall be equally spaced in the flange. Complete anchor bolt assemblies shall be zinc plated steel and shall consist of a drive in type anchor sleeve, a threaded stud and two nuts. Anchors shall be installed in field drilled holes in the cone. Minimum diameter of the threaded stud shall be ½

inch. The Contractor shall seal the frame to the to the manhole by installing a length of butyl rubber joint sealant to form a gasket between frame and manhole. The butyl rubber joint sealant shall have a one inch cross section, and shall make two full circles when placed on the cone section, and shall be compressed by the frame with the anchor bolts. Butyl rubber joint sealant shall be "Rubber Seal " as manufactured by Ru Van, Inc., or approved equal. Cement mortar grouting of the frame shall be required. Brick may not be used to adjust rim elevations of above grad manholes.

Manholes that are installed flush with pavement or grade shall have frames attached to the manhole with a bed of cement mortar grout. 8-inch tall frames are required for all manholes that are flush with pavement or finished grade unless otherwise approved. Standard size brick or reinforced concrete grade rings may be used to adjust the finished rim elevation of such manholes. This adjustment may not exceed 21-inches in height.

5. Manhole Step Testing: The Contractor will furnish a hydraulic driven system consisting of cylinder, connecting hose and above ground pump with gauge to test manhole steps to exceed 1000 lbs. of resistance of pullout. All field installed steps will be tested. In lieu of field testing steps installed at the plant, certified shop reports by the manufacturer showing that each step passed the required 100 lb. pullout will be accepted. The certificates will be furnished to the inspector prior to field installation.

   Unless the Contractor can furnish the manufacturer's certification on step tests, the Contractor will be required to test 10% of the plant installed steps. An additional 10% will be tested for each failure.

~~6. False Walls: False walls shall be constructed in manholes when specified on the Plans. Holes of the appropriate size shall be cored or blocked out in the manhole wall at the elevation and alignment shown on the Plans. A four-inch thick masonry wall shall be constructed in the opening. Inverts shall be constructed to match proposed pipe elevations and alignments and permit installation of the future extension without demolition work other than removal of the false wall.~~

7. Steel Vent Pipes: Steel vent pipes will be installed in accordance with the Standard Details. Shop drawings of strap on vents, mounting straps, and anchor bolts will be subject to approval of the ***Owner*** ~~Engineer~~. Material shall be as specified in the Materials Specification Section.

~~L. PIERS~~

Pier locations as shown on the Plans shall be considered a guide only, with final determination made at the time of construction by the Engineer. Pier spacing center to center, will be as shown on the Plans, but all pier locations may be adjusted by the Engineer due to field conditions.

Piers will be placed parallel to the flow of the creek unless otherwise directed by the Engineer.

1. Steel Pile Piers: The work covered by this section consists of furnishing and driving piles, as indicated on the plans, the standard details, and as approved by the Engineer.

   a. Installation: General - The HP8X36 or W8X35 pilings shall be driven to obtain a bearing capacity of 20 tons based on the following formula (the Engineering News Record Pie Driving Equation) and to a minimum depth of 10 feet in undisturbed earth below the bottom of the creek channel or existing ground when not adjacent to the creek.

   S = penetration per blow (inches)
   R = specified bearing capacity (pounds) ENR Formula: $S = \frac{(2E/R) - C}{}$
   E = energy per blow (ft lbs)
   C = 1.0 for drop hammer; 0.1 for air, steam, or diesel hammer

   b. Piles Lengths: Full length piles shall be used where practicable and not more than 2 pieces (1 splice) of steel pile will be permitted in making up one full length pile unless approved by the Engineer. Splices, where necessary and approved by the Engineer, shall be made as to maintain the true alignment and position of the pile sections. Both pieces of a spliced pile shall be the same shape (HP8X36 or W8X35).

   Splices should develop not less than 100 percent of the bending strength of the pile and not less than 100 percent of the axial load strength of the pile. All welded splices will be of butt weld type and back-up plates welded to the flanges and web of the steel piles. All welding of structural steel in the shop or in the field shall meet the requirements of the AWS Code and be done by qualified welders. Certification of welders and welds will be required by the Engineer in accordance with the AWS Code.

   c. Driving: Steel piles shall be driven with a diesel, steam, drop, or air hammer with a rated energy of not less than 15,000 ft. lbs., fixed leads and a ram weight of one (1) to one and a half (1½) times the pile weight. In case the required penetration is not obtained by the

use of a hammer complying with the above minimum requirements, the Contractor shall provide a heavier hammer, at his own expense. The piles shall be driven on a batter of 15° to the vertical or as shown on the plans, and shall not be out of position at the top of the pile by more than three inches in any direction after driving.

d. Cross bracing: Cross bracing will be required only when the undisturbed ground level is below the intersection of the cross bracing.

e. Painting Steel Piers: Unless otherwise directed, all steel in the piers shall have a coal tar epoxy coating consisting of two coats of coal tar epoxy as specified. All surfaces of the steel to one foot below the disturbed ground or to one foot below the cross bracing, whichever is greater, shall receive the coating system and shall be thoroughly sand blasted prior to application to remove rust, dirt, grease, and other foreign material and to provide a clean surface to receive the coating. Each coat of paint shall be approved by the Engineer prior to application of the next coat. The total dry film thickness shall be at least 16 mils. Areas with coatings less than 16 mils shall be recoated as required to provide the specified film thickness.

f. Testing And Inspection: The Inspector will be present during all pile driving operations and the Contractor will provide him evidence that the average penetration for the last 10 blows is less than S calculated by use of the above formula.

Test piles furnished and driven by the Contractor for his use in determining the lengths of piles to be furnished may be so located that they may be cut off and become a part of the completed structure, provided that such test piles conform to the specifications and are approved by the Engineer.

Test piles shall be driven with equipment of the same type and capacity as that used for driving for the structure.

Test piles which are not to be incorporated in the completed structure shall be removed to at least 2 feet below the surface of the ground or the stream bed, and the remaining hole backfilled with earth or other suitable material.

The Contractor shall give written notice before beginning construction on the steel piles in order to coordinate this work with York County Water/Sewer Department.

2. Concrete Piers: If the required penetration for a pile is not obtained, as

~~determined solely by the Engineer, the Contractor may be directed to construct a reinforced concrete pier. The Contractor will not attempt to drive a second pile at a pier location at which the first pile did not achieve the required penetration unless the Engineer has determined that the first pile will be used.~~

~~A pile, which will not be incorporated in the completed structure, will be removed or cut off so that the top of the pile is below the concrete footing.~~

M. REMOVAL AND RESTORATION OF PAVEMENT AND ROAD SURFACES

All removal and restoration of pavement and road surfaces will be in accordance with the specifications approved by the York County Public Work Department or of the South Carolina Department of Transportation and Safety whichever applies.

All restored bituminous and concrete pavements shall be placed to existing cross-section and ride quality. Restored pavement will in all instances be flush and level with existing pavement at the sawed edges, and at existing gutter lines where applicable unless otherwise approved by the ***Owner*** ~~Engineer~~. When pavement repairs do not meet the above criteria or are not performed in a workmanship manner as determined by the ***Owner*** ~~Engineer~~, York County Public Works, or South Carolina Department of Transportation, whichever applies, the contractor will remove and re-perform the restoration as specified.

When cuts are to be made in street rights-of-way under maintenance by York County Public Works, the Contractor shall contact the road Maintenance Supervisor or his designated representative before each separate pavement cut is made and secure a permit.

Pavement will be replaced as follows. In all pavement cuts either the permanent pavement or a temporary pavement consisting of 1"-1½" of black asphaltic concrete (later to be replaced permanently) will be placed immediately upon completion of the subgrade unless otherwise approved by the ***Owner*** ~~Engineer~~.

1. Specifications for Cutting Pavement: Unless otherwise approved or required, concrete pavement shall be removed to the nearest expansion or contraction joint. The Contractor will contact the Superintendent of Streets and/or D.O.T.'s District Engineer for determination of the limits of concrete replacement and location of joints. Where sawed joints are allowed, the depth of the sawed cut shall be at least one (1) inch and shall extend at least 1/5 of the depth of the concrete. More depth may be required if necessary to prevent damage to surrounding pavement.

   Bituminous pavement shall be cut in a smooth and straight line. Sawing

is required on asphaltic concrete. The width of pavement left between the edge of the ditch and the existing edge of the pavement or the front line of the gutter, shall be at least 2 feet. Residual strips of pavement less than 2 feet in width must be removed and replaced. Existing pavement shall be removed on each side of the trench for at least 12 inches beyond top of trench.

The Contractor shall remove and replace pavement, which, in the opinion of the ***Owner*** ~~Engineer~~, has been cracked or displaced by the operation of the Contractor.

2. Specification For Restoring Concrete Pavement: The concrete used to restore pavement shall have a minimum 28 day compressive strength of 3600 P.S.I. The concrete as placed shall conform to the shape, grade, and finish of the existing pavement and will be one (1) inch deeper than the original pavement including base, but in no instance less than six (6) inches.

3. Specification For Restoring Asphalt Pavement: All material above the sub-base level shall be hot-mix bituminous concrete conforming to South Carolina Department of Transportation standard specifications for roads and structures for both mix design and placement. The asphalt pavement as placed shall be one (1) inch deeper than the original pavement including base, but in no instance less than six (6) inches within City maintained roadways or eight (8) inches within state maintained roadways. The asphalt shall be placed in lifts not greater than 4 inches and shall be hot mix bituminous concrete binder Type H. The last two (2) inches in either instance shall be bituminous plant mix (1-2) suitable to the appropriate controlling agency. 1-2 asphalt pavement resurfacing will be placed with paving machines and/or rollers of a size and type currently approved by the South Carolina Department of Transportation for use on resurfacing contracts.

   If a bituminous surfacing overlays a concrete base, the Contractor, at the option of the ***Owner*** ~~Engineer~~, shall replace the concrete to its original thickness, or to a level 2 inches below the finished surface. The ***Owner*** ~~Engineer~~ may direct the Contractor to omit all concrete and to replace the pavement with bituminous materials.

   Tack coats shall be employed with each lift. Tack costs shall be placed on both horizontal and vertical surfaces (pavement cuts or face of concrete gutters).

   Under normal conditions, asphalt binder will be placed in pavement cuts at the end of each workday. 1-2 shall be replaced weekly or within five days following completion of pipeline construction along a continuous

section of pavement.
During inclement weather, the ***Owner*** ~~Engineer~~ may permit the use of temporary asphalt (cold mix) to seal the trench until permanent asphalt can be placed.

N. CONCRETE CONSTRUCTION

1. Acceptance of Concrete: Concrete shall be accepted on the basis of its meeting the requirements listed under the Material Specifications and Detail Specifications Section of this contract. The Inspector will accept no ready mix concrete without the plant dispatch ticket.

   The ***Owner*** ~~Engineer~~ shall make or require any tests as he deems necessary to insure that the concrete meets specifications. The ***Owner*** ~~Engineer~~ may require the test to be performed by an independent testing laboratory at the Contractor's expense.

2. Placement: Concrete will not be accepted if it cannot be placed within ninety (90) minutes of the dispatch time. Time requirements may fluctuate marginally due to temperature. Concrete shall be deposited in such a manner so as to prevent contamination by foreign material and segregation due to rehandling or flowing. Segregated concrete and/or concrete containing foreign material will not be accepted. Depositing will not be permitted when temperature has not exceeded 35° and rising by 10:00 A.M. Depositing shall cease when the descending air temperature in the shade falls below 40° F. It shall not resume until the ascending air temperature rises to 35° F. All concrete shall be kept from freezing by the Contractor. Frozen concrete shall be replaced at the Contractor's expense. Free fall shall not exceed 3 feet in any case.

3. Forms: Forms may be made of wood, plywood, metal, or any other material approved by the ***Owner*** ~~Engineer~~. Forms shall be mortar tight, of material strong enough to resist noticeable deflection or bulging between supports, and the interior dimensions of the forms shall be such that the finished concrete shall be of the form and dimensions shown on the Plans. The design of the forms shall take into account the effect of vibration of concrete as it is placed and also the rate of speed at which the forms will be filled. Forms shall be coated with a lubricant as approved by the ***Owner*** ~~Engineer~~.

   Mechanical vibrators, of an approved type, and continuous spading and/or rodding of concrete shall be used of produce proper contact of concrete with forms and reinforcing steel in piers and with forms and pipe in monolithic inverts insuring a compact, dense and impervious artificial stone of uniform texture.

4. Curing: All concrete will be cured for a seven (7) day period after

placement according to the following procedure:

a. Forms will normally be left in place for the entire seven (7) day period. Exposed surfaces not covered by forms will be kept moist continuously for the entire seven day period or will be cured through use of an approved curing compound which will be applied after all surface water has disappeared.

b. At the discretion of the ***Owner*** ~~Engineer~~, forms may be removed after the initial set and before the end of the seven day period. In such cases, the areas previously covered by forms shall be cured as described above.

c. The ***Owner*** ~~Engineer~~ may permit backfill of certain structures (e.g. concrete piers) before the end of the curing period. In such cases, the forms shall be stripped and the surfaces that remain exposed after backfill shall be cured as described in (a) above. Curing compound shall not be required for backfilled surfaces except where specified by the plans or Special Provisions.

5. Finishing: The structure shall have a uniform and textured surface. All form marks exposed to view shall be rubbed off with a stone.

6. Testing: The following tests will be performed by York County Technicians to ensure the concrete quality:

a. Compressive strength in accordance with ASTM C-31 and ASTM C-39. Test cylinders which are formed in the field will be left in the field until compression testing (7 day, 14 day, 28 day) is completed thereby more closely approximately the curing conditions of the field placed concrete.

b. Slump Test in accordance with ASTM C-143.

c. Air Content Test in accordance with either ASTM C-173 or ASTM C-231.

O. DRY BORE WITH STEEL ENCASEMENT

1. Bore Pits (or Tunnel Pits): Bore or tunnel pits shall be safed-up, shore***d***, well marked, lighted, and not left unattended except as approved by the controlling agency. Requirements for stabilization and dewatering of bore pits shall be as hereinbefore specified. The angle of repose method (sloping pit walls) for creating a safe working area shall not be used.

2. Installation: Smooth wall or spiral weld steel pipe may be jacked through dry bores slightly larger than the pipe, bored progressively ahead of the leading edge of the advancing pipe as soil is mucked by the auger back through the pipe. As the dry boring operation progresses, each new section of encasement pipe shall be butt welded to the section previously jacked into place. Continuous checks shall be made as to the elevation, grade and alignment of each successive section of encasement as well as the tracks (rails) upon which the boring rig travels.

   If voids are encountered or occur outside the encasement pipe, grout holes shall be installed in the top section of the encasement pipe at ten (10) foot centers and the voids filled with 1:3 Portland Cement grout at sufficient pressure to prevent settlement in the roadway/railway.

   Boring operations shall be continuous to their completion, and unnecessary or prolonged stoppages shall not be allowed.

   In the event an obstruction is encountered during the boring and jacking operations, the auger is to be withdrawn and the excess pipe is to be cut off, capped, and filled with 1:3 Portland Cement Grout at sufficient pressure to fill all voids before reapplying to the Controlling Agency for permission to open cut, bore at an alternate location, or install a tunnel.

   Installation shall be to the limits specified by the Controlling Agency and/or as delineated in their encroachment issued to the County. (Copy of the encroachment agreement must be kept at the site throughout boring operations).

   The completed casing installation shall be such as to prevent the formation of a waterway under the road or railbed.

   The Controlling Agency shall have full authority to require remedial measures and/or to stop all work if, in its opinion, said work will cause any damage to the roadway/railway section or endanger traffic. In all instances the Controlling Agencies reserve the right to sample, test, and approve all materials and methods used.

   The Contractor shall notify the Controlling Agency through the Construction Engineer and acknowledgment shall be received a minimum of five (5) working days prior to beginning any work within roadway or railway rights-of-way. If required, 24-hours notice will be given prior to completion.

P. GUARANTEED CASING INSTALLATION

The casing shall be installed by jacking, with simultaneous removal of spoil. The spoil removal shall not proceed more than 18-inches ahead of the casing. The

diameter of the excavated hole shall be no larger than necessary to keep the casing moving freely and lubricant may be used to reduce the jacking forces. Casing sections shall be joined by butt weld.

After the casing is jacked in place, 2-inch grout holes shall be used to pump a 1:3 Portland Cement grout to fill the void outside the casing. Sufficient pressure should be applied to force grout out of the adjacent grout hole. Grout holes shall be a maximum of ten feet apart at the top of the casing.

The casing size and thickness shall be as shown on the ***drawings*** ~~Plans~~ or Special Provisions.

~~Q. TUNNELLING OPERATIONS USING STRUCTURAL STEEL LINER PLATES~~

~~All plates shall be formed to provide circumferential flanged joints. Longitudinal joints may be flanged or offset lap seam type. All plates shall be punched for bolting on both longitudinal and circumferential seam or joints. Bolt spacing in circumferential flanges shall be in accordance with the manufacturer's standard spacing and shall be multiples of the plate length so that plates having the same curvature shall be interchangeable to permit staggering of the longitudinal seam. Bolt spacing at flanged longitudinal seams shall be in accordance with the manufacturer's standard spacing. For lapped longitudinal seams, bolt size and spacing shall be in accordance with the manufacturer's standard but not less than that required to meet the longitudinal seam strength requirements of the design specifications. All liner plates for the full length of a specified tunnel shall be either the flanged or the lapped seam type. The two types shall not be mixed in the same tunnel.~~

~~Liner plates shall be assembled in accordance with the manufacturer's instructions. Galvanized and coated plates shall be handled in such a manner as to prevent bruising, scaling, or breaking of the coating. Any plates that are damaged during handling or placing shall be replaced, except that small areas with minor damage may be repaired to the satisfaction of the Construction Engineer or his representative.~~

~~Galvanized surfaces shall be repaired by thoroughly wire brushing the damaged areas and removing all loose cracked coating, after which the cleaned areas shall be painted with two (2) coats of zinc rich paint as approved, and an acceptable bituminous coating restored.~~

~~When tunneling has proceeded a distance sufficient for placing one section of the tunnel liner, that section of liner will be placed before excavating further. Excavation shall be controlled so that the space outside the liner plate shall be held to a minimum. All voids between the liner plate and tunnel wall shall be~~

~~filled with 1:3 Portland Cement grout, containing no more water than necessary, placed under sufficient pressure to fill all voids.~~

~~Grout shall be placed through the grout holes provided in the top of the tunnel liner plates. Grout holes 2" in diameter shall be provided at not more than 4.5 foot center or every third ring of plates to permit grouting as the erection of the tunnel liner progresses. At no time will the grouting operations be further than 10' from the front end or head of the tunnel construction.~~

~~At the end of each day's operations, the voids outside installed liner plates shall be grouted whether 10' or less. Grout will be forced into each grout hole. If the grout from one hole should flow along the liner plates so as to plug the next hole, the plug shall be opened by punching through the grout so that each hole may be used for grouting. The grouting operation will be continued at each hole until all spaces outside the liner plates are filled and no grout will flow.~~

~~The tunnel shall be constructed to the limits, grade and alignment shown on the Construction Plans. Excavation, without the use of jetting, shall be done in such a manner as to protect public and/or private property from damage. Prior to beginning any construction, the Contractor shall submit pit shoring and tunnel liner details for approval, and no tunneling may begin prior to approval of these details by the appropriate Controlling Agency. After approval of tunnel liner and pit shoring details, a five (5) day notice to the Controlling Agency, through the Construction Engineer, shall be provided as previously specified.~~

~~No blasting will be done without prior written approval of the controlling agency and then only in strict accordance with all Federal, State, and Local laws, ordinances, rules, or regulations governing the storage and use of explosives. Where blasting is required, only small controlled charges of 40% dynamite or plastic explosives shall be used. The depths of the holes for these charges shall not exceed the depth necessary to clear an area sufficient to place one section of tunnel liner.~~

~~The charges for the initial series of blasts should be placed in the triangle method. The second series should be placed in the radial method a minimum distance from the desired diameter of the tunnel. The triangular charges shall be set to go off first, with the radial charges to go off following a short interval or using the time-lag method.~~

~~Where is encountered before approaching the shoulder or pavement, the first four series of charges will be used in determining the amount of controlled blasting to be used before beginning any blasting beneath the railway or shoulders or pavement of the highway as applicable. If rock is encountered after tunneling progresses beneath the pavement or railway, the charges will initially be set at very low levels and increased in small increments until the proper amount of charge is determined.~~

~~In no case will an overshoot be permitted. If a boulder is encountered and removed by blasting or by other methods, a bulkhead will be formed immediately after removal of the boulder and the area filled with grout before proceeding with the tunneling operations.~~

~~If there is any indication of a vertical split in the rock formation, or any indication of settlement of the roadway or railway fill, all operations shall be stopped and the Controlling Agency notified immediately. If the vertical split is not determined to be of too great a magnitude or too close to the rails/pavement, the split shall be filled with grout at a pressure specified by the Controlling Agency, allowed to set and tunneling operations may be continued.~~

~~If it is determined that the vertical split is too great of a magnitude or too close to the pavement or railway, the Controlling Agency shall determine the method to be used to correct the split. If settlement of the roadway or railway occurs, the Controlling Agency will advise the Owner and his Contractor of the proper steps to be taken to correct the settlement. If deemed necessary by the Controlling Agency, adequate warning devices (signs, flasher, etc.) accompanied by responsible flagmen shall be placed at a distance allowing any and all traffic time to stop safely before reaching the questionable area. At the option of the Controlling Agency, it may provide the necessary flagmen, warning devices, etc., at the Contractor's expense. Traffic shall be allowed over the questionable area only as directed by the Controlling Agency.~~

~~The Controlling Agency shall have full authority to inspect entire tunnel operation, require disposition of remedial measures, and to stop all work if, in its opinion, the work will cause any damage to the roadway/railway section or endanger traffic. In all instances the Controlling Agencies reserve the right to sample, test, and approve all materials used.~~

~~The completed liner shall consist of a series of structural steel liner plates assembled with staggered longitudinal joints. Liner plates shall have been fabricated to fit the cross section of the tunnel. All plates shall be connected by bolts on both longitudinal and circumferential seams or joints.~~

~~After tunneling operations have been completed the Contractor will install the carrier pipe in a manner approved by the Engineer. Concrete fill (1:3 Portland Cement grout) will then be placed after completing installation of the sewer pipe within the tunnel liner as directed by the Engineer and end enclosure walls installed as shown on the Construction Plans or Standard Details. Ends of the tunnel liner will be sealed with an eight-inch (8") masonry wall on the lower end and a twelve-inch (12") masonry wall on the higher end. Weep holes will be provided on the downstream end for drainage – See Standard Detail #16. The Contractor shall then remove the vertical shoring for pits (if ground conditions allow), surplus spoils, and material from the site.~~

~~The site shall then be returned to its original condition, seeded, mulched, or~~

restored as specified and left in a neat and satisfactory condition. Shoring material shall be removed in such a manner so as to avoid collapse and to allow proper backfill. The backfill shall be placed in accordance with these Specifications or the requirements of the Controlling Agency.

Insurance requirements for work performed on Railroad (CSX, Norfolk Southern, etc.) property will be as outlined in the Special Provision Section of this contract. The Contractor shall furnish for approval a certificate of Insurance to this office. All required submittals will be sent to the Utility Department for review and this office will then forward the documentation on to the railroad.

R. BLASTING

Prior to commencing any blasting operations the Contractor shall notify either the City Fire Department - Fire Prevention Section or the County Fire Administrator as applicable, and obtain blasting permits as required. The Contractor must furnish certification of Insurance specifically covering any and all obligations assumed pursuant to the use of explosives.

All blasting operations shall be conducted in strict accordance with any and all decrees, rules, regulations, ordinances, and laws as may be imposed by any regulatory body and/or agency having jurisdiction over the work relative to handling, transporting, use and storage of explosives. Blasting shall be done only by competent, sober and experienced personnel whose activities shall be conducted in a workmanlike manner. Satisfactory information must be provided to the ***Owner*** Engineer that the blaster meets or exceeds the qualifications enumerated in OSHA Regulations Part 1926, Subpart U, Section 1926.901 - Blaster Qualifications.

All rock, dirt and debris from blasting shall be contained within the excavation by use of weighted mats or undisturbed overburden. The Contractor's blaster shall be fully responsible for determining the method of containment and the weight, size and placement of material required to contain the charge he is using. Charges shall be sized such that no damage to houses, structures, roadways, etc., outside the limits of the excavation will occur. Where there is a possibility of such damage, the charge will initially be set at a very low level and increased in small increments until the proper charge is determined. The Contractor shall be held responsible for any and all injury to persons or damage to public or private property.

1. Permission to Blast: The Contractor shall not be allowed to blast within any rights-of-way maintained by any agency (D.O.T., R.R., Gas, etc.) other than the City without specific approval of the controlling agency and only in accordance with their respective requirements.

S. TESTING AND INTERNAL INSPECTION

The Contractor shall provide proper ventilation of sewer lines and manholes during any test or inspection procedure. The Contractor shall be responsible for providing all equipment and personnel necessary to comply with OSHA confined space regulations.

1. Gravity Sewer Pipe Leakage Testing: No sooner than 10 days following completion of backfill, the Contractor along with the project inspector will be required to determine the level of the ground water table. If the level of ground water table is above the top of the pipe, the sewer line shall be tested for infiltration. If there is no ground water above the top of the pipe the sewer line shall be low pressure air tested. Each test shall be performed as follows:

    a. Infiltration: The infiltration shall not exceed 100 gallons per day per inch diameter per mile as measured for a reach of pipe the same diameter up to one mile long. However, when excessive infiltration can be isolated to a particular section (manhole-manhole) the limit will be applied to that section. There shall be no visible points of infiltration. Any section (manhole-manhole) must be isolated and tested separately if so directed by the ***Owner*** ~~Engineer~~. The York County Water/Sewer Department reserves the right to TV any sewer line to detect sources of infiltration.

    b. Low Pressure Air Test: Tests shall be performed in accordance with ASTM C-828 and C-924 on sewer lines 42-inches in diameter and smaller. Test pressure will be measured by gauges furnished and installed by the Contractor above ground at the manhole opposite the air supply. The Contractor shall furnish all other test equipment required including connecting hoses at the manhole opposite the air supply. The Contractor shall furnish all other test equipment required including connecting hoses.

        Sewer lines larger than 42-inches in diameter shall be tested for infiltration as specified above and each joint shall be visually inspected by a York County ***Engineering*** ~~Water/Sewer~~ representative.

2. Manhole Leakage Testing: Manholes shall be tested by plugging the inlet and outlet pipes with airtight plugs and using one of the following procedures:

    a. Exfiltration: Fill the manhole to the rim with water and allow the level to equalize due to saturation. Refill the manhole and mark the level to begin the test. The test shall last at least 2 hours and allowable leakage shall be 3 gallons per hour. The ***Owner***

~~Engineer~~ will select 25% of the manholes on the project to be tested. If any manhole fails, an additional manhole will be tested. Manholes that fail the test shall be repaired and retested until they pass.

b. Vacuum Air: Manhole vacuum air testing shall be performed in accordance with ASTM C-1244. The ***Owner*** ~~Engineer~~ will select 25% of the manholes on the project to be tested. Manholes that fail the test shall be repaired as specified and retested until they pass. Manholes that show leaks and are repaired prior to testing shall be tested as specified.

~~3. Deflection Testing of PVC Pipe: Not less than 30 days following completion of backfill, the pipe shall be tested for deflection with a 5% mandrel sized as defined in ASTM D-3034. Mandrels shall be furnished by the Contractor. The mandrel shall be pulled through each section of pipe from manhole to manhole. The mandrel must slide freely through the pipe with only a nominal hand force applied. No mechanical device shall be used in pulling the mandrel. Any pipe, which refuses the mandrel, shall be removed and replaced or re-rounded and the bedding shall be properly constructed as specified to prevent excessive deflection. Such sections shall be retested for deflection after completion of backfill.~~

~~4. Force Main Sewer Pipe Leakage Testing: Pressure and leakage tests must be conducted in accordance with AWWA C600 Standards for ductile iron material and AWWA C605 Standards for PVC material . On completion of the line or sections of the lines, connections and appurtenances, the line shall be filled and hydrostatically tested. The water for this purpose can be taken from existing lines under the supervision of the Engineer's Inspector and leakage will be measured by the Inspector with a meter furnished by the contractor. All leaks and any defective material shall be repaired or replaced to the satisfaction of the Engineer and the tests repeated until the requirements of this specification are met. Any special equipment, pumps, etc. required to make the test shall be furnished and operated by the contractor as directed by the Inspector.~~

~~The Contractor shall use great care to be sure that all air is expelled from each section under test. If openings are not available for the purpose of expelling air, the Contractor shall provide air releases of sufficient size (as determined by the Engineer) in accordance with County Standard Drawings, at his expense.~~
~~Specific procedures for testing mains are as follows:~~

~~a. Test pressure will be held for at least two (2) hours at atleast 1.5 times the maximum working pressure at the low point of the section under test. When testing against valves, the differential~~

pressure valve must not exceed 150 PSI for valves rated at 150 PSI.

If the test cannot be made with differential pressure of 150 PSI, 250 PSI valves will be specified. Differential pressures across valves may be up to 200 PSI (R.61-58.4.D.(11)(e)).

b. Allowable leakage will be determined by Table 6, AWWA C-600 (see below) or by the following formulas:

Ductile Iron: **PVC:**

$L = [SD(P)^{1/2}] / (133,200)$ $L = [ND(P)^{1/2}] / (7,400)$

L = allowable leakage (gals/hr) L = allowable leakage (gals/hr)
S = length of the pipeline tested (ft) N = # of joints in pipeline tested (ft)
D = diameter of pipe (in.) D = diameter of pipe (in.)
P = average test pressure (psig) P = average test pressure (psig)

Add .0043gal/hr. for each ¾ inch service and .0057 gal/hr. for each 1-inch service.

TABLE 6

Allowable Leakage per 1000 ft. (305m) of Pipeline - gph*†

Avg. Test Pressure psi (Bar)	Nominal Pipe Diameter -in.															
	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54
450 (31)	0.48	0.64	0.95	1.27	1.59	1.91	2.23	2.55	2.87	3.82	3.82	4.78	5.73	6.69	7.64	8.60
400 (28)	0.45	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.60	3.60	4.50	5.41	6.31	7.21	8.11
350 (24)	0.42	0.56	0.84	1.12	1.40	1.69	1.97	2.25	2.53	3.37	3.37	4.21	5.06	5.90	6.74	7.58
300 (21)	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08	2.34	3.12	3.12	3.90	4.68	5.45	6.24	7.02
275 (19)	0.37	0.50	0.75	1.00	1.24	1.47	1.74	1.99	2.24	2.99	2.99	3.73	4.48	5.23	5.98	6.72
250 (17)	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.91	2.14	2.85	2.85	3.56	4.27	4.99	5.70	6.64
225 (16)	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.70	2.70	3.38	4.05	4.73	5.41	6.03
200 (14)	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.55	2.55	3.19	3.82	4.46	5.09	5.73
175 (12)	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79	2.38	2.38	2.98	3.58	4.17	4.77	5.36
150 (10)	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.66	2.21	2.21	2.76	3.31	3.86	4.41	4.97
125 (9)	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34	1.51	2.01	2.01	2.52	3.02	3.53	4.03	4.53
100 (7)	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.80	1.80	2.25	2.70	3.15	3.60	4.05

* If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.
† To obtain leakage in liters/hours, multiply the values in the table by 3.785.

c. Pressure and leakage tests will be run concurrently and for a duration of four hours except as modified below.

d. The Contractor will pressurize the line and verify that it is within allowable leakage before the official test is started.

e. The Inspector will begin the test and remain at the job for the first hour, making sure that the test pressure is maintained within ± 5 PSI. The Contractor is to maintain the pressure within ± 5 PSI for the duration of the test period. At the end of the first hour, with the line pumped to full test pressure, he will read the meter and record the first hour leakage. If the first hour leakage is allowable, he will return at the end of the fourth hour and again read the meter. If the total leakage for the four hour period does not exceed four times the first hour leakage, the test will be terminated. If the total leakage exceeds four times the first hour leakage, but is still within allowable, the test will be held an additional hour. If the fifth hour leakage does not exceed the average hourly leakage for the first four hours, the test will be terminated at the end of the fifth hour. Otherwise, the test will be held until the leakage is non-increasing and within allowable for two consecutive hours. All visible leaks shall be repaired regardless of the amount of leakage.

f. If leakage exceeds allowable for the four hour test, the test will be terminated and re-scheduled after the Contractor has verified that actual leakage is within the allowable leakage, but no earlier than the next work day.

g. If the first hour leakage does not exceed 10% of the allowable, or if the allowable leakage rate does not exceed .4 gal/hr., the test may be terminated at the end of two hours provided the second hour leakage does not exceed the first hour leakage. If the second hour leakage exceeds the first hour leakage, the test will be held for an additional period as described in Paragraph (e) above.

h. The maximum length pipe tested in one test shall be 5,000 feet or as close to 5,000 feet as possible depending on valve spacing.

i. During the last stages of the test and without any reduction in pressure, first the hydrant guard valves will be closed and pressure released to determine if it is holding pressure (minimum 10 minutes per valve closing).

j. Unless otherwise directed by the Engineer, each valve will be tested to 150 PSI for a minimum of 10 minutes after the pipeline has been successfully tested.

T. REPAIRS

All leaks shall be repaired by identifying and exposing the defective section of pipe and completing repairs as follows:

1. ~~PVC or~~ Ductile Iron Pipe: Defective or damaged pipe including leaking joints shall be removed and replaced with sound new pipe. The pipe shall be re- connected with approved couplings as specified in the ***drawings*** ~~MS Section of this document~~.

2. Manholes: Any damage to the interior wall of the manhole resulting from penetration of the lift holes shall be repaired with non-shrink cement grout.

   Leaks through manhole joints or walls or around pipe collars, may be repaired from inside the manhole with non-shrink cement grout. If the size of the leak, or the external water pressure, prevents such repairs, the manhole shall be excavated and repaired from outside.

   Leaks around boots or gaskets used to join pipe to manholes shall be repaired by external concrete collars or as approved by the ***Owner*** ~~Engineer~~.

U. ABANDONMENT

The following requirements shall apply for proposed abandonment of existing facilities unless otherwise shown on the plans or approved by the ***Owner*** ~~Engineer~~. All areas disturbed by abandonment will be restored.

1. Abandonment of Existing Manholes: Manholes which are to be abandoned will first have both influent and effluent lines plugged inside the manhole with watertight masonry. ***The manhole upper cone shall be removed.*** The manhole will then be filled with non-compressible material (***sand or*** #67 stone or as approved), to a point three feet (3'-0") below the finish grade. ~~The remainder of the manhole shall be broken down and removed.~~ Then the excavation shall be filled to finish grade with suitable soil compacted in place.

2. Abandonment of Mains At Manholes Which Remain In Service: Abandoned mains at active manholes shall be completely disconnected from the manhole by cutting the pipe outside the manhole and then plugging the abandoned main and the manhole wall with watertight masonry. The invert shall then be rebuilt to conform

with the standard details.

3. Abandonment of Exposed Pipe: Exposed sections of abandoned mains shall be removed to a point not less than 5 feet into the adjacent banks. The remaining ends of the pipe shall be plugged with watertight masonry. Concrete piers or collars in the creek channel shall be removed completely. Concrete piers or collard not located in the creek channel shall be removed to a point three feet (3'- 0") below the finish grade. Steel piers shall be cut off three feet (3'-0") below finish grade.

4. Abandonment of Existing Pump Stations: Pumps, motors, controls, etc., shall be salvaged and transported by the Contractor to the sewer maintenance yard in New Heritage. All influent and effluent pipes shall be plugged with watertight masonry. The pipe chamber and wetwell (if abandoned) will be filled with noncompressible material (#67 stone or as approved), to a point three feet (3'-0") below the finish grade. The remainder of the structure shall be broken down and removed. Then the excavation shall be filled to finish grade with suitable soil compacted in place. All above ground structures associated with the pump station, including fencing and the access road shall be removed and the area restored.

V. RESTORATION

All surfaces and structures (both public and private) within and adjacent to the construction operations shall be restored to a condition comparable to that existing prior to construction or as specified in the special provisions.

All surplus materials shall be disposed of in manner acceptable to the ***Owner*** ~~Engineer~~, and the construction area shall be left in a neat condition, with special attention called to proper drainage, smoothness of surface, and general clean up. No machinery or equipment shall be left or stored on the job site after the project is completed.

Unless otherwise specified, complete restoration to include fertilizing, seeding, and mulching of any and all areas disturbed during construction shall be completed within thirty (30) working days following the initial ground disturbing activity.

1. Water meters, valve boxes, drain pipes, and other structures encountered shall be reset or re-laid to match or clear surface grade and/or water main pipe grade as applicable.

2. All shoulder areas shall be restored, stabilized, and maintained to

their original condition. Concrete, asphalt, gravel, and dirt walks, drives and roadways are to be replaced to their original shape and serviceability. Unless otherwise approved by the ***Owner*** ~~Engineer~~ all areas (shoulders, side streets, drive, parking areas, etc.) which exhibit a gravel surface at the time of construction will be re-graveled with a minimum depth of six (6) inches of C.A.B.C stone compacted -in-place for the width and length of the disturbed area and then feathered gradually into the existing cross section. When a driveway is finished with other than C.A.B.C stone, a one-inch finish coating to match existing gravel gradation and appearance shall be placed.

The Contractor should note that all existing side streets and drives, which are either dirt or gravel, will be restored as specified for graveled areas.

3. Refuse Burial: Timber, rock and other refuse may not be buried within the permanent sewer rights-of-way with the exception of rock smaller than ¾ cubic foot which is allowed as previously specified.

4. Rip-Rap: The Contractor shall place stone rip-rap as specified in those areas subject to severe water action where directed by the ***Owner*** ~~Engineer~~.

   Placement of rip-rap as shown on the Construction ***Drawings*** ~~Plans~~ shall be considered a guide only, with final determination made at the time of construction by the ***Owner*** ~~Engineer~~. Either the addition or deletion of quantities may be required.

   Stone rip-rap will be placed as indicated on the Standard Details immediately following pipe installation and will be installed no steeper than a 2:1 slope except when specifically approved by the ***Owner*** ~~Engineer~~. Grading will be required as necessary to insure continuous even flow.

   In locations where a creek bank is eroded near the sewer line the Contractor will be required to place compacted fill material along the creek bank in order to maintain 3' of cover over the sewer line in all directions. This is to be done before the rip-rap is placed.

   The rip-rap installation shall include all earthwork necessary to stabilize the creek bank and to provide cover for the sewer line.

5. Jute Netting/Erosion Blanket: The Contractor shall install jute netting or Erosion Control Blanket in areas subject to high runoff velocities, areas subject to concentrated runoff and on steep slopes as shown on the plans and/or as directed by the ***Owner*** ~~Engineer~~.

6. Fertilizing, Seeding, and Mulching: Established lawns and landscaped areas damaged by construction shall be restored to their former condition by seeding, unless the type and condition of the existing sod warrants it being cut, removed, preserved, and replaced. All areas, regardless of previous condition, damaged by construction shall be fertilized, seeded, and mulched as outlined below:

a. Seed Bed Preparation: The seed bed shall be prepared by pulverizing the soil in an approved manner to a depth of three (3) inches for field conditions or slopes that are 3:1 or flatter and to a depth of one (1) to three
(3) inches, as determined on site for slopes steeper than 3:1. The soil shall be tilled until a well pulverized, firm, reasonably uniform seed bed is prepared conforming substantially to ground elevations as shown on the Plans and/or as existed prior to construction. The disturbed area shall blend uniformly into adjacent topography. Good surface drainage must be provided, allowances for settlement made and ground elevations adjusted accordingly. Visible ponding will not be allowed. All stones, roots,sticks, rubbish, and other objectionable material shall be removed.

b. Soil Improvements: Soil additives shall be incorporated in an approved manner into the topsoil at the following rates:

(1) Fertilizer - 20 pounds per 1000 square feet of 5-10-10 fertilizer generally and 30 pounds per 1000 square feet of 10-10-10 fertilizer for established lawn areas.

(2) Lime-100 pounds per 1000 square feet.

(3) Superphosphate (0-20-0) - 12 pounds per 1000 square feet.

c. Seeding: Seeding must be done within thirty (30) calendar days after the initial ground disturbing activity.

(1) The seed must be in good, friable condition and not muddy or hard at the time seeding is performed.

(2) Seed shall be applied at the rate specified and raked or tilled into the topsoil with the resulting furroughs running across the natural slope of the ground. Under no circumstances will any tilling activity be allowed parallel with said slope.

Slopes steeper than 3:1 shall require the use of hydraulic seeding unless otherwise specifically approved by the Engineer.

d. Mulching: After fertilizing, seeding and raking, dried straw shall be spread uniformly over the area at a rate of 90 pounds per 1000 square feet. Approximately ¼ of the ground should remain visible to avoid smothering seedings. The straw shall be sprayed with liquid asphalt to bond it together and anchor it in place within road right-of-way and areas subject to erosion.

(1) Liquid asphalt, thinned with kerosene, shall be used during freezing weather and shall be either rapid or medium curing. It shall be applied at a rate of 200 gallons per ton of straw or approximately 9 gallons per 1000 square feet.

(2) Emulsified asphalt, thinned with water shall be used when temperatures are less severe, shall be rapid curing only, and shall be applied at a rate of 150 gallons per ton of straw or approximately 7 gallons per 1000 square feet.

e. Maintenance: The Contractor shall maintain the seeded areas until there is a uniform growth three (3) inches high. Maintenance shall consist of watering, weed and pest control within established lawns, fertilization, erosion repair, reseeding and all else necessary to establish a vigorous healthy and uniform stand of grass. All areas and spots, which do not show a uniform stand of grass, for any reason, shall be treated repeatedly until a uniform stand is attained.

Seasonal seeding mixtures and rates of application shall be as follows. All rates are in pounds per 1000 square feet and any rates listed below may be cut by ½ for temporary erosion control measures only.

SEPTEMBER 15 – MARCH 1

Maintained/Established Lawns or road rights-of-way

6# Kentucky Fescue No. 31
2# Rye Grain
30# Fertilizer (10-10-10)
100# Lime
12# Superphosphate

Open Field (Anything other than an established lawn)

~~4# Kentucky Fescue No. 31~~
~~2# Rye Grain~~
~~20# Fertilizer (5-10-10)~~
~~100# Lime~~
~~12# Superphosphate~~

~~Open Field For Slopes 2:1 or greater or areas subject to erosion~~

~~2# Kentucky Fescue No. 31~~
~~4# Sericea Lespedeza (Unscarified) 2# Rye Grain~~
~~30# Fertilizer (5-10-10)~~
~~100# Lime~~
~~12# Superphosphate~~

~~FEBRUARY 1 - OCTOBER 15~~

~~Maintained/Established Lawns or road rights-of-way~~

~~8# Kentucky Fescue No. 31~~
~~30# Fertilizer (10-10-10)~~
~~100# Lime~~
~~12# Superphosphate~~

~~Open Field (Anything other than an established lawn)~~

~~6# Kentucky Fescue No. 31~~
~~2# Sudangrass (May, June, and July only)~~
~~20# Fertilizer (5-10-10)~~
~~100# Lime~~
~~12# Superphosphate~~

~~Open Field For Slopes 2:1 or greater or areas subject to erosion~~

~~2# Kentucky Fescue No. 31~~
~~4# Sericea Lespedeza (Scarified)~~
~~2# Sudangrass (May, June, and July only)~~
~~20# Fertilizer (5-10-10)~~
~~100# Lime~~
~~12# Superphosphate~~

~~The Engineer will be consulted prior to seeding for a determination of appropriate seed mixture.~~

Chapter 24

CONSTRUCTION SUPPORT

GEOTECHNICAL DESIGN MANUAL

January 2019

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CHAPTER 24

CONSTRUCTION SUPPORT

24.1 INTRODUCTION

The purpose of this Chapter is to provide a basic understanding of construction support as it is applied to geotechnical construction issues. Typically geotechnical construction issues are the verification of foundation resistance and integrity, review and acceptance of foundation installation plans, the implementation, review and acceptance of geotechnical instrumentation or the review and acceptance of shop plans.

24.2 QUALITY CONTROL/QUALITY ASSURANCE

Construction support performed by the GEOR typically consists of review of Quality Control (QC) and conducting Quality Assurance (QA). QC is a system of routine technical activities implemented by the Contractor to measure and control the quality of the construction materials being used on a project. QA is a systemic review and auditing of procedures and the testing of a select number of samples by the Department to provide an independent verification of the Contractor's QC program and to provide verification that the construction materials meet the project specifications. QC is performed by the Contractor, while QA is performed by the Department. Ultimately the Contractor is responsible for all materials brought on to a project site; however, it is incumbent on the Department to assure that materials meet Departmental criteria. Construction support performed by the GEOR consists of the review of the results of both QC and QA testing to assure that the project specifications are being met. Construction QA/QC is performed on foundations, some ground improvement installations and geotechnical instrumentation.

24.3 SHALLOW FOUNDATIONS

Shallow foundations are typically not used to support bridges; however, if shallow foundations are used, contact the PC/GDS for guidance in developing QA/QC procedures for shallow foundation verification.

24.4 DEEP FOUNDATIONS

24.4.1 Driven Piles

The Standard Specifications require the Contractor to submit a *Pile Installation Plan* (PIP) for review and acceptance prior to commencing pile installation. The PIP will be submitted to the Department in accordance with the contract documents. For consultant designed projects, the PIP should be forwarded by the RPG/GDS to the GEC for review. The GEOR shall review the PIP for adequacy and for containing the information required by the specifications and plans. The review is to include hammer analysis as described below and should include comments on items such as adjusting hammer fuel settings if needed to protect the pile integrity during driving. On consultant reviewed projects, the GEC will return the PIP to the RPG/GDS with a cover letter containing appropriate comments concerning the PIP. The PIP will be accepted or rejected by the RPG/GDS, regardless of who designed the project, (i.e. either the Department or a consultant) and shall be forwarded to the Bridge Construction Office for distribution to the Contractor. As required, rejected PIPs shall be resubmitted. One of the components of the PIP is the "Pile and Driving Equipment Data Form." Using the information contained on this form,

the GEOR shall perform a Wave Equation Analysis of Pile Driving (WEAP). The WEAP analysis is used to verify that the pile driving hammer should be capable of installing the piles to the correct tip elevation and resistance without inducing excessive stresses in the pile. Piles are typically installed using 1 of 2 criteria, either resistance or elevation (depth). In some cases, both criteria may be required. Resistance driven criteria is typically based on a required blow count being achieved. The exception to this is if practical refusal is achieved. Practical refusal is defined by Section 711.4 of the Standard Specifications as 5 blows per ¼ inch of penetration. Practical refusal driving criteria may be used as long as the minimum tip elevation has been achieved. The wave equation analysis uses a range of resistances, bracketing the required (nominal) resistance, and range of different strokes. A typical Pile Installation Chart (also known as a Bearing Resistance Chart or Graph) providing driving criterion is depicted in Figure 24-1.

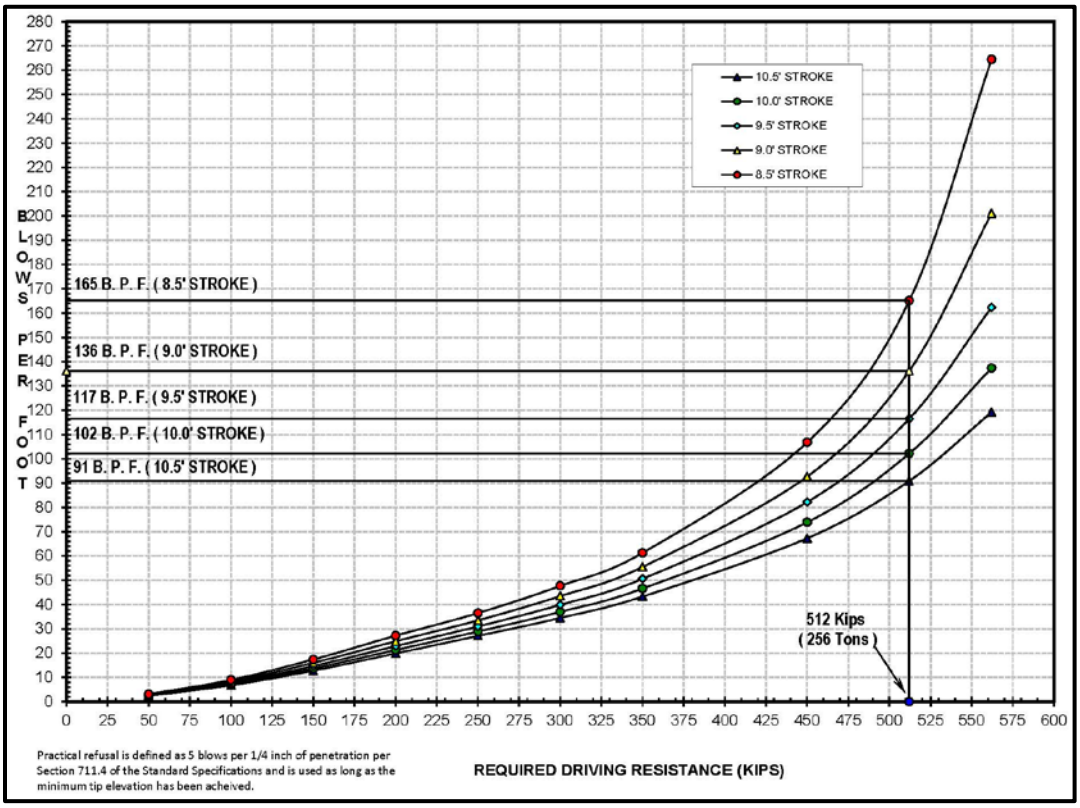

Figure 24-1, Pile Installation Chart

After the GEOR reviews and accepts the PIP, the GEOR shall be responsible for developing Pile Installation Charts as described above or if a PDA or load test is performed as described below. The GEOR shall be responsible for recommending pile lengths as needed based on index pile and/or previous production pile data.

The other criterion to control the installation of a pile is elevation (depth). This criterion is used when it is anticipated that the piles will gain strength with time or the lateral stability of the pile controls the tip elevation. Using both criteria, the GEOR should ensure that the hammer will achieve blow count criteria as set forth in the Standard Specifications. The stresses induced by the hammer should be checked to ensure conformance with the Standard Specifications.

Depending on the resistance factor (φ) selected during design, (refer to Chapter 9), load testing may be required. The load testing may consist of either high-strain (Pile Driving Analyzer (PDA)), rapid (Statnamic®) or static load tests. PDA testing may be conducted during initial driving or on restrike or sometimes both. PDA testing can confirm resistance and driving stresses. However, the resistance obtained from PDA testing is approximate and may require

further refinement by using CAse Pile Wave Analysis Program (CAPWAP). Production piles that are to be tested using PDA should be 2 feet, minimum, longer than production piles to allow for the attachment of the PDA gauges. Index piles should be detailed 2 feet, minimum, longer than production piles to get full driving data to be used in determining pile lengths. Using the results from CAPWAP, a second WEAP analysis should be performed to more accurately model the installation of the pile. This is especially important when the pile is being driven to a specific resistance at a specific blow count. The GEOR shall also develop a Pile Installation Chart for this second WEAP analysis. Monitoring of stresses using the PDA is critical when piles are installed into or through dense formations or partially weathered rock (PWR), or through very soft formations. PDA testing shall conform to the requirements of ASTM D4945 – *Standard Test Method for High-Strain Dynamic Testing of Deep Foundations* as well as the requirements contained in the Standard Specifications.

Statnamic® and static load testing are performed after the installation of the pile, if required. These tests are normally performed prior to production pile driving. Statnamic® is a rapid load test and is different from the PDA, in that the pile is subjected to a "fast push" rather than a sharp blow as would be observed from a pile hammer. Statnamic® load testing of piles can be relatively costly, especially given the capacity requirements. Statnamic® load testing, if used, should follow the standard testing method developed and presented in ASTM D7383 – *Standard Test Methods for Axial Compressive Force Pulse (Rapid) Testing of Deep Foundation* and should also comply with STS SC-M-712-3 for *Rapid Axial Load Testing of Drilled Shafts.* It should be noted that modification of the STS (i.e., a Special Provision) may be required to use this STS with driven piling. In case of conflict between the ASTM and the STS, the STS shall govern. Static load testing, if required, follows the standard testing method developed and presented in ASTM D1143 – *Standard Test Methods for Deep Foundations Static Axial Compressive Load*. Static load testing can not only be expensive, but also time consuming, and is therefore not used except in design testing programs. When static load testing is performed, the results of the testing shall use the Davisson failure criterion.

24.4.2 Drilled Shafts

Similarly to driven piles, the Standard Specifications require the Contractor to submit a *Drilled Foundation Installation Plan* (DFIP) for review and acceptance prior to commencing drilled foundation installation. The DFIP will be submitted to the Department in accordance with the contract documents. On consultant designed projects, the DFIP should be forwarded by the RPG/GDS to the GEC for review. The GEOR shall review the DFIP for adequacy and for containing the information required by the specifications and plans. On consultant reviewed projects, the GEC will return the DFIP to the RPG/GDS with a cover letter containing appropriate comments concerning the DFIP. The DFIP will be accepted or rejected by the RPG/GDS, regardless of who designed the project (i.e., the Department or a consultant) and shall be forwarded to the Bridge Construction Office for distribution to the Contractor. As required, rejected DFIPs shall be resubmitted.

To verify the acceptability of constructed drilled shafts, crosshole sonic logging (CSL) testing should be required and tubes shall be installed as required by the Standard Specifications, project plans or Special Provisions. A testing report will be generated by a testing firm for review. If the CSL testing indicates no areas of concern, then the drilled shaft is accepted. However, if the CSL testing indicates areas of concern, then the following forms should be requested by the GEOR for review:

- Drilled Shaft Log
- Drilled Shaft Excavation Log
- Slurry Inspection Log
- Drilled Shaft Inspection Log

- Drilled Shaft Concrete Placement Log
- Drilled Shaft Concrete Volumes Log
- Concrete Slump Loss Test

After reviewing these logs, the GEOR should consult with the Bridge Construction Engineer on required actions. On consultant designed projects, the project team shall be responsible for evaluating the drilled foundation to determine if it meets both the structural and load resistance design requirements. The GEOR shall provide written recommendations to the Department concerning drilled foundation acceptance and/or actions to be taken as developed by the project team.

Depending on the resistance factor (φ) selected during design (refer to Chapter 9), a load test may be required. Load tests can be used to verify the existing design or modify the design based on the load test results. The GEOR should evaluate the test results and provide written recommendations concerning the diameter, penetration depth relative to a particular stratum, and/or tip elevation of the production shafts. Drilled foundation load testing consists of static (uni-directional and bi-directional), rapid (Statnamic®) or high-strain (dynamic) load testing. In a uni-directional static load test, the load is applied at the top of the drilled shafts, usually by means of a reaction beam and anchorage foundations. Typically, this type of test is impractical for drilled shafts, unless the drilled shafts have diameters ranging from 3 to 4 feet. Typically drilled shafts in this range have nominal resistances of 1,200 kips, which require a reaction system and jack to have 2,400 kips of reaction capacity. Drilled shafts having larger diameters would require very large reaction systems that would become impractical and potentially unsafe. Therefore, uni-directional static load tests are not normally performed on drilled shafts. Uni=-directional testing, if required, follows the standard testing method developed and presented in ASTM D1143 – *Standard Test Methods for Deep Foundations Static Axial Compressive Load*. Uni-directional testing can not only be expensive, but also time consuming, and is therefore not used except in design testing programs. When uni-directional testing is performed, the results of the testing shall use the Davisson failure criterion.

Bi-directional static load tests are performed by applying the load with an expendable jack(s) located between an upper and lower loading plate cast into the drilled shaft. The test is conducted by using the upper portion of the shaft as a reaction element against the base and lower portion of the drilled shaft and vice versa. An effective example of this bi-directional loading system is the Osterberg cell (O-cell) (see Figure 24-2). The maximum test load is limited by the resistance of the shaft above and below the O-cell or the maximum resistance of the O-cell. Therefore, the O-cell should be placed at the point in the shaft where the resistance above the O-cell is approximately equal to the capacity below the O-cell. The use of multiple O-cells may be used to counter the effect of either too much side resistance or too much end resistance, when compared to end or side resistance respectively (see Figure 24-3). The Davisson failure criterion shall be used to interpret the results of uni-directional and bi-directional static load tests. Refer to STS SC-M-712-1 for *Bi-Directional Static Load Testing of Drilled Shafts* construction requirements.

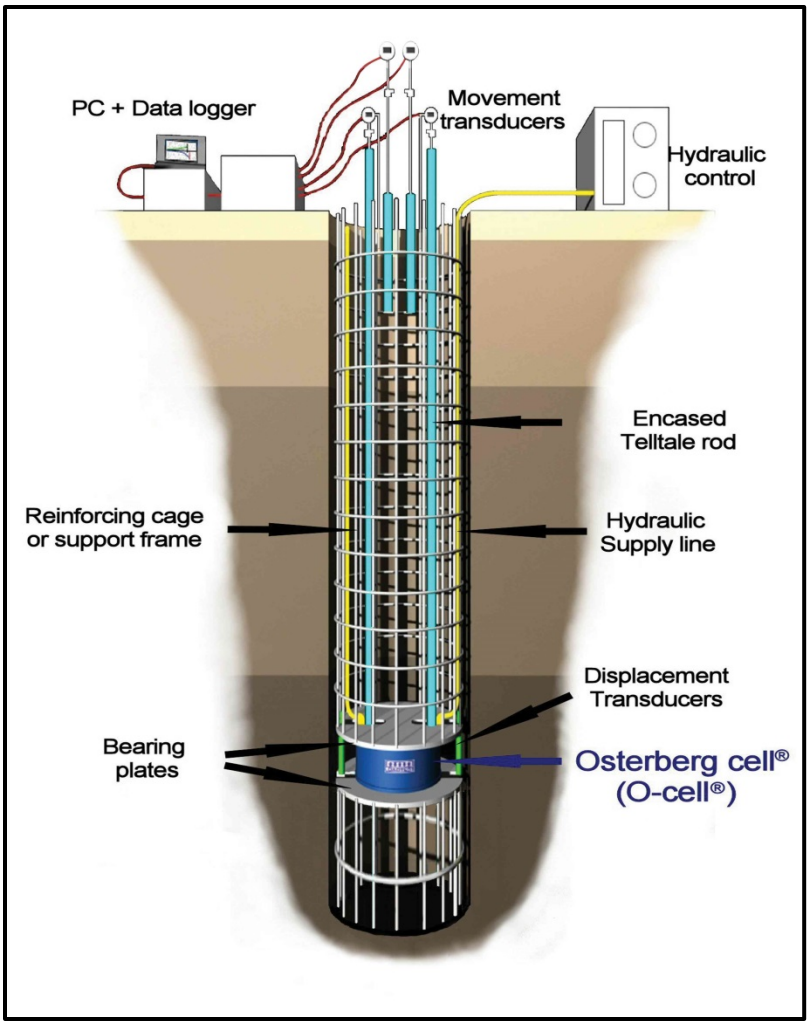

Figure 24-2, Bi-Directional Testing Schematic (LOADTEST, Inc. (2015))

Listed below are some advantages of the bi-directional static load test:

- Large reaction capacity allows testing of production-sized shafts
- With multiple cells or proper instrumentation, the base and side resistance are isolated from the resistance of other geomaterial layers
- Loading is static and can be maintained to observe creep behavior

Following are some of the disadvantages of bi-directional static load testing:

- The test shaft must be preselected so that the O-cells can be included
- It is not possible to test an existing shaft
- For each installed device, testing is limited to failure of 1 part of the shaft only, unless multiple O-cells are used
- The performance of a production shaft subject to top down loading must be computed and may require extrapolation of data in some cases
- Limitations exist related to using a test shaft as a production shaft
- The effect of upward directed loading compared to top down loading in a rock socket is not completely understood
- Displacement/capacity of shaft is limited by the stroke of the O-cell
- O-cell must be calibrated for anticipated displacement prior to testing or max capacity may not be achieved

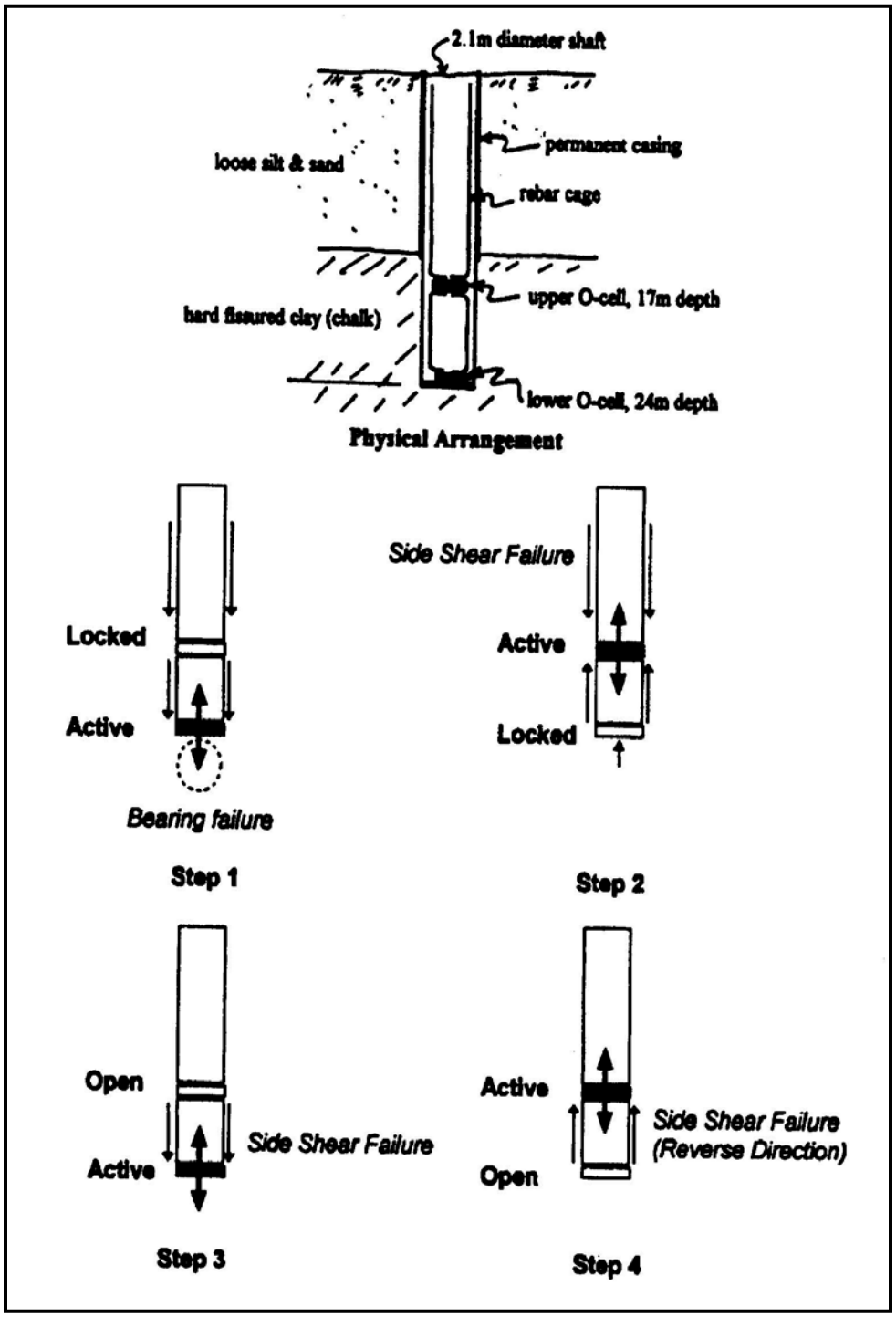

Figure 24-3, Multiple O-cell Arrangement
(O'Neil and Reese, 1999)

Rapid load testing is between static load testing and high-strain testing of drilled shafts. Rapid load testing is typically performed on a test shaft that will not be incorporated into the structure. In rapid load testing the drilled shaft is subjected to a "fast push" instead of a sharp blow as would be delivered by a pile driving hammer or a falling weight. In a rapid test, the drilled shaft acts essentially as a rigid body with the top and base of the shaft moving together. Refer to STS SC-M-713-3 for *Rapid Axial Load Testing of Drilled Shafts* construction requirements.

There are 2 methods of inducing load during the rapid test. The first method consists of dropping a weight onto the shaft, but having a soft cushion located at the top of the shaft. The soft cushion causes the weight to decelerate over a required time interval. The second method, and most common, is to accelerate a heavy mass upward using combustion gas pressure, thus pushing the shaft into the ground. Using the second method, commercially available as the Statnamic® load test apparatus, a reaction mass is accelerated vertically while an equal and opposite reaction occurs in the drilled shaft.

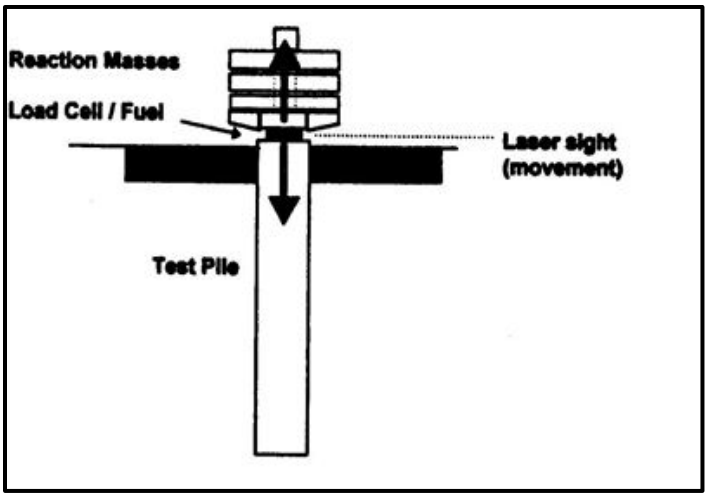

Figure 24-4, Rapid Load Test Setup
(O'Neil and Reese, 1999)

Listed below are advantages of the rapid load test method:

- Test resistances up to 10,000 kips (Statnamic®)
- Can test existing or production shafts
- Economies of scale for multiple tests
- Easily used for verification testing on shafts
- Reaction system not needed

Some disadvantages are:

- High capacity, but still limited compared to bi-directional tests
- Rate effects must be considered
- Mobilization costs for reaction weights

High-strain load testing of drilled shafts uses the same equipment and principles as PDA testing and CAPWAP analysis in driven piles. High-strain load testing uses a hammer or weight to strike the top of a shaft inducing a compression wave that propagates the length of the shaft and reflects back to the top. High-strain load testing is typically performed on a test shaft that will not be incorporated into the structure. The impact load can be induced using drop weights (see Figure 24-5) or a large pile driving hammer. If suitable measurements are obtained, then the applied load and drilled shaft response can be determined. The measurements are obtained using transducers and accelerometers mounted directly to the top of the shaft. A computer model of the shaft response to the blow is calibrated to the measurements using a signal matching technique (i.e., CAPWAP). The high-strain dynamic load test setup should always be modeled prior to testing using a wave equation model for specific shaft size and axial capacity. Because the high impact velocity can produce significant compression and tension forces in the shaft, the blow is typically cushioned using a cushioning material such as plywood or a striker plate. Refer to STS SC-M-712-2 for *High Strain Dynamic Load Testing of Drilled Shafts* construction requirements.

Figure 24-5, High-Strain Load Testing Apparatus (GRL Engineers, Inc. (2015))

Listed below are advantages of high-strain load testing:

- Large load applied at top of shaft
- Can test existing or production shafts
- Economies of scale for multiple tests
- Easily used for verification testing on production shafts
- Reaction system is not needed

Some disadvantages are:

- High resistance possible, but still limited compared to bi-directional tests
- Test includes dynamic effects which must be considered
- The applied force is interpreted from measurements on the shaft rather than from direct measurement of load and therefore is sensitive to the shaft modulus, area, and uniformity in the top 1 to 1-1/2 diameters
- Test must be designed to avoid potential damage to the shaft from driving stresses
- Mobilization costs for a large pile driving hammer or drop hammer
- Location and configuration of reinforcing steel must be accommodated
- Changes in impedance along the length of the shaft can be confused with changes in axial resistance, and therefore the impedance profile of the shaft must be reliably known.
- There may be incomplete mobilization of base resistance at early blows and loss of side resistance after multiple blows, and this issue complicates the interpretation of results.

24.5 EARTH-BORNE CONSTRUCTION VIBRATION MONITORING

Earth-borne vibrations are the motion of a ground particle, at a point in the subsurface or on the ground surface, caused as vibration energy passes through that point. The actual distance that the ground particle moves, either positively or negatively, from it's at-rest position is called displacement and is typically very small and is reported in units of inches or mils (thousandth of an inch). Construction induced vibrations may also be described as velocity, measured in

inches per second (ips), and/or acceleration measured in inches per second per second (in/sec^2). Velocity is the speed at which the ground particle oscillates and should not be confused with the velocity which the wave travels through the ground (i.e. propagation velocity). Acceleration is the rate of change of velocity with time and is often normalized with the gravitational acceleration on the earth's surface (32.2 ft/sec^2 or 386.4 in/sec^2) and is reported in g's as a percent of gravity. The most common way of determining the impact of earth-borne vibrations is velocity with the peak particle velocity (PPV) being the maximum instantaneous positive or negative peak of the vibration signal. Earth-borne vibrations may be generated by various construction activities including but not limited to: pile driving (both impact and vibratory), compaction efforts (both static and vibratory), drilled shaft installation, normal construction traffic (i.e. loaded dump trucks, bulldozers, etc.), and paving operations including pavement breaking. Monitoring of earth-borne vibrations is a relatively specialized area and may be performed on construction projects that have no other instrumentation; therefore, monitoring of earth-borne vibrations is exempted from the requirements of the Geotechnical Instrumentation Monitoring Plan (GIMP), as discussed in later Sections of this Chapter. However, the GEOR may elect to include the monitoring of earth-borne vibrations in the GIMP if other geotechnical instruments are required during construction.

24.5.1 General

Construction induced ground motions are divided into 3 main wave types: compression (P), shear (S) and surface (R – Rayleigh). P- and S-waves are called "body" waves, while the R-wave is "surface" wave. The "surface" may be the ground surface or a boundary of the halfspace. R-waves consist of horizontal and vertical components that attenuate (i.e. dampen out) rapidly with depth. P- and S-waves tend to propagate through the soil in a hemispheric shape, while R-waves tend to propagate cylindrically through the soil. P-, S-, and R-waves travel at different speeds, with the P-wave being the fastest, followed by the S-wave with the R-wave being the slowest. Therefore, the P-wave arrives first at the receptor, then the S-wave, followed lastly by the R-wave (see Figure 24-6). According to Andrews, Buehler, Gill, and Bender (2013) approximately 67 percent of the wave energy is transmitted by the R-wave, 26 percent by the S-wave and the remaining 7 percent by the P-wave.

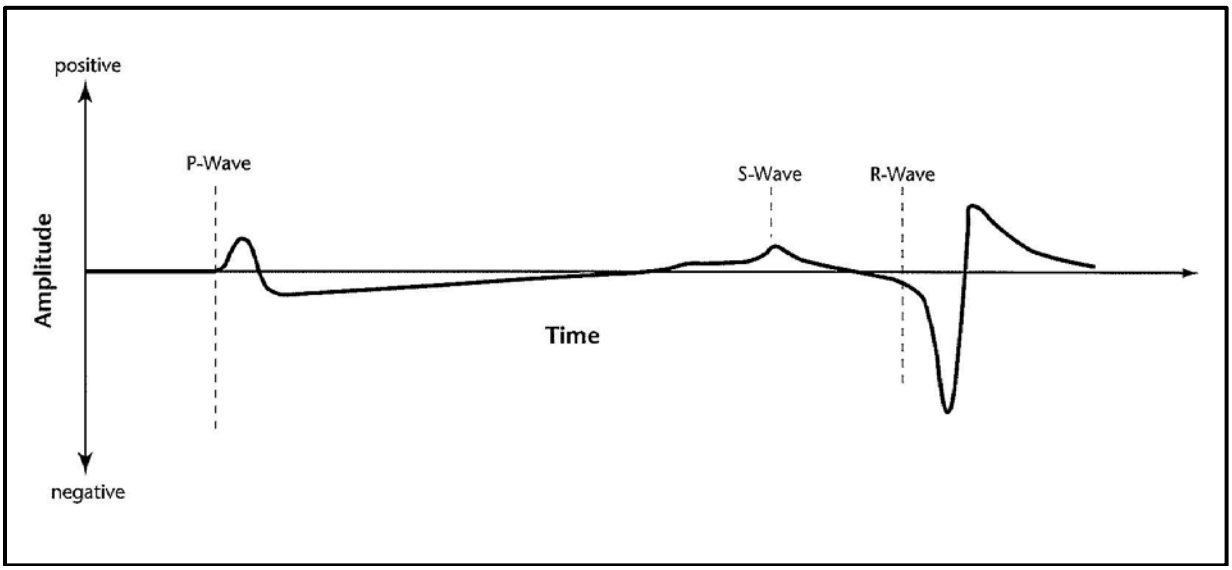

Figure 24-6, Arrival Time for P-, S-, and R-waves (Andrews, et al. (2013))

To properly describe the ground motion as the earth-borne vibrations passes through it, 3 mutually perpendicular components must be measured. A triaxial geophone has 3 independent transducers, each aligned at mutually perpendicular directions. The longitudinal direction is

aligned with the axis of vibration propagation and the longitudinal geophone measures the compression or P-wave. The transverse direction is at a right angle to the longitudinal direction within the same horizontal plane. The transverse geophone measures the shear or S-wave. The vertical direction measures the movement in the vertical plane, which often has the highest amplitude.

Vibration-producing activities such as blasting, pile driving, vibratory compaction, and the operation of other heavy equipment are common activities on a highway construction project. It may be desirable to monitor the ground vibrations induced by these activities if sensitive equipment or structures are located close to the work zone. Please note that earth-borne vibrations induced by blasting are not included in this Manual, contact the PCS/GDS if blasting is required on a project for specific instructions on design and preparation of a Special Provision to monitor earth-borne vibrations induced by blasting.

Earth-borne construction vibrations can adversely impact 3 types of receivers: structures, people and equipment/operations. Of these 3 types of receivers, structures typically can sustain the highest vibration levels without being impacted; these impacts are normally described as damage. The impacts to humans are best described as annoyance or disturbance, while the impacts to equipment/operations are described in terms of hindering or reducing functionality. The impacts to these receivers are discussed in the following paragraphs.

24.5.2 Structures

The use of the term damage can be a very misleading term since damage can range from hairline cracks in sheetrock walls to complete collapse of the structure. Dowding (1996) provides a more precise definition of damage as generally used by the blasting industry. The definitions are provided below:

- Cosmetic cracking including threshold damage – Opening of old cracks, and formation of new plaster cracks; dislodging of loose structural particles such as loose bricks in chimneys
- Architectural or minor damage – Superficial, not affecting the strength of the building (e.g. broken windows, loosened or fallen plaster), hairline cracks in masonry
- Structural cracking or major damage – Serious weakening of the building or adjacent facilities (e.g. large cracks or shifting of foundations or bearing walls, major settlement resulting in distortion or weakening of the structure, walls out of plumb)

Project vibration limits are typically established to prevent threshold or cosmetic cracking.

24.5.3 People

Earth-borne construction vibrations affect people in 2 ways; the vibrations can annoy people and/or the vibrations cause the perception of damage. People can feel vibrations far below the level that causes damage to structures, but can be very annoying or cause loose items within the structure to rattle (i.e. windows, dishes, etc.). When people feel vibrations or hear items rattling, they almost immediately think of damage and start looking for evidence of damage. Often people discover cracks in walls, ceilings, or foundations that hadn't been previously noticed and now associate the cracks with the earth-borne construction vibrations.

24.5.4 Equipment/Operations

Vibrations can adversely impact sensitive equipment and/or operations, such as hospitals, computerized industries, research centers or industrial machinery. Some equipment (i.e. optical microscopes, cell probing devices, magnetic resonance imaging (MRI) machines, scanning

electron microscopes, photolithography equipment, micro-lathes, and precision milling equipment, etc.) can be more sensitive than humans since the operation of the equipment can be impaired below the vibration perception threshold. However, most of this equipment and/or operations must be isolated within the building housing the equipment or operations to prevent normal building activity from disturbing the equipment and/or operation. Because of this earth-borne construction vibrations rarely impact sensitive equipment/operations.

24.5.5 Impact of Earth-borne Construction Vibrations

Based on research performed by the Minnesota Department of Transportation (MnDOT), cosmetic damage cannot typically be attributed to construction vibration levels below 0.5 ips. Therefore, MnDOT established the distance at which earth-borne construction vibrations will be below 0.1 ips. This level (0.1 ips) was selected since people complain about vibrations having a velocity of more than 0.1 ips. These distances are provided in the following table for various construction activities and may be used for preliminary estimating.

Table 24-1, Distance where Vibration drops below 0.1 ips (MnDOT (2013))

Construction Activity	Distance[1] (feet)
Embankment Compaction	50
Subgrade Compaction	100
Vibratory Pile Driving[2]	150
Pavement Breaking	180
Bituminous Overlay	200
Impact Pile Driving	200
Construction Blasting	300

[1]For estimating purposes only

[2]SCDOT assumes that vibration of drilled shaft casing would have the same distance

Pile driving can create earth-borne vibrations that can cause damage to structures and disturb people nearby. Other construction activities, such as pavement breaking, vibratory compaction, and the general use of heavy hauling and excavating equipment, typically produce earth-borne vibrations that are below the level necessary to cause damage, unless the source of the vibrations is very close (< 25 feet). Therefore, these lower intensity vibrations can be considered annoying and may cause people to believe that the building is being damaged, when in reality it is not being damaged. However, there are certain conditions such as close proximity to historical buildings or buildings that house historical or antique artifacts that may require special attention to avoid damaging the structure or the artifacts in the structure.

People's perception of vibration is not an accurate gauge of the damage potential of vibration. Therefore, when assessing the potential for impacts due to earth-borne construction vibrations, it is necessary to consider both: the actual potential to cause damage and the potential for causing complaints about being damaged. Vibrations do not affect all structures similarly. Some of the factors that may affect a structures ability to withstand vibrations are: condition, type of construction, geometry, orientation, subsurface geology, etc.

Structures are typically strongest immediately after construction and become weaker through the years as the structure receives many cycles of stress-strain caused by changes in temperature and humidity, ongoing vibration events, and settlement of the foundation soils. Damaged structures are typically more susceptible to additional damage caused by an external vibration event. Historic structures are typically in poorer condition than more modern structures due to their longevity and inferior building materials. Therefore, historic structures are typically

given a lower vibration limit than more modern structures, since materials to make repairs may no longer be available and permanent loss of the historic structure may not be considered tolerable to the public. The existing condition of a historic structure shall always be assessed within a given radius of the source of earth-borne construction vibrations. This radius is normally established based on prior experience; calculations based on damage probability and predicted vibration levels; political concerns; or a combination of all 3.

Structures that have been engineered are typically constructed of stronger, more durable materials (e.g. steel and concrete) than non-engineered structures constructed of materials like wood. The engineered structures are often founded on deep foundations or on improved soil to increase bearing resistance and decrease settlement.

24.5.6 Vibration Prediction

Andrews, et al. (2013) provides various equations to estimate the PPV for various pieces of construction equipment at differing distances from the construction equipment. The construction equipment includes impact pile drivers, vibratory pile drivers, hydraulic breakers, and other general construction equipment (i.e. vibratory rollers, bulldozers, loaded trucks, etc.). The equation for estimating the PPV for impact pile driving (IPD) is:

$$PPV_{IPD} = 0.65 * \left(\frac{25}{D}\right)^{n} * \left(\frac{E_{IPDEquip}}{36{,}000}\right)^{0.5} \qquad \textbf{Equation 24-1}$$

Where,

PPV_{IPD} = Peak Particle Velocity induced by impact pile driving, ips
D = Distance from pile driver to the receiver, ft
n = A value related to the vibration attenuation rate through ground, see Table 24-2
$E_{IPDEquip}$ = Rated energy of impact pile driver, foot-pounds (ft-lbs)

The constant 0.65 in the above equation is the reference PPV for the reference pile driver at a distance of 25 feet from the pile driver and has units of ips. The constant 36,000 is the rated energy of the reference pile driver in ft-lbs. The term “n” is determined using Table 24-2 to more accurately account for in-situ soils.

Table 24-2, Suggested “n” Values Based on Soil Class (Andrews, et al. (2013))

Soil Class	Description of Soil Material	“n”
I	Weak or soft soils: loose soils, dry or partially saturated peat and muck, loose beach sand, and dune sand, recently plowed ground, soft spongy forest or jungle floor, organic soils, top soil. (shovel penetrates easily)	1.4
II	Competent soils: most sands, sandy clays, silty clays, gravel, silts, weathered rock. (can dig with shovel)	1.3
III	Hard soils: dense compacted sand, dry consolidated clay, consolidated glacial till, some exposed rock. (cannot dig with shovel, need pick to break up)	1.1
IV	Hard, competent rock: bedrock, freshly exposed rock. (difficult to brake with hammer)	1.0

The equation for estimating the PPV for vibratory pile driver (VPD) is very similar to the equation for impact pile drivers; with the exception the rated energy of the pile hammer is not required. The equation below is used to estimate the PPV_{VPD}:

$$PPV_{VPD} = 0.65 * \left(\frac{25}{D}\right)^{n}$$ **Equation 24-2**

Where,

PPV_{VPD} = Peak Particle Velocity induced by vibratory pile driving, ips
D = Distance from pile driver to the receiver, ft
n = A value related to the vibration attenuation rate through ground, see Table 24-2

The constant 0.65 in the above equation is the reference PPV for the reference pile driver at a distance of 25 feet from the pile driver and has units of ips.

The equation for estimating the PPV for hydraulic breakers (HB) (also called hoe-rams, mounted impact hammers, etc.), for the demolition of concrete structure or pavement (i.e., asphaltic concrete or Portland cement concrete) is very similar to the equation for impact pile drivers; with the exception that the referenced energy of the hydraulic breaker is reduced to 5,000 ft-lbs and the PPV_{REF} is reduced to 0.24 ips for the reference hydraulic breaker. The equation below is used to estimate the PPV_{HB}:

$$PPV_{HB} = 0.24 * \left(\frac{25}{D}\right)^{n} * \left(\frac{E_{HBEquip}}{5{,}000}\right)^{0.5}$$ **Equation 24-3**

Where,

PPV_{HB} = Peak Particle Velocity induced by hydraulic breaker, ips
D = Distance from hydraulic breaker to the receiver, ft
n = A value related to the vibration attenuation rate through ground, see Table 24-2
$E_{HBEquip}$ = Rated energy of hydraulic breaker, foot-pounds (ft-lbs)

Andrews, et al. (2013) recommend that the PPV for other construction equipment ($PPV_{ConstEquip}$) can be estimated using the following equation. The reference PPV (PPV_{Ref}) for different pieces of construction equipment can be obtained from Table 24-3.

$$PPV_{ConstEquip} = PPV_{Ref} * \left(\frac{25}{D}\right)^{n}$$ **Equation 24-4**

Where,

$PPV_{ConstEquip}$ = Peak Particle Velocity induced by various pieces of construction equipment, ips
PPV_{Ref} = Reference PPV for various pieces of construction equipment at 25 ft, ips, see Table 24-3
D = Distance from construction equipment to the receiver, ft
n = A value related to the vibration attenuation rate through ground, see Table 24-2

Table 24-3, Reference PPV for Various Pieces of Construction Equipment (Andrews, et al. (2013))

Equipment	PPV_{Ref} at 25 ft (ips)
Vibratory roller	0.210
Large bulldozer	0.089
Caisson drilling	0.089
Loaded trucks	0.076
Jackhammer	0.035
Small bulldozer	0.003
Crack-and-seat operation	2.400

24.5.7 Vibration Criteria

Vibrations can be created by either continuous/frequent intermittent sources or by transient sources. Continuous sources of vibrations include: excavation equipment; static compaction equipment; tracked vehicles; traffic on a highway; vibratory pile drivers; pile-extraction equipment; and vibratory compaction equipment. Transient sources of vibrations include: impact pile drivers; blasting (not covered by this Manual); drop balls; "pogo stick" compactors; and rubblization (i.e., break-and-seat or crack-and-seat) equipment. Single transient vibration sources will not be considered for developing criteria; however, some of the sources of transient vibrations such as impact pile driving and crack-and-seat operations will be considered frequent intermittent sources for this Manual. Provided in the following table are structure types including condition and the maximum allowable PPV.

Table 24-4, Maximum Allowable PPV for Structures

Structure Type and Condition	Maximum PPV[2] (ips)
Extremely fragile historic buildings, ruins, ancient monuments[1]	0.08
Fragile buildings[1] (i.e. sensitive structures and hospitals)	0.10
Historic and some old buildings[1]	0.25
Older residential structures (i.e. built with plaster and lathe)	0.30
New residential structures (i.e. built with sheetrock)	0.50
Modern industrial/commercial buildings (i.e. engineered)	0.50

[1]Contact SCDOT Environmental Services or the Program Manager for a list of historic structures adjacent to the project site.

[2]PPVs will have frequencies in the range of 1 to 100 Hertz.

As indicated previously, people living near a construction site can feel the earth-borne vibrations that are induced by construction. An individual's reaction may include annoyance and/or the perception that damage is being caused by the vibrations. Provided in the following table are various PPVs that could lead to annoyance of those people who reside around the construction site.

Table 24-5, Maximum Allowable PPV to Avoid Annoyance

Human Response	Maximum PPV (ips)
Barely Perceptible	0.01
Distinctly Perceptible	0.04
Strongly Perceptible	0.10
Severe	0.40

No maximum PPV values have been established for sensitive equipment or operations. Project specific PPVs will need to be developed for ultra-sensitive/sensitive equipment or operations.

24.5.8 Earth-borne Vibration Monitoring Evaluation

The GEOR shall evaluate the potential impact of earth-borne vibrations from a construction site on the surrounding/adjacent properties. Previous studies have shown that blasting, pile driving and pavement breaking have been documented to have the potential to cause damage to structures. As indicated previously, blasting will not be covered by this Manual. If blasting is required on a project site, contact the PCS/GDS for further instructions. For pile driving and pavement breaking, the potential damage from earth-borne vibration is at locations in relatively close proximity to the activity. However, because the threshold of perception for vibration is much lower than the threshold for damage, claims of damage often arise because of perceptible vibration and not because of actual damage. To limit the potential for damage claims related to earth-borne vibrations, Andrews, et al. (2013) has developed the following process:

1) Identify potential problem areas surrounding the project site
2) Determine conditions that exist before construction begins
3) Inform the public about the project and potential vibration-related consequences
4) Schedule work to reduce adverse effects
5) Design construction activities to reduce vibrations
6) Notify nearby residences and property owners that vibration-generating activity is imminent
7) Monitor and record vibration from the activity
8) Respond to and investigate complaints

As part of first step, the GEOR shall estimate the PPV at various distances from the project for the various pieces of construction equipment anticipated being used for project construction. These estimated PPVs shall be provided in both the preliminary as well as final geotechnical reports for the project site. The PPVs estimated for the PGER should be anticipated being very approximate since no pile energy requirements will be developed at this stage. The estimated PPVs from this study will be used to determine if there is a potential earth-borne vibration concern at a project site. The distances provided in the table below shall be used. These distances are measured from the source of the vibration (i.e. from either end of the bridge for pile driving). However, it should be noted that the distance between potential vibration sources and receptors may need to be increased, especially if the project is not viewed by the general public as being beneficial or if the project is unpopular. The GEOR shall consult with the project team to determine if there is public perception concern with the project.

Table 24-6, Distance between Vibration Source and Potential Receptors

Potential Receptor	Distance (ft)
Sensitive structures	700
Hospitals	500
Extremely fragile historic buildings, ruins, ancient monuments[1], other historic or old buildings	300
Residential structures: Older residential structures (i.e. built with plaster and lathe) New residential structures (i.e. built with sheetrock)	250
Engineered structures (i.e., modern industrial/commercial buildings)	150

[1]Contact SCDOT Environmental Services or the Program Manager for a list of historic structures adjacent to the project site.

The identification of these potential receptors shall be made during the initial site visit prior to commencing field operations. The GEOR shall attempt to identify all potential receptors within the given radius. For example, if a hospital is located 450 feet from one end of the project, a 500-foot radius from either end of the project will be used and all residential and engineered structures within that radius will be identified. Therefore the larger distance shall be used for potential receptor identification purposes and all structures within that distance shall be considered regardless if the structure is located beyond the limit established for that structure, (i.e., a residential structure located 350 feet from the bridge with a hospital located 450 feet away from the bridge). The identification will include the type of structure (i.e. residential, engineered, historic, etc.), the name of the property owner, the street address of the property and unique identifier for each property. Names of property owners can be obtained from the SCDOT ROW Office or from local property tax records.

For the purpose of this Manual, sensitive receptors have equipment and/or operations similar to optical microscopes, cell probing devices, magnetic resonance imaging (MRI) machines, scanning electron microscopes, photolithography equipment, micro-lathes, and precision milling equipment. This list is not meant to be all inclusive. If industrial facilities are noted within 700

feet, contact the Program Manager for additional information. The Program Manager should either contact the facility or request the ROW Office to contact the facility to determine what the industrial process is and if it is vibration sensitive. A hospital as defined for this Manual is a medical facility that contains surgical suites; operating theatres or MRI machines. This could include some Medical Office Buildings that have the capability for having outpatient procedures performed. As indicated in Table 24-6, contact either the SCDOT Environmental Services Office or the Program Manager for a list of identified historic buildings, ruins and monuments. Residential structures can be single or multi-family. Engineered structures are typically constructed of steel and/or concrete, are used for non-residential purposes and do not contain sensitive operations as previously discussed.

Once the GEOR has identified the potential receptors or lack thereof around a construction site, in the second step, the Director of Construction in consultation with the project team, the SCDOT Construction Office, and the District Construction Engineer (DCE) will determine whether vibration monitoring is required or not.

There will be times when a property owner will not allow their structures to be surveyed. A notation shall be made as to time and date, the specific comment made as well as who made the statement. On some occasions, a property owner may terminate the preconstruction damage assessment survey prior to its completion. This termination shall be noted with the same information as that required when survey isn't permitted.

It may be advantageous to conduct a post construction damage assessment survey to verify that no additional damage has been caused by construction activities. The decision to perform a post construction damage assessment survey should be made by project team in consultation with the Director of Construction, the DCE and the RCE.

The third step in this evaluation process is notifying the public vibrations may be generated during construction. This announcement should be prepared by the project team and sent to all property owners previously identified in Step 1. This announcement will be made in whatever method is deemed appropriate by the project team, including the SCDOT ROW Office.

The fourth step is to schedule work to reduce adverse effects of earth-borne vibrations. For example, if pile driving is to be performed in a primarily residential area, the contract may include a Special Provision indicating that pile driving may only be performed during certain hours, with those hours coinciding with the normal work day. The Contractor will typically be responsible for determining the construction schedule and the Contractor should be aware of the potential impacts on the surrounding properties from earth-borne vibrations induced by construction activities.

The fifth step is to design construction activities to minimize earth-borne vibrations. The GEOR may minimize earth-borne vibrations by using a smaller hammer, requiring a new pile cushion for each pile, etc.

As part of the sixth step, the project team is required to inform all property owners identified previously that vibration inducing activities will commence on a given date. In addition, provide a written notice 7 calendar days prior to the construction activity at a minimum. The notice should consist of a letter sent to each property owner.

Earth-borne vibrations shall be monitored and recorded in accordance with the project specific Special Provision for *Earth-borne Vibration Monitoring*.
The final step is to respond to and investigate all complaints that have been generated as a result of the earth-borne vibrations. The process for handling complaints and the investigation

of the complaints shall be determined by the RCE with consultation with the project team, the Director of Construction the DCE and the RCE.

24.5.9 Addressing Earth-borne Vibration Concerns

SCDOT has developed 2 levels of earth-borne vibration monitoring that can be provided on a project, depending on several things such as structure susceptibility to damage, proximity to vibration producing activities, etc.

Level 1 – No potential receptors within the specified distances previously provided. No vibration monitoring required.

Level 2 – Potential receptors are located within the specified distances indicated in Table 24-6. Earth-borne vibration monitoring may be required. The need for earth-borne vibration monitoring will be determined by the project team in conjunction with the Director of Construction, the DCE and the RCE. If required, earth-borne vibration monitoring will be performed by SCDOT. In addition, the project team, the Director of Construction, the DCE and the RCE will jointly decide if a pre-construction baseline vibration monitoring study is required. The RCE in conjunction with the project team, the Director of Construction, and the DCE will determine whether a pre-construction and/or post-construction damage assessment survey will be required and conducted. The GEOR shall prepare a Special Provision for each project that requires earth-borne vibration monitoring.

The appropriate level of Earth-borne Vibration Monitoring shall be indicated on the "General Notes" sheet of bridge plans. In addition, the appropriate level shall also be indicated on the "General Notes" sheet of road plans as required.

24.5.10 Earth-borne Vibration Monitoring Equipment

A vibration-monitoring unit generally consists of some combination of geophones, sound sensors and connecting cables attached to an input and readout unit. Ground vibrations are typically reported in terms of the peak particle velocity (PPV), although other parameters such as peak acceleration, principle frequencies, and peak sound pressure levels can also be obtained with most monitoring units. Vibration monitoring results are then compared with pre-established threshold levels of structures or equipment to determine the level of risk involved.

Portable seismographs are typically used for monitoring the velocities of ground vibrations resulting from construction activities. The seismographs should have the following minimum features:

- Seismic range: 0.01 to 5 ips with an accuracy of ±5 percent of the measured PPV or better at frequencies between 1 and 100 Hz and with a resolution of 0.01 ips or less.
- Frequency response (±3 dB (decibels)) : 2 to 200 Hz

Three channels for simultaneous time-domain monitoring of vibration velocities in digital format on 3 perpendicular axes or components: 1 vertical and 2 horizontal (radial and transverse). The seismograph shall be positioned with the longitudinal axis toward the vibration source.

24.5.11 Baseline Earth-borne Vibration Study

For a Level 2 earth-borne vibration monitoring scenario, the project team, the Director of Construction, the DCE and the RCE may require a baseline earth-borne vibration study. This baseline study should be considered if sensitive structures, hospitals or historic buildings are

located within the specified distances given in Table 24-6 of the proposed project site. In addition, the baseline earth-borne vibration study may be considered for other structures around the project. The purpose of the baseline earth-borne vibration study is to establish the background levels of vibration that are induced at a site by existing sources such as traffic, industrial machinery or railroads, etc. In some cases the vibrations from these sources may exceed the limits allowed in this Chapter. The baseline vibration study should be performed for at least 6 months but for no more than 12 months prior to the commencement of construction. The baseline earth-borne vibration study shall be performed by 1 of the consultants selected for the "On Call Structure Foundation Testing and Engineering Services" contract. GECs shall contact the RPG/GDS for list of consultants on the contract. The results of the baseline earth-borne vibration study shall be provided to the GEOR, who shall use the baseline study to prepare an Earth-borne Vibration Monitoring Special Provision.

24.5.12 Pre- and Post-Construction Condition Survey

As indicated previously, the RCE in consultation with the project team, the Director of Construction and the DCE will determine if Pre- and/or Post-Construction Condition Survey of the structures surrounding the project is required. The Pre- and Post-Construction Condition Survey will occur prior to the commencement of vibration inducing construction activities and immediately after completing vibration inducing construction activities. The purpose of this survey is to determine the condition of the structures surveyed prior to commencing vibration inducing construction activities and serves as evidence of or lack of damage induced by the vibrations. Measure the Source to Potential Receptor distance from both ends of the bridge or source of vibrations. Include documentation of interior floor surfaces whether slab-on-grade or floor with crawl space beneath and above grade accessible walls, ceilings, floors, roofs and the visible exterior as viewed from the ground level. The survey should detail (by engineering sketches (including measurements), digital video, digital photographs and/or field notes) any existing structural, cosmetic, plumbing or electrical damage. All documentation of existing building conditions and information concerning the type and location of crack monitors shall be presented to the GEOR in a report prior to or immediately after any vibration inducing construction activity. If crack montiors are used, the GEOR shall estiablish the schedule for when the monitors are to read. This schedule shall be provided to the RCE for the actual collection of the data by 1 of the consultants selected for the "On Call Structure Foundation Testing and Engineering Services" contract. The consultant shall provide the results to the RCE who will in-trun provide the results to the GEOR for evaluation. Likewise immediately after the completion of vibration inducting construction activities, conduct a Post-Construction Condition Survey to include documentation of any differences in the defects noted in the Pre-Construction Condition Survey as well as any new defects.

24.5.13 Earth-borne Vibration Monitoring Plan Notes

The GEOR shall ensure that 1 of the notes provided in Chapter 22 is placed on the appropriate plan sheets.

24.5.14 Earth-borne Vibration Monitoring Special Provision

The GEOR is required to prepare an Earth-borne Vibration Monitoring Special Provision for inclusion in the construction contract. The Special Provision shall indicate the Level of Earth-borne Vibration Monitoring required for that specific project. For Level 1 no earth-borne vibration monitoring is required since there are no potential receptors present within the indicated distances (see Table 24-6). As indicated previously, the project team, the Director of Construction, the DCE and the RCE will decide if earth-borne vibration monitoring is required for Level 2 based on the number, location and type of potential receptors near the project. Please note that Level 2 will be marked on the appropriate "General Notes" sheets because of the

presence of potential receptors. If the decision is made to not perform earth-borne vibration monitoring, then no Special Provision will be required. If the decision is made to perform earth-borne vibration monitoring, then a Special Provision is prepared indicating to the Contractor that is a Level 2 site and the monitoring will be performed by the Department. The Special Provision should include at a minimum:

- The required threshold PPV to be below
- The distance to the nearest structure of concern
- If earth-borne vibration monitoring affects the Contractor's means and methods, any and all costs associated with changing means and methods are considered incidental to the construction item
- That RCE may halt construction if the threshold PPV is exceeded
- No time or money will be provided to the Contractor if the RCE halts construction due to exceeding the threshold PPV
- The Contractor is required to alter vibration producing activity to obtain PPVs below the threshold PPV
- Indicate if a Pre-Construction Condition Survey is conducted
- Indicate that the RCE will determine if a Post-Construction Condition Survey will be conducted
- All damage that occurs from exceedance of the threshold PPV will be the responsibility of the Contractor to repair at no additional cost to SCDOT
- Any damage that occurs below the threshold PPV will be the responsibility of SCDOT

24.6 GEOTECHNICAL INSTRUMENTATION

This Section provides a general overview of the selection and use of geotechnical instrumentation for SCDOT construction projects. There are 2 general classes of geotechnical instrumentation. The first class is those instruments used to investigate and evaluate soil and rock properties. This class of geotechnical instrumentation is presented in Chapter 5 – Field and Laboratory Testing Procedures. The second class is those geotechnical instruments that monitor performance during and after construction. This Section is not intended to provide specifications for individual instruments, but rather to provide a systematic approach to the planning for and implementation of an instrumentation and monitoring plan that includes a discussion of the requirements for the instrumentation, location of the instrumentation and monitoring of the instrumentation. For more specifics regarding the information presented herein, please refer to Dunnicliff (1998). Listed below are the Supplemental Technical Specifications (STSs) for selected geotechnical instruments. If a geotechnical instrument is required for which an STS is not written, then the GEOR is required to develop a Special Provision in accordance with Chapter 23.

Table 24-7, STSs Available from SCDOT

STS Name	STS Number
Settlement Plates	SC-M-203-4
Vibrating Wire Piezometer	SC-M-203-6
Settlement Sensors	SC-M-203-7
Vibrating Wire Rod Extensometer	SC-M-203-8
Slope Inclinometer Casing	SC-M-203-9
Total Pressure Cell	SC-M-203-10
Vibrating Wire Data Collection Centers	SC-M-899-1

This Section also discusses the interpretation of the results of geotechnical instrumentation. The results obtained from geotechnical instrumentation require review by the GEOR in order to determine if the data is meaningful. On projects in which the GEC reviews the results of

geotechnical instrumentation, the GEC shall be responsible for evaluating the geotechnical instrumentation data to determine if it meets the design requirements. The first question concerning the results of geotechnical instrumentation is: "Was the data collected in a manner consistent with the plans, specifications and special provisions?" If the data was not collected in a consistent manner, every effort should be made to determine why not. If the data collected is consistent, next check to determine the numerical accuracy. Finally, the data should be checked for consistency with previous data. If the data is not consistent, does a hypothesis exist that explains all the data? If not, then consideration should be given to the point that the data is bad and should be discarded. The interpretation of data collected from the various forms of geotechnical instrumentation will be discussed within each Subsection that covers a specific geotechnical instrument.

Field instrumentation on highway projects can play several vital roles, including the following:

- Verification of Design Parameters – Data obtained from instrumentation can be used to verify that the constructed embankment, slope, wall, etc. behaves as predicted during and after construction. Initial data can be used to modify the design if necessary.

- Evaluate Performance During Construction – Field instrumentation can be used to monitor construction performance of the embankment, slope, wall, etc. that may affect or be affected by construction activities and that may affect the construction schedule.

- Evaluate Performance of Existing Structures – Existing embankments, slopes, walls, etc. can be instrumented to assess the existing conditions and to guide remediation measures, if necessary.

- Detect short and long-term trends – Before potential problems are visible to observers, instrumentation can provide the first indication of how a structure is going to perform over short-term and long-term periods.

- Safety – Field instrumentation can serve as the first warning sign of a potentially unsafe situation. An instrumentation and monitoring program can also play a role in easing public concerns over safety of areas surrounding the construction site.

- Legal Protection – Instrumentation can provide documentation as to the relationship between construction activities and surrounding structures. In the event of litigation, data from these instruments can be used to prove/disprove connection of damage in surrounding areas to construction activity.

The planning of an instrumentation and monitoring program should be guided by a systematic approach. The steps listed in this Chapter provide a typical list of planning considerations that can be applied to most highway construction projects. The overall objective for the program should be decided before selection of instruments commences. As part of the planning process, the need for instruments should be gauged against such factors as relevance of the data obtained, impedance of construction, and cost.

Although the goal of this Chapter is not to provide specific guidelines on field instrumentation, the general philosophy given in Dunicliff (1998) should be applied to nearly every project where field instrumentation is to be used. First, every instrument should be installed to answer a specific question. More instrumentation than is required produces additional, perhaps harmful, discontinuities in the structure and may provide a false sense of security. Second, in general the simpler the instrumentation is, the more desirable it should be. Although some situations may arise where sophisticated instrumentation cannot be avoided, such as the need for remote monitoring, simpler instruments generally provide data that is just as reliable while having less

chance of malfunction, and at a reduced cost. Third, redundancy, or a system of checks, should always be built into the monitoring program to add another level of reliability beyond what is provided by a single instrument. If sophisticated instruments are to be used, standard, "low-tech" instruments can also be installed to maintain the flow of incoming data in case of malfunction in the sophisticated instruments.

24.7 MONITORING PLAN

A Geotechnical Instrumentation Monitoring Plan (GIMP) shall be prepared and submitted by the GEOR when any of the following conditions are met:

- A Vibrating Wire Data Collection Center or other automated monitoring device is to be used for a project
- When more than 2 geotechnical monitoring instruments are required
- When the consequences of failure of the construction being monitored could lead to a potential loss of life
- When a Chain of Command is required
- A GIMP is required by SCDOT

The GIMP should be submitted as part of either the BGER or the RGER, but may be submitted as a stand-alone document if permitted by the PC/GDS. The GIMP shall be submitted at least 3 months prior to the project letting date. After review and acceptance of the GIMP, the GEOR shall convert the GIMP into a Special Provision. The following Section shall be added at the end of the GIMP Special Provision:

> **BASIS OF PAYMENT**
>
> No payment will be made for the Geotechnical Instrumentation Monitoring Plan (GIMP). All payments are considered incidental to the individual Geotechnical Monitoring Instruments required for this project.

The GIMP Special Provision shall be forwarded to the Letting Preparation Engineer for inclusion with the construction contract documents.

The elements to be included in the GIMP are detailed below and generally follow the guidelines set forth in Dunnicliff (1998). Table 24-8 provides a list of the elements used in developing a monitoring plan.

Table 24-8, Monitoring Plan Elements

1. Definition of Project Conditions	2. Objectives of Instrumentation
3. Predicted Magnitude of Change	4. Define Remedial Actions
5. Establish Responsibilities and Chain of Command	6. Types of Instruments and Locations
7. Recording of Outside Factors	8. Procedures for Ensuring Data Validity
9. Estimated Costs	10. Installation and Protection Plans
11. Calibration and Maintenance of Field Instruments	12. Data Processing

The monitoring plan as well as certain construction related items, such as monitoring, calibration and maintenance, data collection, processing, presentation, interpretation and reporting, are considered "professional services" and should not be left to the Contractor to perform. On most SCDOT construction projects geotechnical instrumentation is installed by the Contractor under the supervision of a licensed engineer. In addition, in many cases the monitoring, calibration

and maintenance and data collection are made the responsibility of the Contractor. In these cases, the Contractor shall be required to retain the services of a GEC, familiar with the instrumentation being used. The processing, presentation, interpretation and reporting are typically provided by the GEOR.

24.7.1 Definition of Project Conditions

This Section of the instrumentation plan should include a summary of existing conditions and of proposed construction, if applicable. A short summary of the relevant information from BGER or RGER should be included in the monitoring plan. Other information that may be relevant to monitoring, such as condition surveys of existing structures or reports of environmental conditions, should also be summarized in the monitoring plan. All pertinent information about the project related to the monitoring program should be properly referenced in the monitoring plan. If additional information is needed to fully characterize the site, a plan for obtaining this information shall be submitted with the monitoring plan.

24.7.2 Objectives of Instrumentation

The objectives of field instrumentation to be used on the project shall be clearly defined in the monitoring plan. The first step to defining objectives for field instrumentation is to predict potential failure mechanisms that may occur during or after project completion. Secondly, what instruments can be installed to monitor parameters such as pore water pressure, horizontal and/or vertical displacements, in-situ stresses, etc. that are indicative of a failure. Finally, the information gained from the field instruments shall be used to support any further action that may be necessary. If the objectives of the instrumentation cannot be clearly defined, delete the instrumentation. Only use instrumentation that has clearly defined objectives.

24.7.3 Predicted Magnitudes of Change

The lower bound of predicted magnitudes will provide the required accuracy of field instruments, while taking into account the full range of predicted magnitudes will convey the required data range of field instruments. Threshold levels which correspond to escalating need for remedial action shall also be determined and included with the monitoring plan. A table or similar graphic illustrating these levels should be displayed in a prominent place and all personnel associated with monitoring shall be aware of both the threshold level readings and required remedial actions. The threshold values are chosen based on experience with similar projects, similar subsurface conditions or construction methods, case histories of similar projects, and engineering judgment of project personnel.

24.7.4 Define Remedial Actions

In relation to threshold levels, remedial actions corresponding to each escalating level shall be defined in the monitoring plan. Remedial actions will be project specific but may range from simply informing someone higher up the chain of command of a possibly unsafe situation, to stopping work, or to emergency measures in the event of an impending failure. A detailed description of each action may not be feasible at the time the plan is written, but the plan shall at least describe each action in general terms. Pre-project planning ensures that the required labor and materials will be available in case of emergency.

24.7.5 Establish Responsibilities and Chain of Command

The responsible parties for each phase of a monitoring program, from planning to collection and interpretation of data, shall be designated either in the monitoring plan or in another suitable document. Responsibilities and authority of each party in relation to the other parties regarding

the monitoring program shall also be clearly defined. Regardless of their role and level of authority on the project, monitoring personnel shall always have a direct line of communication between themselves, the construction Contractor, and the GEOR in case a situation arises that needs immediate attention.

24.7.6 Type of Instruments and Locations

The type, number, and manufacturer of each instrument to be used on the project shall be provided in the monitoring plan. The reasons for selecting particular instruments to monitor the conditions described above shall also be explicitly spelled out, keeping in mind that every instrument is installed to answer a specific question. The overriding factor in choosing field instrumentation is reliability. Other factors such as ease of installation, difficulty of interpretation, and cost, may also play a role. Instrument manufacturers can provide valuable information during the instrument selection process about relevance of the instrument to the specific application and limitations of the instrument.

The locations for instrument installation shall be chosen based on potential failure analysis, preexisting information (if for an existing structure or slope), subsurface conditions, and any other pertinent information. If site conditions are generally homogenous, instruments may be installed at selected intervals. If it appears that certain areas will be more critical or have a higher probability of failure, instruments shall be concentrated at these locations. Provisions should be made to order more instruments than necessary to account for damage during installation or malfunction once the instrument is installed. Field instrument locations shall be clearly marked on a plan view of the site. Instrumented cross-sections, if applicable, shall also be included with the monitoring plan.

24.7.7 Recording of Outside Factors

The recording of all outside factors, that can be reasonably assessed, that may influence field instrument data shall be specified in the monitoring plan. This is especially important for monitoring during construction activities, as heavy construction traffic and altering of the site conditions can have a significant effect on instrument data. Monitoring personnel must keep or have access to a detailed record of construction activities in order to correlate monitoring results and filter out anomalies caused by nearby construction activities. Other outside factors that may influence instrument readings include environmental conditions such as temperature, rainfall, sunlight, and seismic activity.

24.7.8 Procedures for Ensuring Data Validity

Procedures shall be in place to ensure the validity of each instrument installed for the project. Redundancy is an effective way to reduce error in instrument data. For example, an open-standpipe piezometer can be installed near a pore-pressure transducer, screened at the same interval, to ensure that pore pressure readings are accurate. Optical or GPS surveying of surface monuments can be used to validate apparent movements indicated by subsurface instruments. Visual observation of site conditions by trained personnel can also be an effective means of validating instrument data. Systematic checks of data reliability should be planned for each type of instrument to be installed.

24.7.9 Estimated Costs

An estimated cost tabulation sheet for both materials and labor associated with the proposed monitoring procedures shall be compiled and submitted either with the monitoring plan or with another suitable document. Contingencies shall also be put in place to cover additional monitoring should the need arise.

24.7.10 Installation and Protection Plans

A detailed set of installation plans, including at least a work plan and sketches, shall be included with the monitoring plan. Oftentimes, the instrument manufacturer will provide detailed installation plans for their instruments. If necessary, the appropriate ASTM or AASHTO standard shall be referenced with regard to installation. Included with the installation plan shall also be methods to assure that the instrument is installed correctly and for the initial calibration of the instrument. If the instrument is to be installed in an active construction zone, plans must include methods for handling, protecting and repairing the instrument.

24.7.11 Calibration and Maintenance of Field Instruments

The instrument manufacturer is required to provide a recommended schedule for calibration and maintenance of field instrumentation. A calibration schedule of at least once per year is recommended, although many instrument manufacturers recommend shorter time periods between calibrations. Periodic calibration checks should also be performed by monitoring personnel to ensure that the instruments remain in calibration throughout the life of the project.

24.7.12 Data Processing

The procedures to be used for data collection, processing, presentation, interpretation, reporting, and implementation shall be provided in the monitoring plan. Field instrument reading schedules shall be detailed out in the monitoring plan, but must remain flexible depending on project progress and the results of initial readings. The plan shall also indicate specific software that may be required for processing data. Typically, field instruments are read on a relatively tight schedule at the beginning of a project and then relaxed as baseline conditions emerge and/or the project progresses beyond critical stages. Management of instrument data from methods of field collection to data storage and backup shall be accounted for in the planning stages of the project. The time needed for post-processing of instrument data will be dependent on instrument type and level of sophistication. Sufficient effort shall be planned for data interpretation by trained personnel. The results of data analysis shall be provided in periodic reports corresponding either to a set time interval (i.e. weekly, monthly, etc.) or to project milestones.

24.8 MONITORING PLAN EXECUTION

As discussed previously, the installation of geotechnical instrumentation is typically the responsibility of the Contractor. The Contractor shall be required to submit an installation plan for review. The plan should include the items in Table 24-9.

Table 24-9, Monitoring Plan Execution

1. Instrumentation Supplier	2. Factory calibration of instrumentation
3. Pre-Installation testing requirements	4. Calibration and Maintenance Requirements
5. Installation methods	6. Protection plan
7. Installation records	8. Installation report
9. Data Collection methods	10. Qualifications of personnel collecting data

24.8.1 Instrumentation Supplier

The Contractor shall be required to provide the name of the supplier of the geotechnical instrumentation and all literature provided by the supplier. The literature shall be used to verify that the instrumentation selected meets the requirements of the project.

24.8.2 Factory Calibration of Instrumentation

All instrumentation shall be calibrated at the factory prior to shipment and calibration certificates shall be provided by the Contractor. Any additional calibration requirements contained in the STSs or Special Provisions shall also be met.

24.8.3 Pre-Installation Testing Requirements

Due to the potential for rough handling during shipment, all instrumentation shall be checked to ascertain that the equipment is in working order prior to installation. The pre-installation testing shall include a verification of the calibration data provided by the manufacturer, by checking 2 or 3 data points within the instrument measurement range. The verification testing shall be performed at a range of temperatures. Tests at the extreme temperature limits of the instrumentation may reveal malfunctions that could lead to erroneous data if not corrected. The pre-installation testing may consist of testing to determine if the instrumentation is in working order. This type of testing is also called function testing. Table 24-10 indicates some possible items for the pre-installation testing program.

Table 24-10, Possible Items in Pre-Installation Tests (Dunnicliff (1998))

Category	Item
Data Supplied by Manufacturer	• Examine factory calibration curve and tabulated data to verify completeness • Examine manufacturer's final quality assurance inspection checklist, to verify completeness
Documentation	• Check, by comparing with procurement document, that model, dimensions, and materials are correct • Check that quantities received correspond to quantities ordered
Calibration Checks	• Check 2 or 3 points, if practicable • Check 0.0 reading, e.g., of vibrating wire piezometers
Function Checks	• Connect to readout and induce change in parameter to be measured • Make and remake connectors several times, to verify correct functioning • Immerse in water, if applicable, and check
Electrical	• Perform resistance and insulation testing, in accordance with criteria provided by the instrument manufacturer
Mechanical	• Check cable length • Check tag numbers on instrument and cable • Verify all components fit together in the correct configuration • Check all components for signs of damage in transit

24.8.4 Calibration and Maintenance Requirements

Calibrations or function checks are required throughout the life of the instrumentation. Typically these calibrations are performed by the same personnel responsible for data collection. All calibrations and function checks shall be traceable (i.e. can be checked). The Contractor shall be required to develop a field calibration plan as part of the overall geotechnical instrumentation plan.

In addition to calibration, the personnel collecting the data shall also perform maintenance of the equipment. All maintenance shall be conducted in accordance with the manufacturer's requirements (if any is required).

24.8.5 Installation Methods

There are numerous ways to install the geotechnical instrumentation. The STSs and Special Provisions will provide some general requirements. The actual installation methods are left to the Contractor and shall be included in the installation plan. As part of the installation methods, the qualifications of the personnel installing the instrumentation shall also be included. The Contractor is solely responsible for installation and the performance of the instrumentation after installation. Badly performing or inoperative instrumentation shall be replaced at no additional cost to SCDOT.

24.8.6 Protection Plan

Geotechnical instrumentation that terminates at the ground surface (natural or man-made) is subject to damage by construction activities. Therefore, special precautions are required. As part of the installation plan, the Contractor is required to specify how the instrumentation is to be protected, not only from construction activities, but also from vandalism.

24.8.7 Installation Records

Detailed installation records are required to be submitted by the Contractor. These records fill 2 purposes. First, by requiring detailed installation records, the installation is more likely to be performed in accordance with the accepted installation plan. Secondly, the records function as an "as-built" record and can indicate why the instrumentation is performing poorly or incorrectly, thus aiding the GEOR in determining if less reliance should be placed on a particular instrument. Having the record will also remove doubt if an instrument performs erratically by removing installation concerns as a potential cause of the problem. Presented in Table 24-11 are some items for possible inclusion on the installation record sheet.

Table 24-11, Possible Content of Installation Record Sheets (Dunnicliff (1998))

Category	Content
Heading	• Project Name • Instrument type and number, including readout unit • Personnel responsible for installation • Date and time of start and completion
Planned Data	• Planned location in plan and elevation • Planned orientation • Planned lengths, widths, diameters, depths, and volumes of backfill • Necessary measurements or readings required during installation to ensure that all previous steps have been followed correctly, including post-installation acceptance tests
As-Built Data	• As-built location in plan and elevation • As-built orientation • As-built lengths, widths, diameters, depths, and volumes of backfill • Plant and equipment used, including diameter and depth of any drill casing used • A log of appropriate subsurface data • Type of backfill used • Post-Installation acceptance test
Weather	• Weather conditions
Notes	• Any notes, including problems encountered, delays, unusual features of the installation, and any events that may have a bearing on instrument behavior

24.8.8 Installation Reports

The purpose of the installation report is to provide a convenient summary of the information that personnel might need who are involved in the data collection, and processing, presentation and interpretation of the data. Listed below are some of the items that should be included in the report:

- Plans and sections sufficient to show instrument numbers and locations
- Appropriate surface and subsurface stratigraphic and geotechnical data
- Descriptions of instruments and readout units, including manufacturer's literature and photographs
- Details of calibration procedures
- Details of installation procedures (photographs are often helpful)
- Initial readings
- A copy of each installation record sheet

24.8.9 Data Collection Methods

Typically on SCDOT projects the collection of data is the responsibility of the Contractor, with the Contractor's personnel meeting the qualifications in the next Section. Data collection is typically obtained manually. In other words, physical measurements are made or the readout device is directly connected to the terminals of the instrument. Automatic Data Acquisition Systems (ADASs) are available, such as Vibrating Wire Data Collection Centers. However, SCDOT does not have much experience in the use of these systems. Therefore, a manual collection system will be required if an ADAS is used. ADASs have the potential for remote downloading of the data, if the communications are properly setup.

24.8.10 Qualifications of Personnel Collecting Data

SCDOT requires that all personnel involved in the collection of instrument data be familiar with the instrumentation being used. These personnel shall be familiar with the installation report, so that if anomalies are encountered, they can provide feedback to the GEC processing the data. In addition, the personnel obtaining the data shall report to a licensed engineer working for the GEC. In the case of settlement plate readings, a licensed land surveyor is required. The qualifications of all personnel involved with the installation, calibration, maintenance and data collections shall be included as part of the Contractor's installation plan.

24.9 FIELD INSTRUMENTATION

The most commonly used types of field instrumentation for highway projects are discussed below. Included in the discussion are the role and typical uses of each instrument, a short description of methods commonly used, and common problems to be aware of with installation, reading, and interpretation of the instrumentation. For more information about particular instruments, the references cited at the end of the Chapter, as well as manufacturer manuals and websites are recommended.

24.9.1 Slope Inclinometers

These instruments are used to monitor the magnitude, direction, and rate of subsurface horizontal deformations. Typical applications include monitoring the rate and extent of horizontal movement of embankments or cut slopes, determining the location of an existing failure surface, and monitoring deflection of retaining walls. Inclinometers can be installed at several levels on an embankment or cut slope to define the extent and nature of subsurface movements. An inclinometer consists of a grooved casing grouted vertically in a borehole. The role of the casing is to deform with the surrounding ground such that readings taken within the casing reflect accurate measurements of ground movement. Typically the grooves are aligned parallel to the direction of movement. The probe is periodically inserted down the casing and deflection of the casing is measured. The inclinometer probe contains accelerometers at either end to measure the parallel and perpendicular tilt of the casing. Successive measurements are plotted to provide a chronological indication of the extent and rate of subsurface movements.

Installation of inclinometer casing must be continued into rock or dense material that is not expected to deform. This will provide a point-of-fixity at the bottom of the casing to which other measurements through the casing can be reliably correlated to. Once drilling has proceeded to the desired depth and the inclinometer casing has been set in the borehole, the annulus between the casing and borehole side is filled with grout that has a similar strength to that of the surrounding soil. Because the grout will induce a buoyant force on the casing, a stabilization method will be required to keep the casing in place during grout placement. Methods involving anchoring or weighting the casing bottom in the borehole are commonly used to overcome this issue. The instrument manufacturer should be consulted for recommended procedures for overcoming buoyancy. Holding the casing in place at the ground surface while grouting will cause the casing to corkscrew within the borehole which may cause errors in future readings. Inclinometers are to be installed and read in accordance with AASHTO Specification R 45-13 – *Standard Practice for Installing, Monitoring, and Processing Data of the Traveling Type Slope Inclinometer* and the manufacturer's specifications. Inclinometer casing conforming to the requirements of STS SC-M-203-9 for *Slope Inclinometer Casing* shall be used.

The review of inclinometer data should indicate first that the bottom of the casing is placed firmly in material that is not moving (i.e., below the potential/actual failure surface). Second, the review should indicate that all subsequent data is indicating movement "downhill." If the data indicates movement in the opposite direction, review the procedures for obtaining the data with

field personnel. In addition, the actual movement data should be compared to the theoretical (design) movements to determine if the predicted is similar to the actual. From this comparison, it may be possible to predict additional movements.

24.9.2 Settlement Monitoring

These instruments are used to record the amount and rate of settlement under load. The most common installation of these instruments is for use with embankments where high settlements are predicted. The instruments listed in the following Subsections are the recommended methods for settlement measurement associated with highway embankments. Some instruments detailed below are designed to measure settlement through depth of strata. Because subsurface settlement instruments are often damaged during construction, some form of long-term settlement monitoring at the top of an embankment should be planned. This will provide a check of the readings obtained from subsurface instruments and can help to fill in the gaps from instruments that have either been damaged or have become unreliable.

The monitoring of settlement is probably the most common type of geotechnical instrumentation used by SCDOT. Typically settlement data consists of either survey (elevation) data or pore pressure data. Survey data is obtained from various points that are compared to established benchmarks, while pore pressure data is obtained from piezometers. The first check of the data is to determine if the numerical calculations are consistent. The second check and more important check, is the trend of the data, i.e. does the data continue to indicate downward movement. With pore pressure data, the second check is whether or not the pore pressures are approaching a static pore pressure level. It should be noted that the before construction pore pressure level will not be obtained, but some higher level will be. Both the survey data and the pore pressure data should approach a trend line where there is very little difference between readings. Once this happens, settlement is assumed to be over. While settlement monitoring is occurring, the amount of actual settlement should be compared to the predicted amount of settlement. One method for determining if settlement (based only on survey data) is complete is to use Taylor's square root of time method. Another method for determining the completion of settlement is the use Asaoka's method.

24.9.2.1 Settlement Plate

The simplest form of settlement indicator is the settlement plate, which typically consists of a steel plate placed on the ground surface prior to embankment construction. The initial elevation of the plate must be recorded before construction begins to provide a reference point for all future readings. A reference rod and protective casing are then attached to the plate. As fill placement progresses, additional rods and casing are added. Settlement is measured by determining the elevation of the top of the reference rod at specified time intervals by surveying methods. The reference rod and initial platform elevations are determined relative to several benchmarks placed outside the construction area. Settlement plates are often placed in areas where the highest settlements are predicted. Settlement plates conforming to the requirements of STS SC-M-203-4 for *Settlement Plates* shall be used.

24.9.2.2 Extensometers

The probe extensometer is another instrument commonly used to measure settlement. In a typical arrangement, corrugated polyethylene pipe surrounded by rings of stainless steel wire at selected intervals is lowered into a borehole. A rigid PVC inner pipe is coupled to the corrugated pipe prior to installation. Inclinometer casing is often used as the rigid inner pipe, thereby eliminating the need for drilling two separate boreholes for measuring horizontal and vertical displacement. The annulus between the rigid inner pipe and outer corrugated pipe is filled with bentonite slurry to minimize friction and the space between the outer pipe and

borehole side is filled with a grout that conforms as nearly as possible to the properties of the surrounding soils. A more rigid system consisting of PVC pipe with telescopic couplings and steel plates instead of wire rings may be more desirable in situations where the likelihood of crushing the corrugated pipe exists, such as in high fill embankments or where high settlements are predicted.

The reading device in a probe extensometer consists of an induction coil housed within a probe attached to a signal cable that leads to a readout unit at the surface. As the probe is lowered, the operator notes at what depth the probe senses the steel rings, indicated by a buzzer on the readout unit. By comparing these depths to the initial depths, a settlement profile can be obtained. A main advantage of this type of instrument to a conventional settlement plate is that a settlement profile is obtained through the entire depth of the strata in question, not just at the surface. Optical surveying is typically not required so long as the bottom of the extensometer is fixed in stable ground. Drawbacks to this method include disruption to construction activities and cost, as compared to conventional settlement plates. Extensometers conforming to the requirements of STS SC-M-203-8 for *Vibrating Wire Rod Extensometers* shall be used.

24.9.2.3 Settlement Sensor

The settlement sensor, or liquid-level gage instrument, consists of a pressure transducer embedded beneath the embankment with liquid-filled tubes connected to a reservoir and readout unit installed on stable ground. As the transducer settles, greater pressure is imparted on the transducer by the column of liquid. Settlement is measured by converting the increase in pressure to feet or meters of liquid head. This method requires that the liquid-filled tubes be run in trenches to areas outside of the construction area. Although trenching may cause some disruption to construction activity, all readings are taken away from the construction area after the instrument is installed. Settlement sensors are often installed at several depths at the same cross-section to better define the full settlement profile. The ease of automation tends to be highest for this type of settlement measurement, especially if the pressure transducer is of the vibrating-wire type. A limitation to this type of instrument is that the soils surrounding the instrument and in the trench must be installed to specifications similar to that of the surrounding fill. Otherwise harmful discontinuities may be introduced into the embankment. This instrument should be used for short-term monitoring, because this instrument can be extremely temperature sensitive. Settlement sensors conforming to the requirements of STS SC-M-203-7 for *Settlement Sensors* shall be used.

24.9.2.4 Settlement Reference Points

Settlement reference points are installed on structures or embankments upon essential completion of construction or topping out. Settlement reference points are intended to provide long-term settlement data by relatively simple methods at the ground surface. Settlement reference points may also be installed on embankments or structures such as a retaining wall to evaluate distress or unanticipated movement.

Settlement reference points are monitored using conventional surveying methods. Settlement reference points may consist of pins driven into the ground or mounted on a structure, or may simply be a painted reference point on a structure. Data collected over time indicates the amount of settlement that has occurred at each reference point. Care should be taken to protect settlement pins from disturbance by construction equipment or traffic that will affect the validity of data.

24.9.2.5 Crack Gauges

Crack gauges refer to simple commercial devices installed on a structure, such as a retaining

wall, to visually monitor vertical and horizontal movements. Crack gauges permit visual monitoring and measurement of structural movements without requiring the use of survey equipment. Several configurations of the gauges are available, such as gauges mounted on a flat surface, or gauges mounted on either side of a corner.

Typical commercial crack gauges consist of 2 overlapping pieces of acrylic or PVC sheets fixed in place by epoxy. The sheets are installed so that the bottom sheet is fixed to the structure on one side of the crack, and the top sheet is fixed to the structure on the opposite side of the crack. The bottom sheet contains an opaque reference grid, and the top sheet is transparent with an intersecting vertical and horizontal marker. After measuring the width of the crack at the start of the monitoring period, horizontal and vertical movements of the structure can be monitored by noting the movement of the marker over the reference grid.

Crack gauges have some limitations and their use requires judgment and experience. Movements indicated on the gauge facing do not necessarily reflect the true peak movement which may occur in a dimension not recognized by an individual gauge as mounted. Crack gauges are typically only capable of monitoring movement in 2 dimensions; therefore, multiple gauges mounted at several locations on the structure will be required to monitor movement in 3 dimensions. When movements exceed the size of the reference grid, the size of the crack is recorded and new gauges can be installed to continue the monitoring program.

24.9.3 Piezometers

Piezometer applications generally fall into 2 categories: 1) Monitoring the flow of groundwater, or 2) Providing an index of soil strength gain. For highway construction, piezometers are typically installed to monitor pore water pressures associated with fill embankments and existing or cut slopes. Pore water pressure monitoring provides an estimate of effective stress within a slope. An increase in pore pressure indicated by a piezometer in a slope can be a signal of an impending slide. If a dewatering system is installed to stabilize a large excavation, piezometers can be used to gauge the effectiveness of the system. The most common use of piezometers in highway construction is to monitor the initial pore pressure rise and subsequent dissipation associated with consolidation of soils beneath an embankment. Pore pressure readings taken during construction of an embankment can be used to verify design settlement assumptions and to guide further construction activities.

The term piezometer is generally used to describe pore pressure monitoring instruments where seals are placed within the ground at selected depths, so as to monitor pore pressure conditions only within a certain strata. A device that has no seals is generally termed an observation well and should only be used in homogenous and continuously permeable soils. The simplest type of piezometer is an open standpipe piezometer. In this application, a section of slotted pipe attached to riser pipe is lowered to the desired elevation. A filter is generally placed around the slotted pipe and sand is placed in the borehole around the filter to create a reading interval. A bentonite seal is then placed atop the sand and a sealing grout is used to fill the remainder of the borehole. Open standpipe piezometers have a slower response time than some of the more sophisticated instruments described below, but are generally more cost effective to install and are more reliable than other methods.

Vibrating-wire piezometers are often used in applications where fast response to pore pressure changes is desired. Other advantages include less disruption to construction activity, less chance for damage in active construction zones (provided the lead cables are protected properly), and ease of reading and automation. A vibrating-wire piezometer consists of a diaphragm connected to a tensioned wire such that changes in pore-pressure affect the tension of the wire. A readout unit is used to pluck the wire and measure the change in wire tension, which can then be converted to pore-pressure readings. Vibrating-wire piezometers are

typically installed in similar fashion to open-standpipe piezometers with the pressure transducer placed inside the screened reading interval, although recent research suggests that similar results can be obtained in a fully-grouted borehole. Please refer to Dunnicliff (1998) for more information on the fully-grouted installation method. Push-in type vibrating-wire piezometers provide a quick and relatively easy installation and are commonly used to monitor pore pressure changes in successive lifts of an embankment. Open standpipe piezometers can also be converted to vibrating-wire piezometers simply by lowering a pressure transducer into the well to a specified depth. Most vibrating-wire type instruments currently come with some form of lightning protection housed inside the body of the instrument, though additional measures may be needed in areas prone to lightning activity. Piezometers conforming to the requirements of STS SC-M-203-6 for *Vibrating Wire Piezometer* shall be used.

Another piezometer type commonly used is the pneumatic piezometer, which consists of a flexible diaphragm and sensor body connected to a junction box at the surface with twin tubes. A filter is commonly used to separate the diaphragm from the surrounding material. Pressurized gas is introduced through the inlet tube. As gas pressure exceeds the pore water pressure, the diaphragm deflects, allowing gas to vent through the outlet tube. When the operator observes a return flow of gas, the gas supply is shut off and the diaphragm returns to its equilibrium position with the pore water pressure. The operator then obtains a reading from a pressure gauge connected to the input tube. This type of instrument also features a relatively short time lag and minimal disruption to construction. Some limitations of this instrument include the complexity of choosing the proper details of instrument, difficulty of reading, and the possibility of minute gas leaks within the system causing errors in data.

Often, it is not immediately known which type of piezometer is better suited to a particular application. One way of narrowing the choice and alleviating concerns over data reliability is to install groups of redundant piezometers of different types at similar locations and depths. Generally, open standpipe piezometers are paired with vibrating-wire or pneumatic piezometers and the data are periodically compared to ensure data validity. This setup also ensures that the flow of data will not be disrupted if 1 instrument malfunctions.

24.9.4 Special Instrumentation

Situations may arise where field instruments other than those described above are desired for use on a project. Many instruments, such as earth pressure cells or strain gauges, are typically not used in construction projects but only in research and special projects. Other instruments, such as borehole extensometers for monitoring a rock slope or tie-backs, may serve a key role on a project. Less common methods, such as horizontal inclinometers or other specialized instruments, should only be specified in special circumstances and with prior approval from the PC/GDS. The need for special instrumentation and the selection of instruments will be evaluated on a case-by-case basis.

24.10 CONCLUSIONS

After assuring its validity, data from field instruments shall be interpreted relative to other instrument data as well as outside factors that may affect the data. For example, during construction of an embankment on soft ground, pore pressure rises and subsequent drops can be correlated to settlement measurements as well as the level of fill placement. A measured change in a single instrument but not in other corresponding instruments may signal error stemming from either the instrument itself or reading methods. Another effective way to validate instrument readings is through routine visual observation. Observation of the monitored area can provide early warning signals, such as a tension crack or evident seepage, which may not be picked up by nearby field instruments and can also guide remedial actions.

The monitoring program of a highway construction project must be able to adapt to changing conditions. Base line readings of installed instruments may paint a picture that is totally different from what was assumed during the design phase. Components such as reading interval, methods of collecting data, and presentation of data may change dramatically over the course of a project.

24.11 SHOP PLAN REVIEW

The Standard Specifications, Supplemental Specifications, Supplemental Technical Specifications, Special Provisions and design drawings occasionally require the Contractor to submit Shop Plans and Installation Plans in addition to the PIP and the DFIP. The GEOR shall review the geotechnical portions of the submitted Shop Plans and Installation Plans for conformance to the Standard Specifications, Supplemental Specifications, Supplemental Technical Specifications, Special Provisions and design drawings. If no review time is specified in the contract, then the GEOR shall conduct the review in 21 calendar days and shall submit the response to the Department.

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ECS Southeast, LLP

Subsurface Exploration Report

York County Gravity Sewer Extension

Fort Mill, York County, South Carolina

ECS Project Number 08:12831

March 5, 2019

ECS SOUTHEAST, LLP
"Setting the Standard for Service"
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SC Registered Engineering Firm 3239

March 5, 2019

Mr. Randall H. Patrick
Michael Baker International
4425 Belle Oaks Drive
North Charleston, SC 29405

ECS Project No. 08:12831

Reference: Subsurface Exploration Report
York County Gravity Sewer
Fort Mill, York County, South Carolina

Dear Mr. Patrick:

ECS Southeast, LLP (ECS) has completed the subsurface exploration for the above-referenced project. Our services were performed in general accordance with our Proposal No. 08:21876P, dated March 9, 2018. This report presents our understanding of the geotechnical aspects of the project, along with the results of the field exploration conducted, and our recommendations for design and construction.

It has been our pleasure to be of service to you during the design phase of this project. Should you have any questions concerning the information contained in this report, or if we can be of further assistance to you, please contact us.

Respectfully submitted,

ECS Southeast, LLP

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SOUTH CAROLINA ECS SOUTHEAST, LLP No. COA3239 CERTIFICATE OF AUTHORIZATION

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APPENDICES

EXECUTIVE SUMMARY

This report contains the results of our subsurface exploration and geotechnical engineering evaluation for the proposed gravity sewer extension along Sugar Creek near Regent Parkway in Fort Mill, York County, South Carolina. We understand that the new gravity sewer will extend from the existing sewer at MH-3 to the "Original" New Heritage Pump Station site and then from the pump station north along Sugar Creek, eventually pivoting southwest along the existing rail road tracks.

The subsurface conditions disclosed by the borings generally consisted of surficial topsoil, underlain by existing fill underlain by alluvial and residual soils , underlain by Partially Weathered Rock (PWR) to the explored depths of the borings, and is summarized as follows:

- Existing fill soils were encountered in Borings B-1, B-2, B-3, B-11, B-13, B-14, B-15, and B-16. Existing fill soils encountered generally consist of Elastic SILT (MH) Sandy CLAY (CL), and Silty SAND (SM) and extend to depths ranging from approximately 3 to 8 feet below existing grades.
- Alluvial materials were encountered underlying the existing fill in Boring B-3 and below surficial materials in Borings B-4, B-5, B-6, and B-7. Alluvial materials encountered generally consist of Sandy CLAY (CL) and Sandy SILT (ML) and extend to depths ranging from approximately 3 to 12 feet below the existing ground surface.
- The residual soils encountered typically consist of Sandy SILT (ML), Silty SAND (SM), Sandy CLAY (CL), Elastic SILT (MH), and Plastic CLAY (CH).
- Partially Weathered Rock (PWR) was encountered in Borings B-5, B-6, B-7, and B-9 through B-17 at depths ranging from approximately 8 to 22 feet below the existing ground surface. Borings B-6, B-7, B-11, B-12, B-14, B-15, B-16, and B-17 were terminated upon auger refusal at depths ranging from approximately 9 to 24 feet below the existing ground surface.

Based on our field exploration and the provided gravity sewer profile from Station 0+00 to 50+00, it appears that difficult excavation into auger refusal materials may be encountered along the proposed sewer alignment in the vicinity of Boring B-11, approximately Station 48+00 to 50+00. Depending on the depth of the planned sewer line beyond Station 50+00, difficult excavation into auger refusal materials may be encountered in the vicinity of Borings B-12 through B-17.

Please note this Executive Summary is an important part of this report, but should be considered a "summary" only. The subsequent sections of this report constitute our findings, conclusions, and recommendations in their entirety. Furthermore, ECS should review our findings and recommendations in their entirety once the final project criteria have been established.

1.0 INTRODUCTION

1.1 GENERAL

The purpose of this study was to provide general subsurface conditions at the site and to evaluate those conditions with regard to general site development. The project will include a gravity sewer extension along Sugar Creek in York County, South Carolina.

This report contains the results of our subsurface exploration, site characterization, and engineering analyses for the planned construction.

1.2 SCOPE OF SERVICES

Sixteen (16) soil test borings were performed at locations selected and located in the field by ECS. This report discusses our exploratory and testing procedures, presents our findings and evaluations, and includes the following:

- Information on site conditions including geologic information and special site features.
- Description of the field exploration and laboratory tests performed.
- Final logs of the soil borings and records of the field exploration and laboratory tests in accordance with the standard practice of geotechnical engineers, including a boring location diagram and vicinity map.
- Measurement of the surficial materials at each boring location and notation of this information on the boring logs and in the text of the report.
- Evaluation of the on-site soil characteristics encountered in the soil borings. Specifically, we discuss the suitability of the on-site materials for reuse as engineered fill to support ground slabs and pavements. A discussion of groundwater, in-place fill, and rock, and their potential impact on structures and project construction will be provided.

1.3 AUTHORIZATION

Our services were provided in accordance with our Proposal No. 08:21876P, dated March 9, 2018, authorized by Mr. Randy Patrick on May 17, 2018, and includes the Terms and Conditions of Service outlined with our Proposal.

2.0 PROJECT INFORMATION

2.1 PROJECT LOCATION

The site consists of the proposed sewer extension along Sugar Creek in York County from the existing sewer at MH-3 to the new heritage Pump Station site and continues northward along Sugar Creek to the existing rail road tracks before pivoting southwest toward Regent Parkway. Refer to Figure 2.1.1 below and the Vicinity Map included in the Appendix.

Figure 2.1.1. Site Location

2.2 PROPOSED CONSTRUCTION

We understand that the project will include the construction of a new gravity sewer extension along Sugar Creek in Fort Mill, York County, South Carolina. Based on the New Heritage Phase 2 Gravity Sewer Plan and Profile sheets, dated November 2018 and prepared by Michael Baker International, invert elevations for the sewer extension between Stations 0+00 and 50+00 range from 502.52 to 523.79 feet.

3.0 FIELD EXPLORATION

3.1 FIELD EXPLORATION PROGRAM

The field exploration was planned with the objective of characterizing the project site in general geotechnical and geological terms, and to evaluate subsequent field data to assist in the determination of geotechnical recommendations.

3.1.1 Test Borings

The subsurface conditions were explored by drilling sixteen (16) soil test borings along the proposed sewer extension alignment. A Simco 2400 drill rig was utilized to drill the soil test borings. Borings were advanced to depths ranging from approximately 9 to 25 feet below the current ground surface.

Boring locations were located in the field by ECS prior to mobilization of our drilling equipment. The approximate as-drilled boring locations are shown on the Boring Location Diagram in Appendix A. Ground surface elevations noted on logs for Borings B-1 through B-11 were estimated from the provided topographic information and elevations noted on logs for Borings B-12 through B-17 were estimated based on Google Earth. Reported elevations should be considered accurate only to the degree implied by the method used to obtain them.

Standard penetration tests (SPTs) were conducted in the borings at regular intervals in general accordance with ASTM D 1586. Small representative samples were obtained during these tests and were used to classify the soils encountered. The standard penetration resistances obtained provide a general indication of soil shear strength and compressibility.

3.1.2 Seismic Refraction Array

One (1) seismic refraction arrays was performed along the proposed sewer extension alignment approximately from Station 30+00 to 32+00 along Sugar Creek. The approximate location of the array is shown in Figure 3 included in the Appendix of this report. The array location was identified in the field by ECS using a handheld GPS device and existing landmarks as reference.

The seismic refraction method of subsurface exploration is a non-invasive technique primarily used to estimate the depth of soil, partially weathered rock (PWR), and competent rock layers. In addition to depth information, seismic velocity data provides an indication of material density or hardness and can be used in estimating excavation techniques that may be required for site development.

Compressive waves are timed from an initiation point on the surface of the ground to receivers (geophones) located some distance away. Wave velocities increase as they are refracted off harder layers. By increasing the source to receiver distance over a straight line, a graph of time versus distance is developed which is used to calculate velocities (densities) and depths of the underlying materials. The information obtained from a single seismic refraction travers is limited to the material directly below the geophone array.

For the seismic refraction field work, 120-foot cable (array) is laid out on the ground surface. Geophones are typically placed at ten-foot intervals and connected to the cable that is connected to a Seismic Source ™ 24-channel DAQ LINK II Data Acquisition Link System Seismograph (DAQII). For this study, 12 channels were used. Shot points (both end points and points along the traverse) are selected.

A sledgehammer blow at each shot point generates elastic body waves (p-waves or compression waves) that move down and outward as ever expanding hemispheres through the underlying horizons. The seismic energy that passes downward is bent or refracted at each change of density below the traverse and returns to the surface. The time required for these waves to move downward, refract and return to the surface is recorded at the surface by the vibration sensitive geophones. The arrival time data for each geophone/shotpoint combination is recorded in the field by the seismograph.

Computer and manual analysis of the field data is used to determine subsurface conditions. Seismic results are typically presented as computer drawn cross-sections showing shaded layers below the alignment. The average p-wave velocity (in feet per second) of each horizon is printed on the cross-section and is indicative of the materials hardness and rippability. Maximum study depth is dependent on velocity distribution determined by algorithms used in the analysis. Reliable data is shown as a color shade on the Seismic Refraction P-Wave Velocity Profile included in Appendix B of this Report.

3.2 REGIONAL/SITE GEOLOGY

The site is located in the Piedmont Physiographic Province of South Carolina. The native soils in the Piedmont Province consist mainly of residuum with underlying saprolites weathered from the parent bedrock, which can be found in both weathered and unweathered states. Although the surficial materials normally retain the structure of the original parent bedrock, they typically have a much lower density and exhibit strengths and other engineering properties typical of soil. In a mature weathering profile of the Piedmont Province, the soils are generally found to be finer grained at the surface where more extensive weathering has occurred. The particle size of the soils generally becomes more granular with increasing depth and gradually changes first to weathered and finally to unweathered parent bedrock. The mineral composition of the parent rock and the environment in which weathering occurs largely control the resulting soil's engineering characteristics. The residual soils are the product of the weathering of the parent bedrock.

In addition, it is apparent that the natural geology along portions of the proposed sewer alignment has been modified in the past by grading that included the placement of fill materials. The quality of man-made fills can vary significantly, and it is often difficult to assess the engineering properties of existing fills. Furthermore, there is no specific correlation between N-values from standard penetration tests performed in soil test borings and the degree of compaction of existing fill soils; however, a qualitative assessment of existing fills can sometimes be made based on the N-values obtained and observations of the materials sampled in the test borings.

3.3 SUBSURFACE CHARACTERIZATION

3.3.1 Soil Test Borings

The following section provides generalized characterizations of the soil and rock strata encountered during our subsurface exploration. For subsurface information at a specific location, refer to the Boring Logs in Appendix B.

Table 3.3.1 Subsurface Stratigraphy

Approximate Depth Range (ft)	Stratum	Description	Ranges of SPT[(1)] N-values (bpf)
0 to 0.3 (Surface cover)	n/a	Varying amounts of surficial organic laden soil was present at the ground surface at Borings B-2, B-5, B-6, B-7, B-9, B-10, and B-11.	N/A
0.3 to 8	I	FILL – Elastic SILT (MH), Sandy CLAY (CL)[(2)]	3 – 22
0 to 12	II	ALLUVIAL – Sandy CLAY (CL) and Sandy SILT (ML)[(3)]	2 to 4
0 to 25	III	RESIDUAL – Sandy SILT (ML), Silty SAND (SM), Sandy CLAY (CL), Elastic SILT (MH), and Plastic CLAY (CH)	3 to 73
8 to 25	IV	PARTIALLY WEATHERED ROCK[(4)] – Sampled as Silty SAND and Sandy SILT[(5)(6)]	50 blows per 6 inches of penetration to 50 blows per 1 inches of penetration

Notes: (1) Standard Penetration Test
(2) Fill was encountered in Borings B-1, B-2, B-3, B-11, B-13, B-14, B-15, and B-16 to depths ranging from approximately 3 to 8 feet below the existing ground surface.
(3) Alluvial soils were encountered underlying the existing fill in Boring B-3 and below surficial materials in Borings B-4, B-5, B-6, and B-7 and extend to depths ranging from 3 to 12 feet below existing grades.
(4) Partially Weathered Rock is defined as residual material exhibiting SPT N-values greater than 100 bpf.
(5) PWR was encountered at Borings B-5, B-6, B-7, and B-9 through B-17.
(6) Borings B-6, B-7, B-11, B-12, B-14, B-15, B-16, and B-17 were terminated at Auger Refusal at depths ranging from approximately 9 and 24 feet below the existing ground surface.

3.3.2 Seismic Refraction

Seismic data generally indicates the presence of three distinguishable velocity zones or subsurface horizons below the traverse performed. The zones can be interpreted as soil, Partially Weathered Rock (PWR), or rock. The model displays an upper line that represents the approximate ground surface. Approximate ground surface elevations were provided in survey information for this project. Shaded areas beneath this line show zones of increasing velocity interpreted as geologic horizons of greater density or hardness. Layers within the models display the measured velocities from the subsurface and are textured to correspond with the legend for a geologic interpretation. The array included in the Appendix displays the estimated cross-section of the recently performed seismic refraction traverse.

The following material definitions typically apply to the velocity ranges shown. As these velocity ranges are approximate, actual excavation techniques required will depend on the degree of weathering or fracturing, overall stratigraphy, type of equipment used, and skill of the equipment operator.

Table 3.3.2 Seismic Refraction Material Definitions

Velocity	Interpretation of material Composition
0-3,000 ft/s	Softer materials generally consisting of soils and saprolites which can be excavated using backhoes and scrapers.
3,000-5,000 ft/s	Partially weathered, fractured rock, and/or intermediate geomaterials which can usually be ripped using large earth moving equipment in mass excavations. Trench excavation may require hoe ramming or blasting for removal.
5,000+ ft/s	Competent rock normally requiring blasting in trench or mass excavations.

The seismic refraction process is limited in some respects. The primary limitation is that if a layer of lower velocity (softer) material underlies a higher velocity (harder) material, the softer material will not be detected. In addition, groundwater levels can skew the results of refraction testing.

3.4 GROUNDWATER OBSERVATIONS

Groundwater measurements were attempted at the termination of drilling and prior to demobilization from the site. Groundwater was encountered at Borings B-1 through B-7, B-9, and B-12 through B-15 at depths ranging from approximately 2 to 21 feet below the existing ground surface. Cave-in depths were attempted to be measured at Borings B-1 through B-17 with cave-in depths ranging from approximately 6.7 to 21 feet. Cave-in of a soil test boring can be caused by groundwater hydrostatic pressure, weak soil layers, and/or drilling activities (i.e. drilling fluid circulation or advancement of bit).

Fluctuations in the groundwater elevation should be expected depending on precipitation, run-off, utility leaks, and other factors not evident at the time of our evaluation. Normally, highest groundwater levels occur in late winter and spring and the lowest levels occur in late summer and fall. Depending on time of construction, groundwater may be encountered at shallower depths and locations not explored during this study. If encountered during construction, engineering personnel from our office should be notified immediately.

4.0 LABORATORY SERVICES

The laboratory testing performed by ECS for this project consisted of selected tests performed on samples obtained during our field exploration operations. The following paragraphs briefly discuss the results of the completed laboratory testing program.

A geotechnical staff professional visually classified each soil sample from the test borings on the basis of texture and plasticity in accordance with the Unified Soil Classification System (USCS) and ASTM D-2488 (Description and Identification of Soils-Visual/Manual Procedures). After classification, the staff professional then grouped the various soil types into the major zones noted on the boring logs in Appendix B. The group symbols for each soil type are indicated in parentheses following the soil descriptions on the boring logs. The stratification lines designating the interfaces between earth materials on the boring logs are approximate; in situ, the transitions may be gradual.

5.0 SITE CONSTRUCTION RECOMMENDATIONS

5.1 BELOW GRADE EXCAVATION

Based on the results of the soil test borings, PWR and Auger Refusal materials (i.e. rock) were encountered within Borings B-5, B-6, B-7, and B-9 through B-17 along the proposed new sewer alignment. Based on review of the provided New Heritage Phase 2 Gravity Sewer Profile and Plan sheets, dated November 2018 and prepared by Michael Baker International, invert elevations of the planned sewer extension from Station 0+00 to 50+00 range from approximately 502.52 feet to 523.79 feet. Based on the results of our subsurface exploration, bedrock and auger refusal material were encountered at elevations ranging from approximately 485 feet to 545 feet.

Results of our subsurface exploration indicate difficult excavation into auger refusal material should be anticipated in the vicinity of Boring B-11, approximately Station 48+00 to 50+00. Information regarding the depth of the planned utilities beyond the New Heritage pump station at Station 50+00 along the planned sewer alignment was not provided at the time of this report. Difficult excavation into auger refusal materials may be encountered in the vicinity of Borings B-12 and B-14 through B-17

In mass excavation for general site work, dense soils and PWR can usually be removed by ripping with a single-tooth ripper attached to a large crawler tractor or by breaking it out with large front-end loader. In confined excavations such as foundations, utility trenches, etc., removal of PWR may require use of heavy duty backhoes, pneumatic spades, or blasting.

As a general guide, we recommend the following definitions be used to define rock:

<u>General Excavation</u>

Rip Rock: Material that cannot be removed by scrapers, loaders, pans, dozers, or graders; and requires the use of a single-tooth ripper mounted on a crawler tractor having a minimum draw bar pull rated at not less than 56,000 pounds.

Blast Rock: Material which cannot be excavated with a single-tooth ripper mounted on a crawler tractor having a minimum draw bar pull rated at not less than 56,000 pounds (Caterpillar D-8 or equivalent) or by a Caterpillar 977 frontend loader or equivalent; and occupying an original volume of at least one (1) cubic yard.

<u>Trench Excavation</u>

Blast Rock: Material which cannot be excavated with a backhoe having a bucket curling force rated at not less than 25,700 pounds (Caterpillar Model 225 or equivalent), and occupying an original volume of at least one-half (1/2) cubic yard.

As noted in the Geology section of this report, the weathering process in the Piedmont can be erratic and significant variations of the depths of the more dense materials can occur in relatively short distances. In some cases, isolated boulders or thin rock seams may be present in the soil matrix.

5.2 CONSTRUCTION DEWATERING

Groundwater or trapped/perched water was encountered within 25 feet of existing grades at Borings B-1 through B-7 and B-9, B-10, and B-12 through B-15. Temporary construction dewatering should be anticipated based on the shallow water depth encountered within the soil borings. We anticipate that water will likely be at or above the excavation limits for foundation construction. We anticipate the use of sump pumps will be sufficient to remove water from the excavations during construction. However, ECS can provide additional recommendations of dewatering if requested.

5.3 UTILITY INSTALLATIONS

Utility Subgrades: The soils encountered in our exploration are expected to be generally suitable for support of utility pipes. The pipe subgrade should be observed for stability by ECS to evaluate the suitability of the materials encountered. Any loose or unsuitable materials encountered at the utility pipe subgrade elevation should be removed and replaced with suitable compacted Structural Fill or pipe bedding material.

Utility Backfilling: The granular bedding material should be at least 4 inches thick, but not less than that specified by the project drawings and specifications. Compacted backfill should be free of topsoil, roots, ice, or any other material designated by ECS as unsuitable. The backfill should be moisture conditioned, placed, and compacted.

Excavation Safety: All excavations and slopes should be made and maintained in accordance with OSHA excavation safety standards. The contractor is solely responsible for designing and constructing stable, temporary excavations and slopes and should shore, slope, or bench the sides of the excavations and slopes as required to maintain stability of both the excavation sides and bottom. The contractor's responsible person, as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. Trench boxes or shielding could be used to limit the width of utility excavations. ECS is providing this information solely as a service to our client. ECS is not assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

6.0 CLOSING

ECS has prepared this report of findings, evaluations, and preliminary recommendations to guide geotechnical-related design and construction aspects of the project.

The description of the proposed project is based on information provided to ECS. If any of this information is inaccurate, either due to our interpretation of the documents provided or site or design changes that may occur later, ECS should be contacted immediately in order that we can review the report in light of the changes and provide additional or alternate recommendations as may be required to reflect the proposed construction.

We recommend that ECS be allowed to review the project's plans and specifications pertaining to our work so that we may ascertain consistency of those plans/specifications with the intent of the geotechnical report.

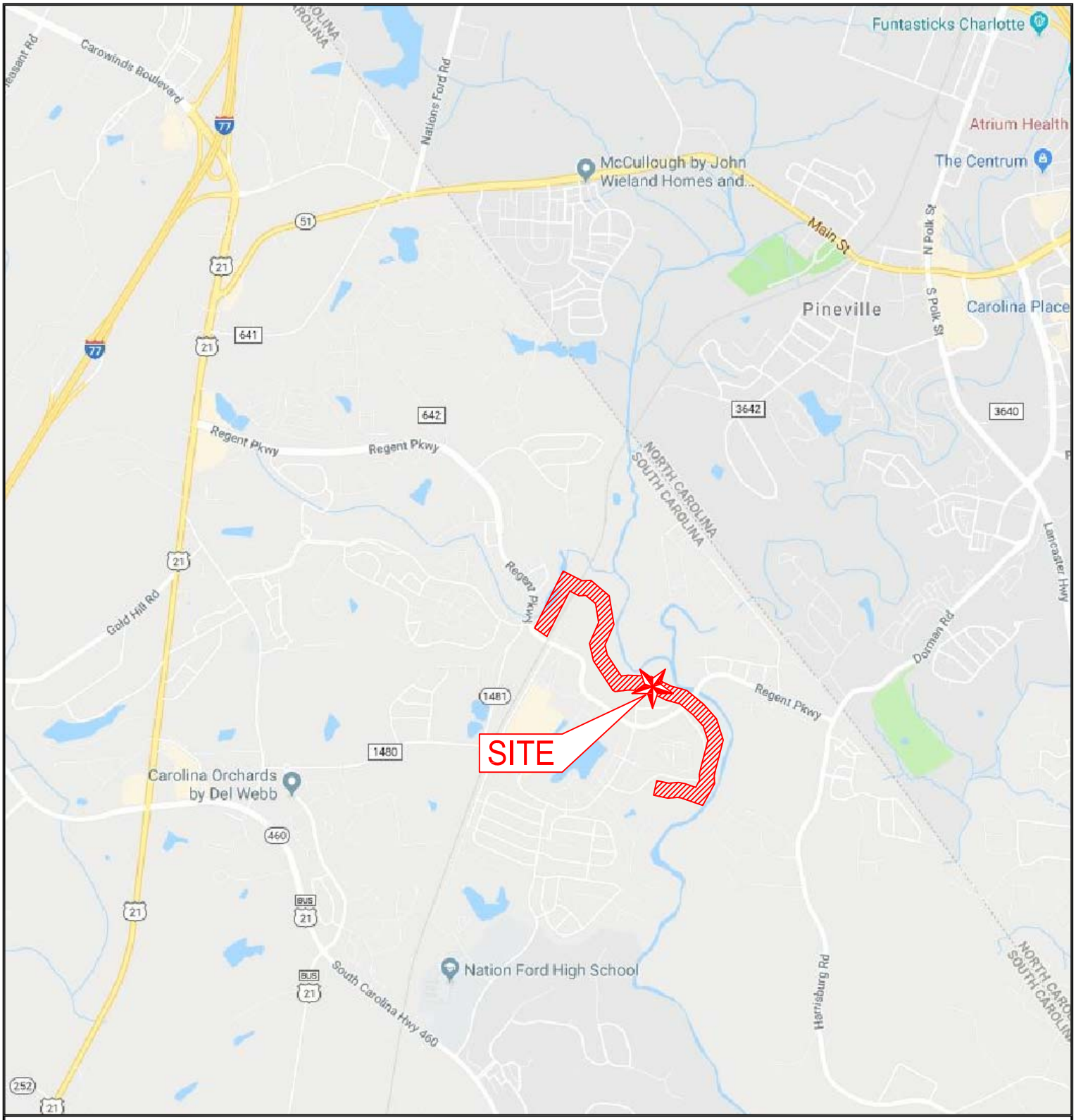
Field observations, monitoring, and quality assurance testing during earthwork and foundation installation are an extension of and integral to the geotechnical design recommendation. We recommend that the owner retain these quality assurance services and that ECS be allowed to continue our involvement throughout these critical phases of construction to provide general consultation as issues arise. ECS is not responsible for the conclusions, opinions, or recommendations of others based on the data in this report.

APPENDIX A – Drawings & Reports

Site Vicinity Map

Boring Location Diagram

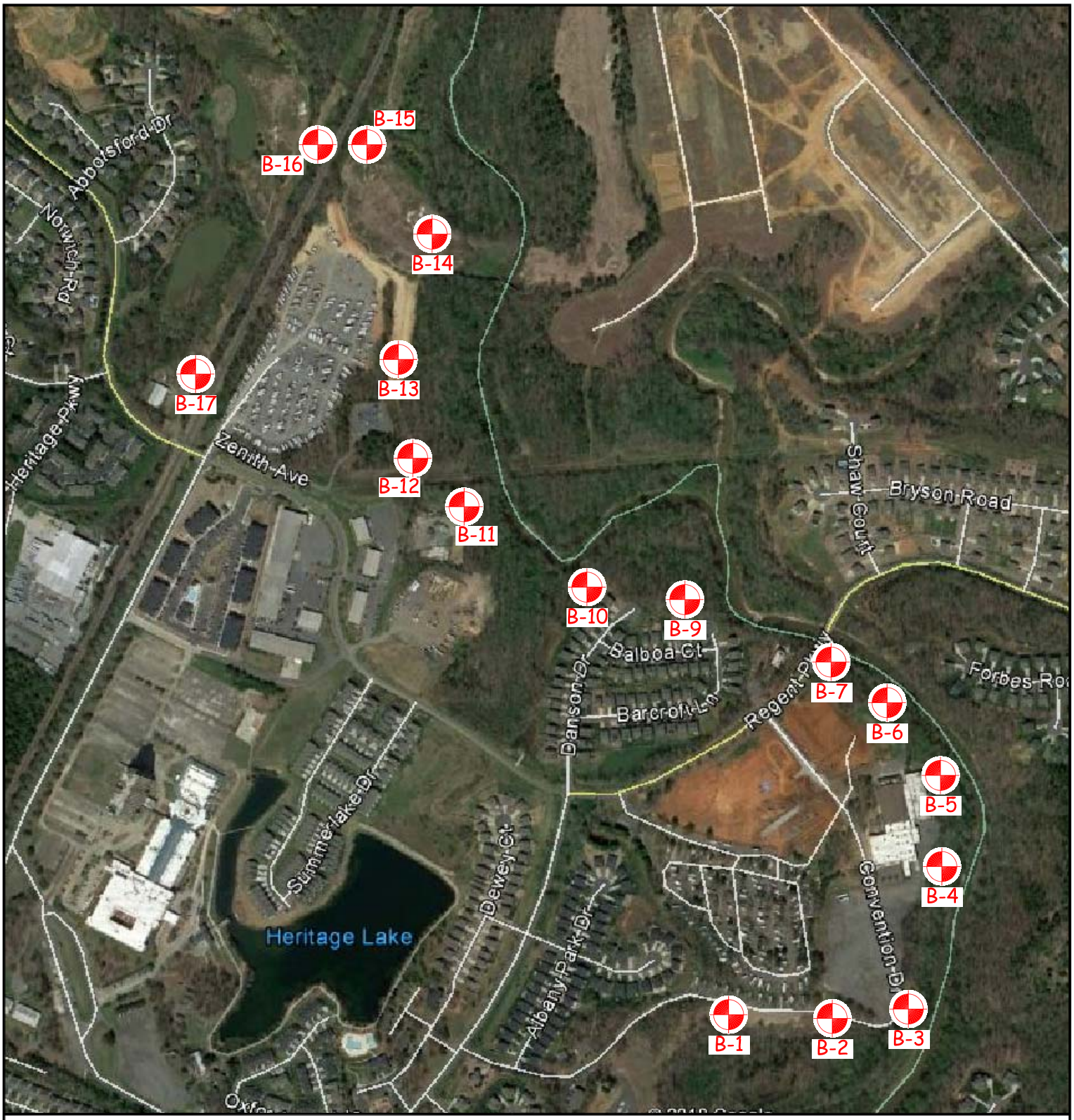
Refraction Testing Location Diagram



LEGEND:

N
W E
S

Source: Google Maps	ECS SETTING THE STANDARD FOR SERVICE	**FIGURE 1** **Site Vicinity Map** **York County -** **Gravity Sewer Extension** **York County, South Carolina**	PROJ. MGR. JDH DRAFTSMAN JRF REVISIONS	SCALE N.T.S. PROJECT NO. 08-12831 FIGURE 1 DATE 02-04-2019



LEGEND:

= Approximate Location of Boring

N W E S

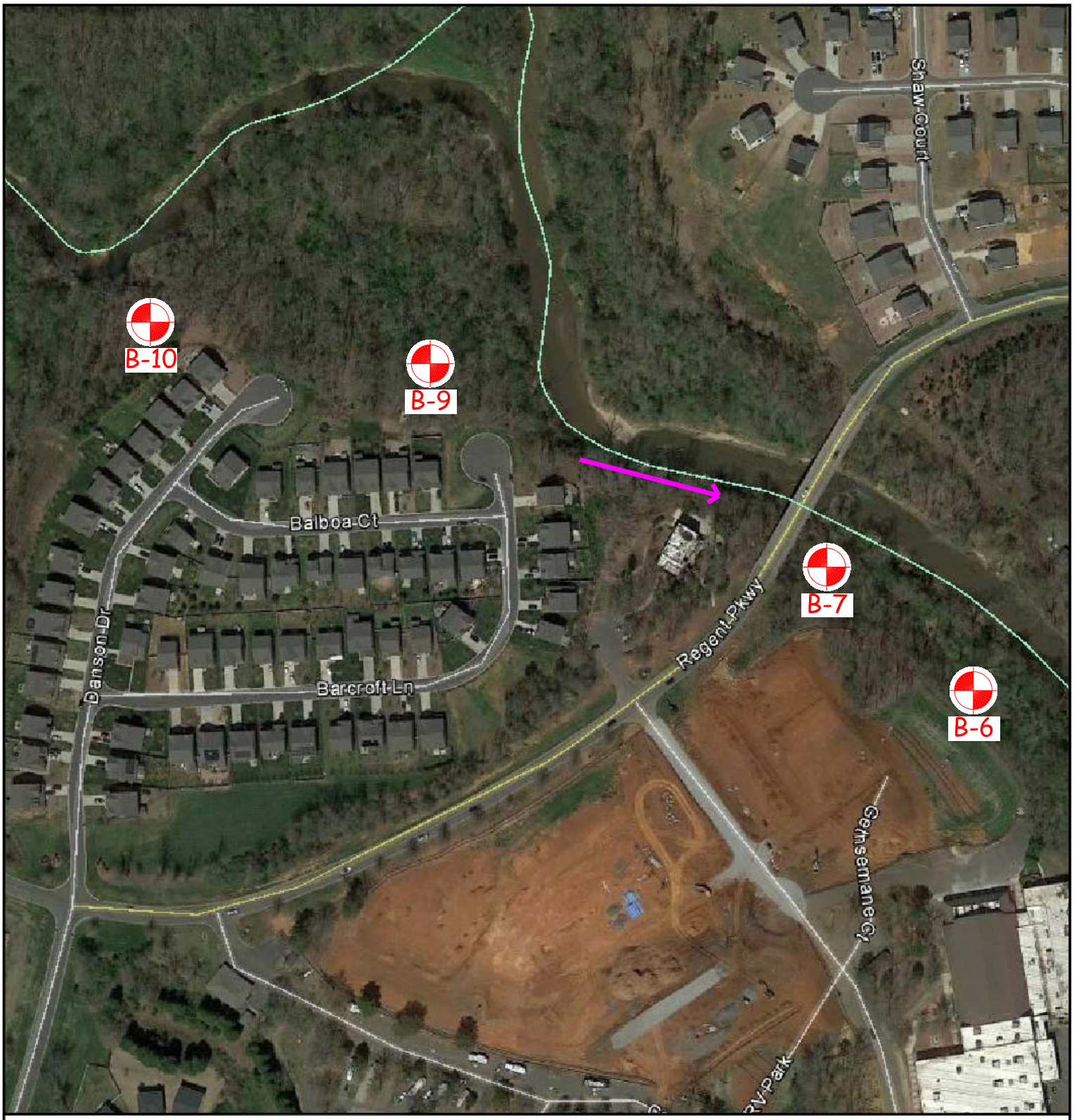
Background Image Provided By:
GOOGLE EARTH
Imagery Date: 03/30/2018

ECS
SETTING THE STANDARD FOR SERVICE

FIGURE 2

Boring Location Diagram
York County -
Gravity Sewer Extension
York County, South Carolina

PROJ. MGR. JDH	SCALE N.T.S.
DRAFTSMAN JRF	PROJECT NO. 08-12831
REVISIONS	FIGURE 2
	DATE 02-04-2019



LEGEND:

= Approximate Location of Boring

= Approximate Location of Refraction Array

N
W
E
S

Background Image Provided By:
GOOGLE EARTH
Imagery Date: 03/30/2018

ECS
SETTING THE STANDARD FOR SERVICE

FIGURE 3

Testing Location Diagram
York County -
Gravity Sewer Extension
York County, South Carolina

PROJ. MGR. JDH	SCALE N.T.S.
DRAFTSMAN JRF	PROJECT NO. 08-12831
REVISIONS	FIGURE 3
	DATE 02-04-2019

APPENDIX B – Field Operations

Reference Notes for Boring Logs

Boring Logs B-1 through B-7 and B-9 through B-17

Seismic Refraction P-Wave Velocity Profile

Generalized Subsurface Profile

REFERENCE NOTES FOR BORING LOGS

MATERIAL[1,2]	
	ASPHALT
	CONCRETE
	GRAVEL
	TOPSOIL
	VOID
	BRICK
	AGGREGATE BASE COURSE
	FILL[3] MAN-PLACED SOILS
GW	**WELL-GRADED GRAVEL** gravel-sand mixtures, little or no fines
GP	**POORLY-GRADED GRAVEL** gravel-sand mixtures, little or no fines
GM	**SILTY GRAVEL** gravel-sand-silt mixtures
GC	**CLAYEY GRAVEL** gravel-sand-clay mixtures
SW	**WELL-GRADED SAND** gravelly sand, little or no fines
SP	**POORLY-GRADED SAND** gravelly sand, little or no fines
SM	**SILTY SAND** sand-silt mixtures
SC	**CLAYEY SAND** sand-clay mixtures
ML	**SILT** non-plastic to medium plasticity
MH	**ELASTIC SILT** high plasticity
CL	**LEAN CLAY** low to medium plasticity
CH	**FAT CLAY** high plasticity
OL	**ORGANIC SILT or CLAY** non-plastic to low plasticity
OH	**ORGANIC SILT or CLAY** high plasticity
PT	**PEAT** highly organic soils

DRILLING SAMPLING SYMBOLS & ABBREVIATIONS			
SS	Split Spoon Sampler	PM	Pressuremeter Test
ST	Shelby Tube Sampler	RD	Rock Bit Drilling
WS	Wash Sample	RC	Rock Core, NX, BX, AX
BS	Bulk Sample of Cuttings	REC	Rock Sample Recovery %
PA	Power Auger (no sample)	RQD	Rock Quality Designation %
HSA	Hollow Stem Auger		

PARTICLE SIZE IDENTIFICATION		
DESIGNATION		**PARTICLE SIZES**
Boulders		12 inches (300 mm) or larger
Cobbles		3 inches to 12 inches (75 mm to 300 mm)
Gravel:	Coarse	¾ inch to 3 inches (19 mm to 75 mm)
	Fine	4.75 mm to 19 mm (No. 4 sieve to ¾ inch)
Sand:	Coarse	2.00 mm to 4.75 mm (No. 10 to No. 4 sieve)
	Medium	0.425 mm to 2.00 mm (No. 40 to No. 10 sieve)
	Fine	0.074 mm to 0.425 mm (No. 200 to No. 40 sieve)
Silt & Clay ("Fines")		<0.074 mm (smaller than a No. 200 sieve)

COHESIVE SILTS & CLAYS		
UNCONFINED COMPRESSIVE STRENGTH, Q_P[4]	**SPT[5] (BPF)**	**CONSISTENCY[7] (COHESIVE)**
<0.25	<3	Very Soft
0.25 - <0.50	3 - 4	Soft
0.50 - <1.00	5 - 8	Medium Stiff
1.00 - <2.00	9 - 15	Stiff
2.00 - <4.00	16 - 30	Very Stiff
4.00 - 8.00	31 - 50	Hard
>8.00	>50	Very Hard

GRAVELS, SANDS & NON-COHESIVE SILTS	
SPT[5]	**DENSITY**
<5	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
>50	Very Dense

RELATIVE AMOUNT[7]	COARSE GRAINED (%)	FINE GRAINED (%)
Trace	<5	<5
Dual Symbol *(ex: SW-SM)*	10	10
With	15 - 20	15-25
Adjective *(ex: "Silty")*	25 - <50	30 - <50

WATER LEVELS[6]		
	WL	Water Level (WS)(WD)
		(WS) While Sampling
		(WD) While Drilling
	SHW	Seasonal High WT
	ACR	After Casing Removal
	SWT	Stabilized Water Table
	DCI	Dry Cave-In
	WCI	Wet Cave-In

[1] *Classifications and symbols per ASTM D 2488-09 (Visual-Manual Procedure) unless noted otherwise.*

[2] *To be consistent with general practice, "POORLY GRADED" has been removed from GP, GP-GM, GP-GC, SP, SP-SM, SP-SC soil types on the boring logs.*

[3] *Non-ASTM designations are included in soil descriptions and symbols along with ASTM symbol [Ex: (SM-**FILL**)].*

[4] *Typically estimated via pocket penetrometer or Torvane shear test and expressed in tons per square foot (tsf).*

[5] *Standard Penetration Test (SPT) refers to the number of hammer blows (blow count) of a 140 lb. hammer falling 30 inches on a 2 inch OD split spoon sampler required to drive the sampler 12 inches (ASTM D 1586). "N-value" is another term for "blow count" and is expressed in blows per foot (bpf).*

[6] *The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in granular soils. In clay and cohesive silts, the determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally employed.*

[7] *Minor deviation from ASTM D 2488-09.*

CLIENT	Job #:	BORING #	SHEET
Michael Baker Jr. Inc.	08:12831	B-1	1 OF 1

PROJECT NAME: York County Gravity Sewer Extension - GEO

ARCHITECT-ENGINEER:

SITE LOCATION: Regent Pkwy, Fort Mill, York County, SC

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

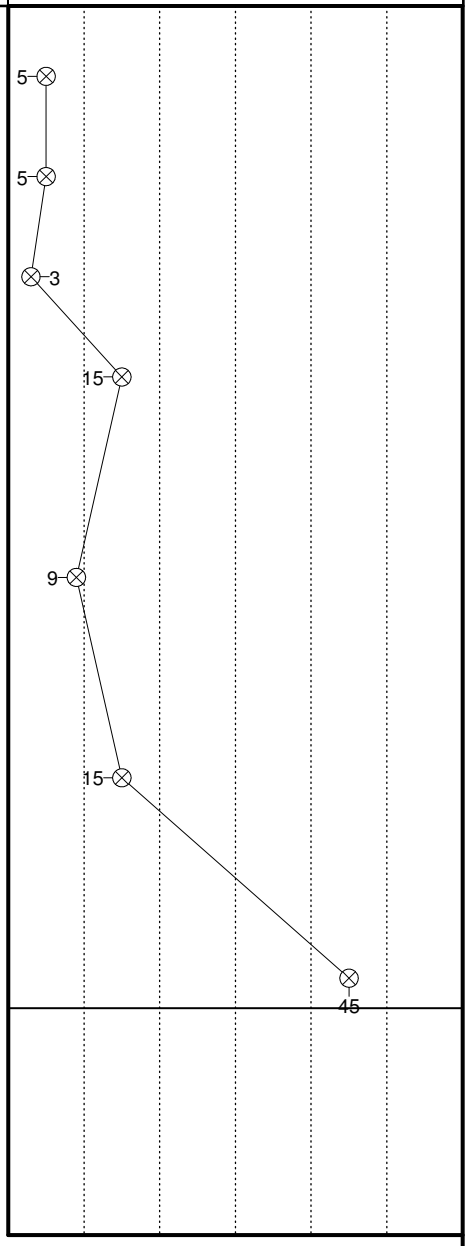
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 522

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					(CL FILL) SANDY CLAY, trace organics, dark brown to reddish brown, firm to soft		520	1 2 3
	S-1	SS	18	18				
	S-2	SS	18	18				2 3 2
5							515	
	S-3	SS	18	2				1 1 2
					(CH RESIDUAL) PLASTIC CLAY, trace organics, orangish gray, stiff			
	S-4	SS	18	18				4 6 9
10							510	
					(SC) CLAYEY SAND, trace organics, orangish gray, moist, loose			
	S-5	SS	18	18				4 4 5
15							505	
					(SM) SILTY SAND, contains slight mica, brown, wet, medium dense			
	S-6	SS	18	18				6 7 8
20							500	
					(SM) SILTY SAND, contains slight mica, grayish tan, wet, very dense			
	S-7	SS	18	16				14 17 28
25					END OF BORING @ 25.0'		495	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 16.0 WS ☐ WD ☒	BORING STARTED 01/11/19	CAVE IN DEPTH 18.0
WL(SHW) WL(ACR) 8.0	BORING COMPLETED 01/11/19	HAMMER TYPE Manual
WL	RIG SIMCO 2400 FOREMAN Cody Presley	DRILLING METHOD 2.25 HSA

CLIENT	Job #:	BORING #	SHEET
Michael Baker Jr. Inc.	08:12831	B-2	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
York County Gravity Sewer Extension - GEO	

SITE LOCATION

Regent Pkwy, Fort Mill, York County, SC

NORTHING	EASTING	STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION (100%)

SURFACE ELEVATION 523

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	ELEVATION (FT)	BLOWS/6"
0						
	S-1	SS	18	4		2 2 2
	S-2	SS	18	16	520	4 5 5
5	S-3	SS	18	18		3 3 3
	S-4	SS	18	18	515	2 1 2
10					510	
	S-5	SS	18	18		2 3 3
15					505	
	S-6	SS	18	9		3 4 5
20					500	
	S-7	SS	18	14		11 19 19
25					495	
30						

Topsoil Thickness [2.00"]

(SM FILL) SILTY SAND, contains slight rock fragments, reddish brown, moist, very loose

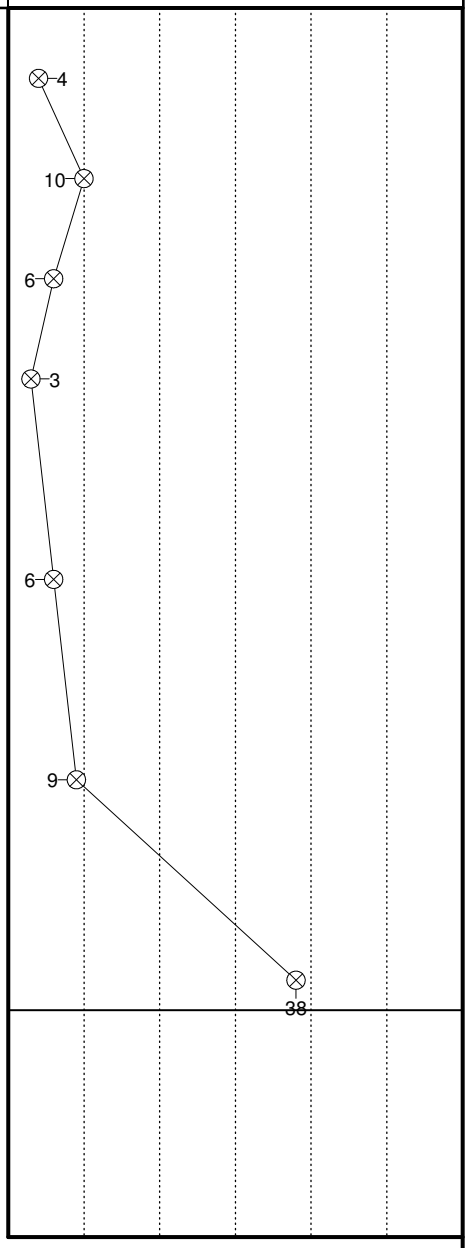
(CL RESIDUAL) SANDY LEAN CLAY, contains slight rock fragments, reddish brown to grayish brown, firm to stiff

(CL) SANDY CLAY, rock fragments, brown to orangish gray, soft to firm

(SC) CLAYEY SAND, orangish gray, wet, loose

(ML) SANDY SILT, contains mica, orangish brown, wet, hard

END OF BORING @ 25.0'



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 11.0 WS ☐ WD ☒	BORING STARTED 01/12/19	CAVE IN DEPTH 21.0
WL(SHW) WL(ACR) 9.4	BORING COMPLETED 01/12/19	HAMMER TYPE Manual
WL	RIG SIMCO 2400 FOREMAN Cody Presley	DRILLING METHOD 2.25 HSA

CLIENT	Job #:	BORING #	SHEET
Michael Baker Jr. Inc.	08:12831	B-3	1 OF 1

PROJECT NAME: York County Gravity Sewer Extension - GEO

ARCHITECT-ENGINEER:

SITE LOCATION: Regent Pkwy, Fort Mill, York County, SC

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

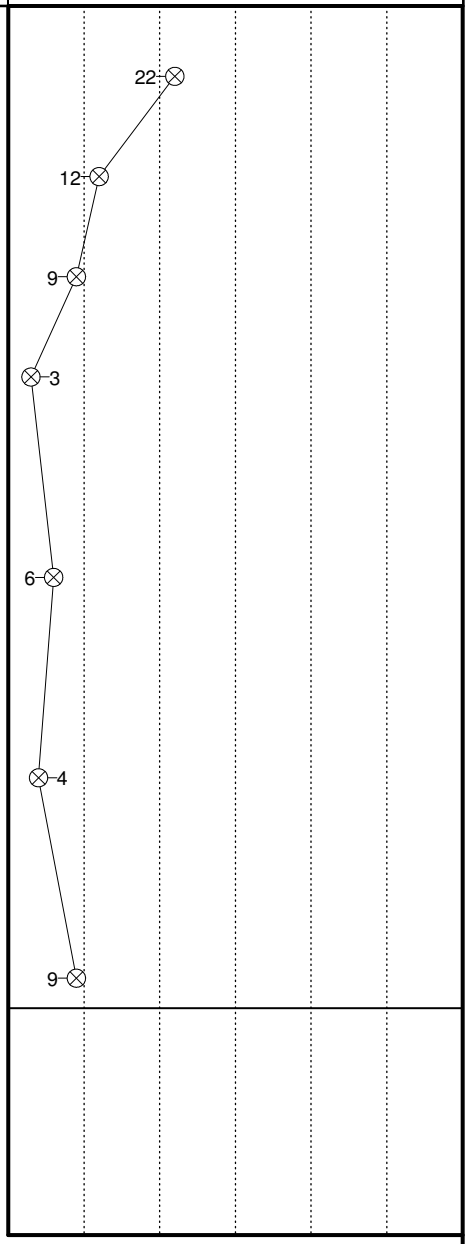
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 530

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0							530	
	S-1	SS	18	18	(CL FILL) SANDY CLAY, trace organics, rock fragments, brown, very stiff			5 10 12
	S-2	SS	18	10	(SM FILL) SILTY SAND, contains asphalt, brownish black, moist, medium dense to loose			5 6 6
5							525	
	S-3	SS	18	16				4 4 5
	S-4	SS	18	18	(CL ALLUVIAL) SANDY CLAY, reddish brown, very soft			2 1 2
10							520	
	S-5	SS	18	18	(CL RESIDUAL) SANDY CLAY, brownish gray, firm			3 3 3
15							515	
	S-6	SS	18	16	(SC) CLAYEY SAND, orangish gray, wet, very loose			2 2 2
20							510	
	S-7	SS	18	18	(SM) SILTY SAND, contains mica, grayish brown, wet, loose			3 3 6
25					END OF BORING @ 25.0'		505	
30							500	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 17.0 WS ☐ WD ☒	BORING STARTED 01/12/19	CAVE IN DEPTH 20.6
WL(SHW) WL(ACR) 17.0	BORING COMPLETED 01/12/19	HAMMER TYPE Manual
WL	RIG SIMCO 2400 FOREMAN Cody Presley	DRILLING METHOD 2.25 HSA

CLIENT	Job #:	BORING #	SHEET
Michael Baker Jr. Inc.	08:12831	B-4	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
York County Gravity Sewer Extension - GEO	

SITE LOCATION: Regent Pkwy, Fort Mill, York County, SC

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

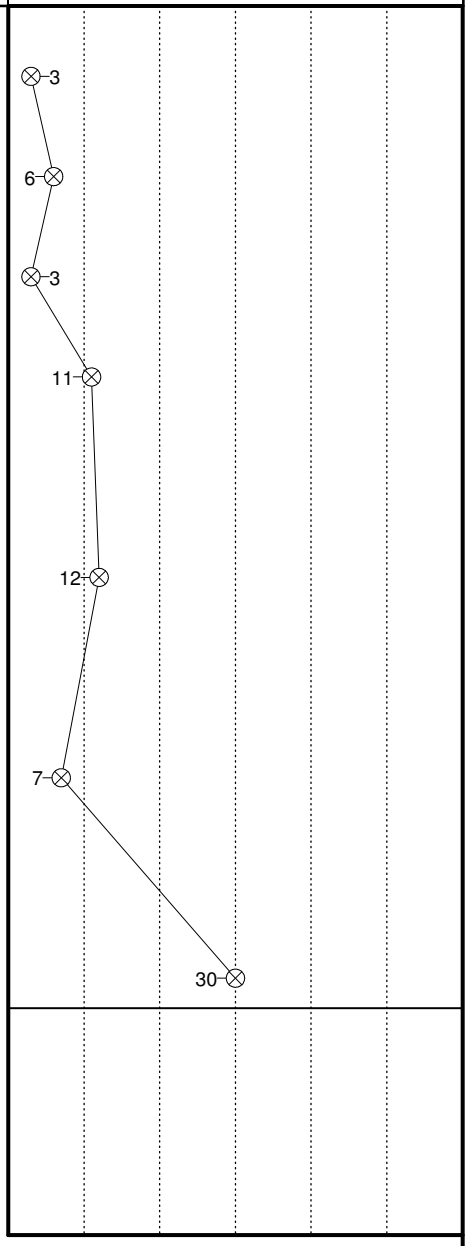
PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 520

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS)	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0							520	
	S-1	SS	18	18	(ML ALLUVIAL) SANDY SILT, trace organics, reddish brown, moist, very soft			1 1 2
	S-2	SS	18	18	(CL) SANDY CLAY, trace organics, reddish brown, firm			2 3 3
5							515	
	S-3	SS	18	18				2 1 2
	S-4	SS	18	18	(CL RESIDUAL) SANDY CLAY, trace organics, reddish brown, very soft to stiff			4 5 6
10							510	
					(MH RESIDUAL) ELASTIC SILT, brown, wet, stiff			
	S-5	SS	18	12				4 6 6
15							505	
					(ML) SANDY SILT, contains mica, tannish gray to brownish gray, wet, medium stiff to very stiff			
	S-6	SS	18	12				2 2 5
20							500	
	S-7	SS	18	14				11 15 15
25					END OF BORING @ 25.0'		495	
30							490	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 17.5 WS ☐ WD ☒	BORING STARTED 01/15/19	CAVE IN DEPTH 19.3
WL(SHW) WL(ACR) 9.1	BORING COMPLETED 01/29/19	HAMMER TYPE Manual
WL	RIG SIMCO 2400 FOREMAN Cody Presley	DRILLING METHOD 2.25 HSA

CLIENT	Job #:	BORING #	SHEET
Michael Baker Jr. Inc.	08:12831	B-5	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
York County Gravity Sewer Extension - GEO	

SITE LOCATION: Regent Pkwy, Fort Mill, York County, SC

NORTHING	EASTING	STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

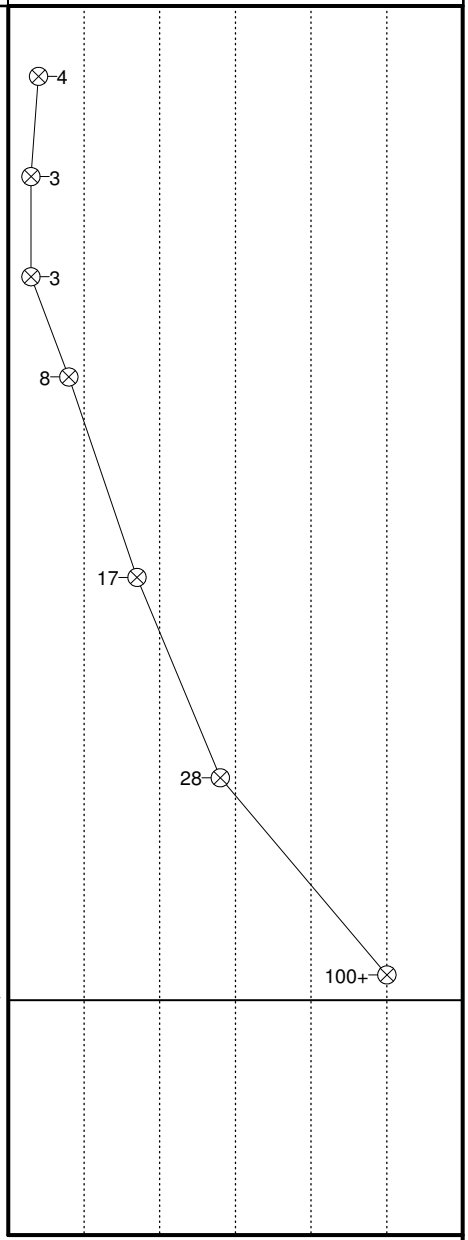
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 520

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Topsoil Thickness [2.50"]		520	
	S-1	SS	18	16	(ML ALLUVIAL) SANDY SILT, trace clay, brown, moist, soft			1 2 2
	S-2	SS	18	18				1 1 2
5							515	
	S-3	SS	18	18	(CL RESIDUAL) SANDY CLAY, dark brown, soft			1 1 2
	S-4	SS	18	18	(ML) SANDY SILT, dark brown to grayish brown, wet, firm to very stiff			4 4 4
10							510	
	S-5	SS	18	12				12 8 9
15							505	
	S-6	SS	18	4	(SM) SILTY SAND, contains rock fragments, tannish brown, wet, medium dense			15 14 14
20							500	
	S-7	SS	16	14	(PWR) PARTIALLY WEATHERED ROCK SAMPLED AS SANDY SILT, contains mica, tannish brown			15 25 50/4
25					END OF BORING @ 24.8'		495	
30							490	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 16.0 WS ☐ WD ☒	BORING STARTED 01/29/19	CAVE IN DEPTH 16.3
WL(SHW) WL(ACR) 11.4	BORING COMPLETED 01/29/19	HAMMER TYPE Manual
WL	RIG SIMCO 2400 FOREMAN Cody Presley	DRILLING METHOD 2.25 HSA

CLIENT	Job #:	BORING #	SHEET
Michael Baker Jr. Inc.	08:12831	B-6	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
York County Gravity Sewer Extension - GEO	

SITE LOCATION: Regent Pkwy, Fort Mill, York County, SC

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 522

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0							
	S-1	SS	18	18		520	1 1 1
	S-2	SS	18	14			1 2 1
5							
	S-3	SS	18	18		515	1 2 1
	S-4	SS	18	18			3 3 5
10						510	
	S-5	SS	18	10			5 5 4
15						505	
	S-6	SS	18	14			3 13 25
20						500	
	S-7	SS	5	5			50/5
25						495	
30							

Topsoil Thickness [2.00"]

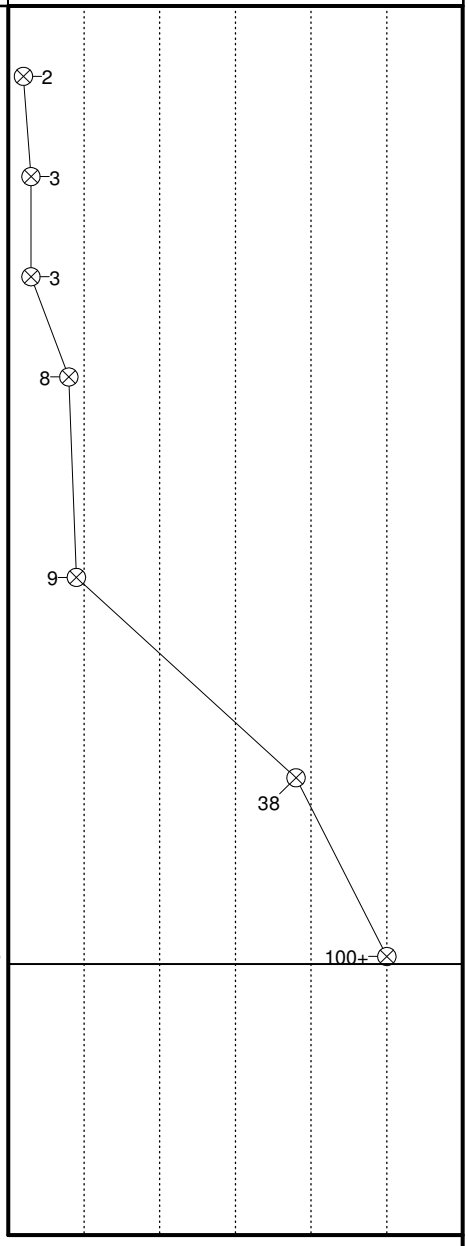
(ML ALLUVIAL) SANDY SILT, brown to reddish brown, moist, very soft to soft

(ML RESIDUAL) SANDY SILT, brown, wet, firm to stiff

(SM) SILTY SAND, tannish brown, wet, dense

(PWR) PARTIALLY WEATHERED ROCK SAMPLED AS SILTY SAND, tannish gray

AUGER REFUSAL @ 23.9'



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 17.0 WS ☐ WD ☒	BORING STARTED 01/29/19	CAVE IN DEPTH 20.4
WL(SHW) WL(ACR) 7.9	BORING COMPLETED 01/29/19	HAMMER TYPE Manual
WL	RIG SIMCO 2400 FOREMAN Cody Presley	DRILLING METHOD 2.25 HSA

CLIENT	Job #:	BORING #	SHEET
Michael Baker Jr. Inc.	08:12831	B-7	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
York County Gravity Sewer Extension - GEO	

SITE LOCATION

Regent Pkwy, Fort Mill, York County, SC

NORTHING	EASTING	STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 524

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Topsoil Thickness [2.00"]			
	S-1	SS	18	18	(ML ALLUVIAL) SANDY SILT, brown, moist, very soft			1 1 1
	S-2	SS	18	16	(ML RESIDUAL) SANDY SILT, brown to light brown, moist, firm to stiff, contains rock fragments		520	2 2 3
5	S-3	SS	18	16				2 2 3
	S-4	SS	18	12			515	3 4 5
10								
	S-5	SS	18	14			510	3 4 4
15								
	S-6	SS	16	13	(PWR) PARTIALLY WEATHERED ROCK SAMPLED AS SILTY SAND, dark gray		505	22 33 50/4
20	S-7	SS	1	1	AUGER REFUSAL @ 22.1'			50/1
							500	
25								
							495	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 17.0 WS ☐ WD ☒	BORING STARTED 01/29/19	CAVE IN DEPTH 19.0
WL(SHW) WL(ACR) 10.2	BORING COMPLETED 01/29/19	HAMMER TYPE Manual
WL	RIG SIMCO 2400 FOREMAN Cody Presley	DRILLING METHOD 2.25 HSA

CLIENT	Job #:	BORING #	SHEET
Michael Baker Jr. Inc.	08:12831	B-9	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
York County Gravity Sewer Extension - GEO	

SITE LOCATION: Regent Pkwy, Fort Mill, York County, SC

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

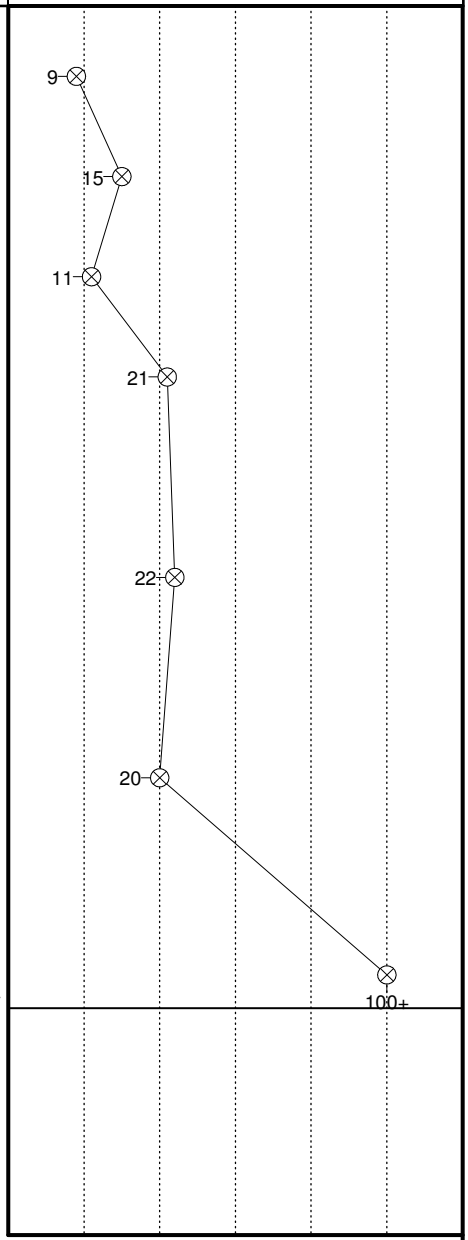
STANDARD PENETRATION BLOWS/FT

BOTTOM OF CASING | LOSS OF CIRCULATION (100%)

SURFACE ELEVATION 522

ENGLISH UNITS

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Topsoil Thickness [2.50"]			
	S-1	SS	18	18	(CL RESIDUAL) SANDY CLAY, contains mica, red, stiff		520	3 4 5
	S-2	SS	18	18	(ML) SANDY SILT, contains mica, grayish reddish to gray brown, moist, stiff			5 6 9
5	S-3	SS	18	18			515	3 5 6
	S-4	SS	18	18	(ML) SANDY SILT, contains mica and rock fragments, grayish black, moist to wet, very stiff			5 9 12
10							510	
	S-5	SS	18	18				6 10 12
15							505	
	S-6	SS	18	18				13 10 10
20							500	
	S-7	SS	16	16	(PWR) PARTIALLY WEATHERED ROCK SAMPLED AS SILTY SAND, contains mica, grayish black			10 26 50/4
25					END OF BORING @ 25.0'		495	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 18.0 WS ☐ WD ☒	BORING STARTED 01/15/19	CAVE IN DEPTH 17.2
WL(SHW) WL(ACR) 12.9	BORING COMPLETED 01/15/19	HAMMER TYPE Manual
WL	RIG SIMCO 2400 FOREMAN Cody Presley	DRILLING METHOD 2.25 HSA

CLIENT	Job #:	BORING #	SHEET
Michael Baker Jr. Inc.	08:12831	B-10	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
York County Gravity Sewer Extension - GEO	

SITE LOCATION: Regent Pkwy, Fort Mill, York County, SC

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

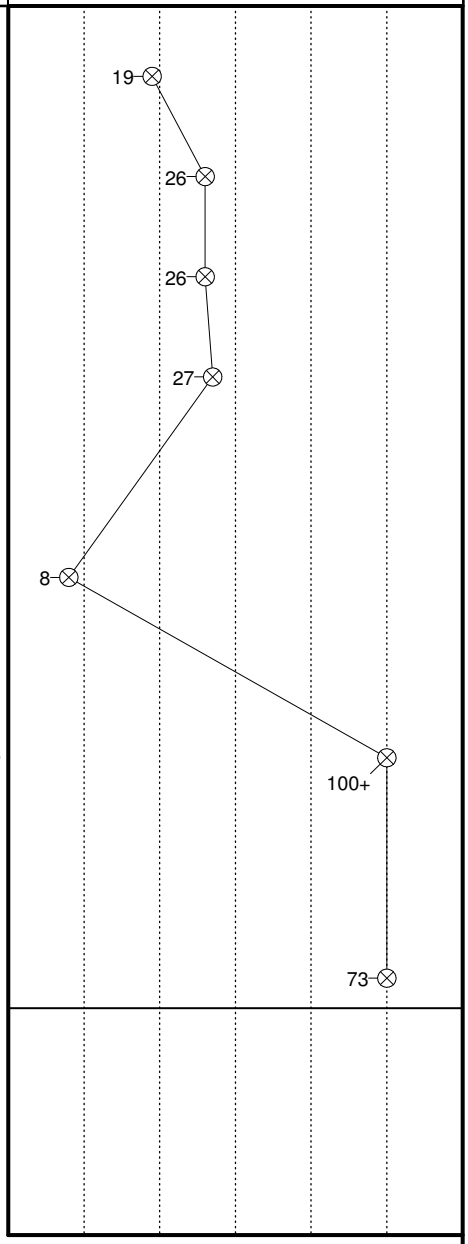
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 532

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Topsoil Thickness [1.00"]			
	S-1	SS	18	18	(MH RESIDUAL) ELASTIC SILT, red to orangish red, moist, very stiff		530	5 9 10
	S-2	SS	18	18				7 10 16
5	S-3	SS	18	18			525	7 10 16
	S-4	SS	18	18	(CL) SANDY CLAY, reddish brown, very stiff			8 11 16
10							520	
	S-5	SS	18	18	(CL) SANDY CLAY, reddish brown, firm			3 4 4
15							515	
	S-6	SS	6	5	(PWR) PARTIALLY WEATHERED ROCK SAMPLED AS SILTY SAND, grayish brown			50/6
20							510	
	S-7	SS	18	16	(SM) SILTY SAND, trace organics, contains mica rock fragments, grayish brown, wet, very dense			29 33 40
25					END OF BORING @ 25.0'		505	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 17.5 WS ☐ WD ☒	BORING STARTED 01/15/19	CAVE IN DEPTH 19.0
WL(SHW) WL(ACR) 16.6	BORING COMPLETED 01/15/19	HAMMER TYPE Manual
WL	RIG SIMCO 2400 FOREMAN Cody Presley	DRILLING METHOD 2.25 HSA

CLIENT	Job #:	BORING #	SHEET
Michael Baker Jr. Inc.	08:12831	B-11	1 OF 1

PROJECT NAME: York County Gravity Sewer Extension - GEO

ARCHITECT-ENGINEER:

SITE LOCATION: Regent Pkwy, Fort Mill, York County, SC

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

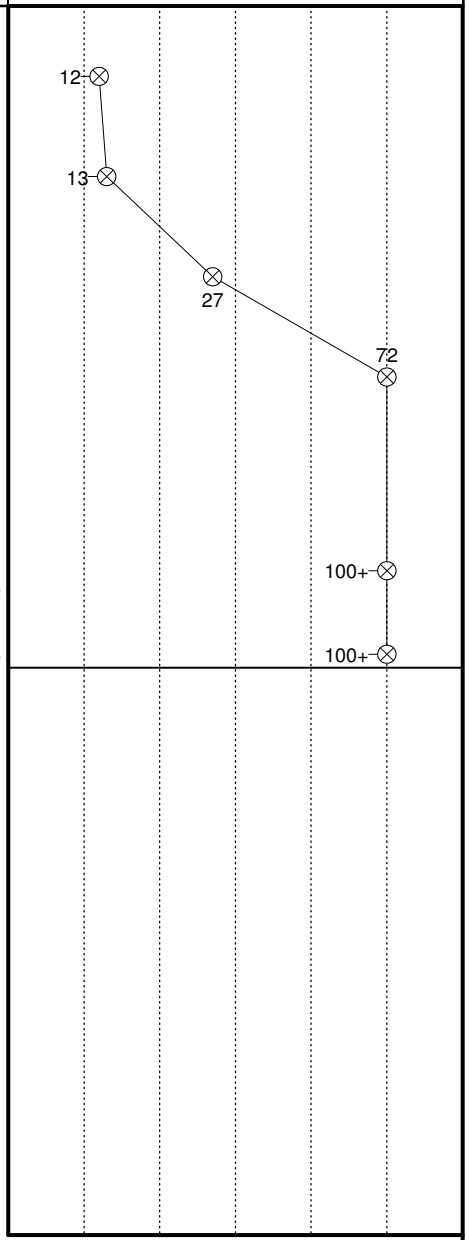
STANDARD PENETRATION BLOWS/FT

ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 537

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Topsoil Thickness [2.50"]			
	S-1	SS	18	18	(MH FILL) ELASTIC SILT, trace organics, contains mica rock fragments, reddish brown, moist, stiff		535	4 6 6
	S-2	SS	18	18	(CH RESIDUAL) PLASTIC CLAY, reddish brown, stiff			4 5 8
5	S-3	SS	18	18	(CL) SANDY CLAY, reddish gray, very stiff		530	5 11 16
	S-4	SS	18	18	(ML) SANDY SILT, grayish brown, moist, very hard			18 28 44
10							525	
	S-5	SS	14	14	(PWR) PARTIALLY WEATHERED ROCK SAMPLED AS SILTY SAND, contains mica, grayish black			18 34 50/2
15	S-6	SS	4	4				50/4
					AUGER REFUSAL @ 16.5'		520	
20							515	
25							510	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL GNE WS ☐ WD ☒	BORING STARTED 01/14/19	CAVE IN DEPTH 12.0
WL(SHW) WL(ACR) GNE	BORING COMPLETED 01/14/19	HAMMER TYPE Manual
WL	RIG SIMCO 2400 FOREMAN Cody Presley	DRILLING METHOD 2.25 HSA

CLIENT	Job #:	BORING #	SHEET
Michael Baker Jr. Inc.	08:12831	B-12	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
York County Gravity Sewer Extension - GEO	

SITE LOCATION: Regent Pkwy, Fort Mill, York County, SC

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

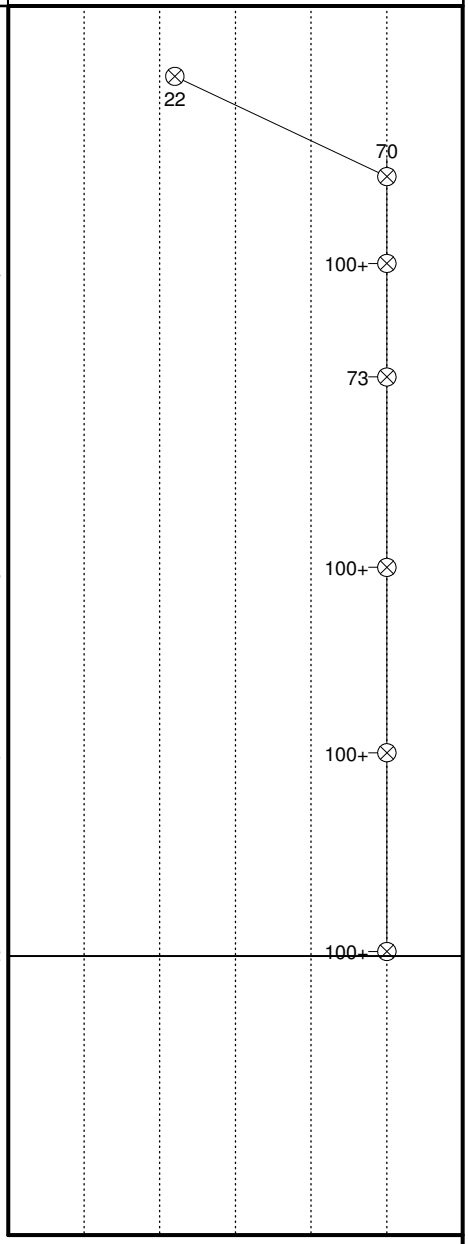
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 540

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					(CL RESIDUAL) SANDY CLAY, contains mica, dark reddish brown, very stiff		540	
	S-1	SS	18	18				6 9 13
					(SM) SILTY SAND, contains mica, tan grayish black, moist, very dense			
	S-2	SS	18	18				14 25 45
5							535	
	S-3	SS	10	10	(PWR) PARTIALLY WEATHERED ROCK SAMPLED AS SILTY SAND, contains mica, grayish black			38 50/4
					(SM) SILTY SAND, contains mica, grayish black, moist, very dense			
	S-4	SS	18	16				31 26 47
10							530	
					(PWR) PARTIALLY WEATHERED ROCK SAMPLED AS SILTY SAND, grayish black			
	S-5	SS	12	12				28 50/6
15							525	
	S-6	SS	3	3				50/3
20							520	
	S-7	SS	2	2				50/2
					AUGER REFUSAL @ 23.7'			
25							515	
30							510	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 21.0 WS ☐ WD ☒	BORING STARTED 01/14/19	CAVE IN DEPTH 15.3
WL(SHW) WL(ACR) 7.5	BORING COMPLETED 01/14/19	HAMMER TYPE Manual
WL	RIG SIMCO 2400 FOREMAN Cody Presley	DRILLING METHOD 2.25 HSA

CLIENT	Job #:	BORING #	SHEET
Michael Baker Jr. Inc.	08:12831	B-13	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
York County Gravity Sewer Extension - GEO	

SITE LOCATION: Regent Pkwy, Fort Mill, York County, SC

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

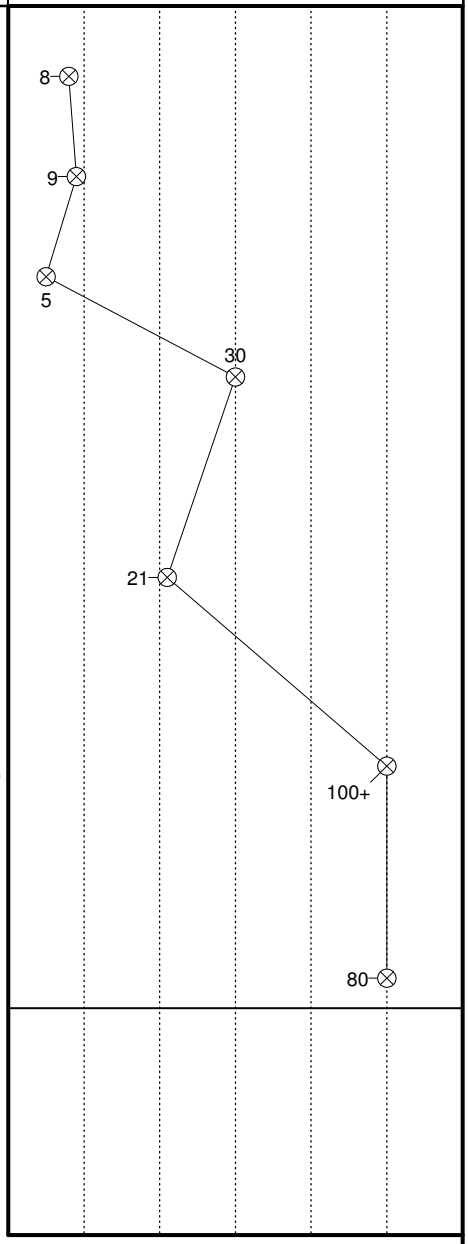
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 534

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					(CL FILL) SANDY CLAY, contains mica, grayish brown, firm to stiff			
	S-1	SS	18	18				2 3 5
	S-2	SS	18	18			530	3 4 5
5								
	S-3	SS	18	16				2 3 2
	S-4	SS	18	18	(CH RESIDUAL) FAT CLAY, grayish orange, very stiff		525	7 13 17
10								
					(CL) SANDY CLAY, contains mica, grayish brown, very stiff			
	S-5	SS	18	18			520	8 10 11
15								
					(PWR) PARTIALLY WEATHERED ROCK SAMPLED AS SILTY SAND, contains mica, grayish black			
	S-6	SS	11	11			515	25 50/5
20								
					(SM) SILTY SAND, contains mica, grayish black, wet, very dense			
	S-7	SS	18	18			510	24 30 50
25					END OF BORING @ 25.0'			
							505	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 18.0 WS ☐ WD ☒	BORING STARTED 01/14/19	CAVE IN DEPTH 19.5
WL(SHW) WL(ACR) 13.3	BORING COMPLETED 01/14/19	HAMMER TYPE Manual
WL	RIG SIMCO 2400 FOREMAN Cody Presley	DRILLING METHOD 2.25 HSA

CLIENT	Job #:	BORING #	SHEET
Michael Baker Jr. Inc.	08:12831	B-14	1 OF 1

PROJECT NAME: York County Gravity Sewer Extension - GEO

ARCHITECT-ENGINEER:

SITE LOCATION: Regent Pkwy, Fort Mill, York County, SC

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

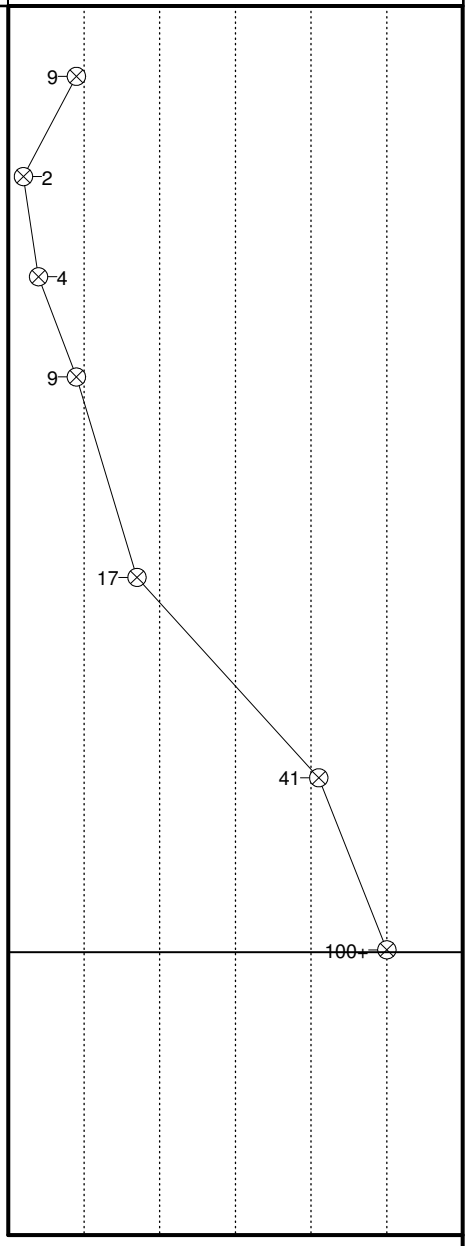
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 535

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					(MH FILL) ELASTIC SILT, contains mica, reddish brown, moist, soft to stiff		535	
	S-1	SS	18	18				3 4 5
	S-2	SS	18	14				1 1 1
5							530	
	S-3	SS	18	10	(CL RESIDUAL) SANDY CLAY, trace organics, contains rock fragments, gray, soft			1 1 3
	S-4	SS	18	18	(CL) SANDY CLAY, grayish red, stiff			3 3 6
10							525	
	S-5	SS	18	14	(SM) SILTY SAND, grayish black, moist to wet, medium dense to dense	▽		6 8 9
15							520	
	S-6	SS	18	18				11 18 23
20							515	
	S-7	SS	1	1	(PWR) PARTIALLY WEATHERED ROCK SAMPLED AS SILTY SAND, grayish black			50/1
					AUGER REFUSAL @ 23.6'			
25							510	
30							505	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

▽ WL 15.0 WS ☐ WD ☒	BORING STARTED 02/14/19	CAVE IN DEPTH 18.4
▽ WL(SHW) ▼ WL(ACR) 16.6	BORING COMPLETED 02/14/19	HAMMER TYPE Manual
▽ WL	RIG SIMCO 2400 FOREMAN Cody Presley	DRILLING METHOD 2.25 HSA

CLIENT	Job #:	BORING #	SHEET
Michael Baker Jr. Inc.	08:12831	B-15	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
York County Gravity Sewer Extension - GEO	

SITE LOCATION: Regent Pkwy, Fort Mill, York County, SC

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 546

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					(CL FILL) SANDY CLAY, trace organics, contains mica rock fragments, reddish brown, stiff		545	4 5 6
	S-1	SS	18	18				11
	S-2	SS	18	16				12 5 6 / 11
5					(CL FILL) trace organics, reddish brown gray, very soft		540	1 1 1
	S-3	SS	18	10				2
	S-4	SS	18	10	(ML RESIDUAL) SANDY SILT, grayish brown, wet, hard		535	13 18 30 / 48
10					(PWR) PARTIALLY WEATHERED ROCK SAMPLED AS SILTY SAND, grayish black			
	S-5	SS	14	14				23 21 50/2 / 100+
15	S-6	SS	2	2	AUGER REFUSAL @ 16.2'		530	50/2 / 100+
20							525	
25							520	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 2.0 WS ☐ WD ☒	BORING STARTED 01/15/19	CAVE IN DEPTH 12.0
WL(SHW) WL(ACR) 3.0	BORING COMPLETED 01/15/19	HAMMER TYPE Manual
WL	RIG SIMCO 2400 FOREMAN Cody Presley	DRILLING METHOD 2.25 HSA

CLIENT	Job #:	BORING #	SHEET
Michael Baker Jr. Inc.	08:12831	B-16	1 OF 1

PROJECT NAME: York County Gravity Sewer Extension - GEO

ARCHITECT-ENGINEER:

SITE LOCATION: Regent Pkwy, Fort Mill, York County, SC

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 554

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	18		3 4 4
	S-2	SS	18	18	550	2 5 7
5	S-3	SS	18	18		8 8 12
	S-4	SS	3	3	545	50/3
10					540	
15					535	
20					530	
25					525	
30						

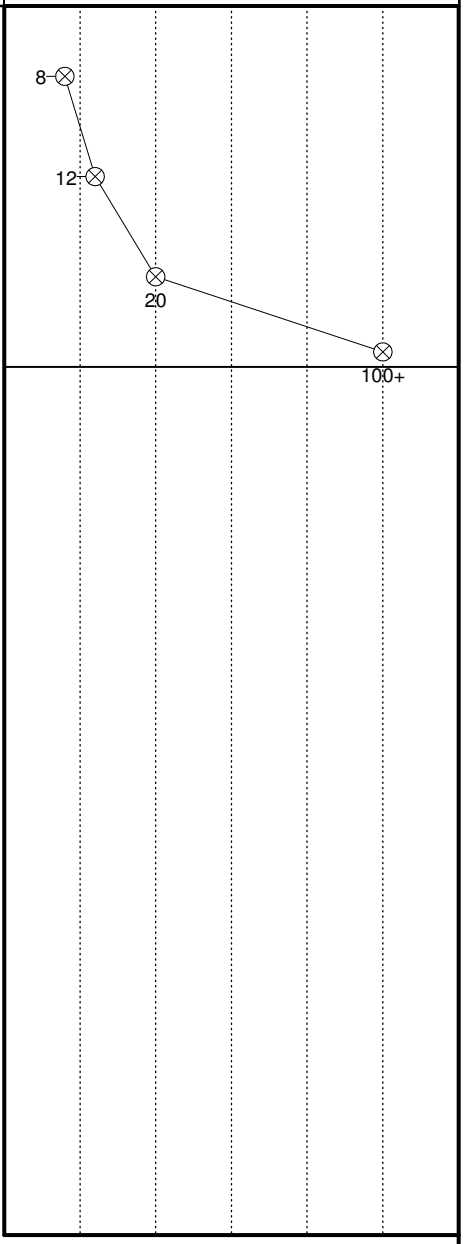
(CL FILL) SANDY CLAY, contains mica, reddish brown, firm

(ML RESIDUAL) SANDY SILT, reddish gray, moist, stiff

(SM) SILTY SAND, contains mica, grayish black, moist, medium dense

(PWR) PARTIALLY WEATHERED ROCK SAMPLED AS SILTY SAND, rock fragments, grayish black

AUGER REFUSAL @ 9.0'



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL GNE WS ☐ WD ☒	BORING STARTED 01/15/19	CAVE IN DEPTH 6.7
WL(SHW) WL(ACR) GNE	BORING COMPLETED 01/15/19	HAMMER TYPE Manual
WL	RIG SIMCO 2400 FOREMAN Cody Presley	DRILLING METHOD 2.25 HSA

CLIENT	Job #:	BORING #	SHEET
Michael Baker Jr. Inc.	08:12831	B-17	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
York County Gravity Sewer Extension - GEO	

SITE LOCATION: Regent Pkwy, Fort Mill, York County, SC

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

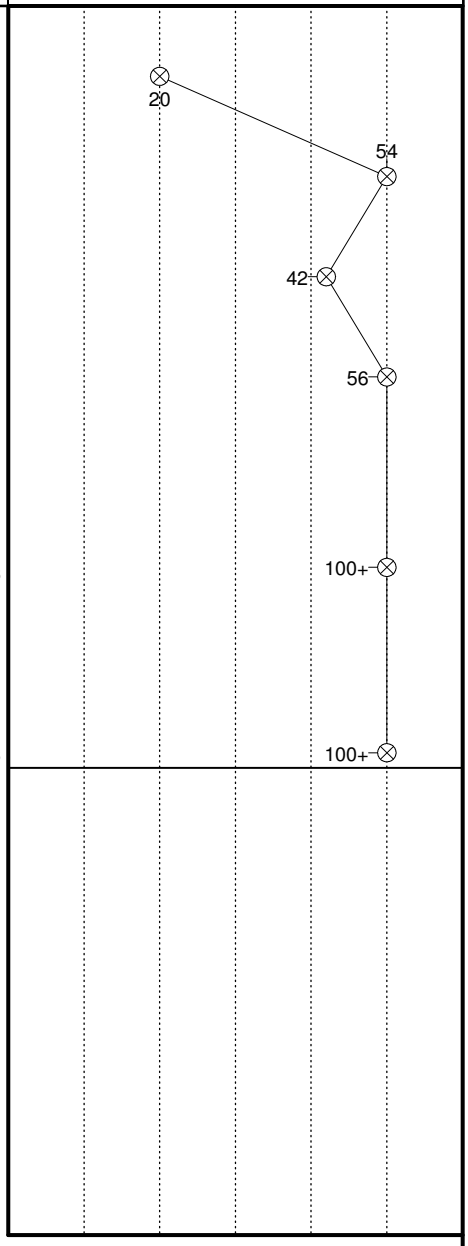
STANDARD PENETRATION BLOWS/FT

BOTTOM OF CASING | LOSS OF CIRCULATION 100%

SURFACE ELEVATION 555

ENGLISH UNITS

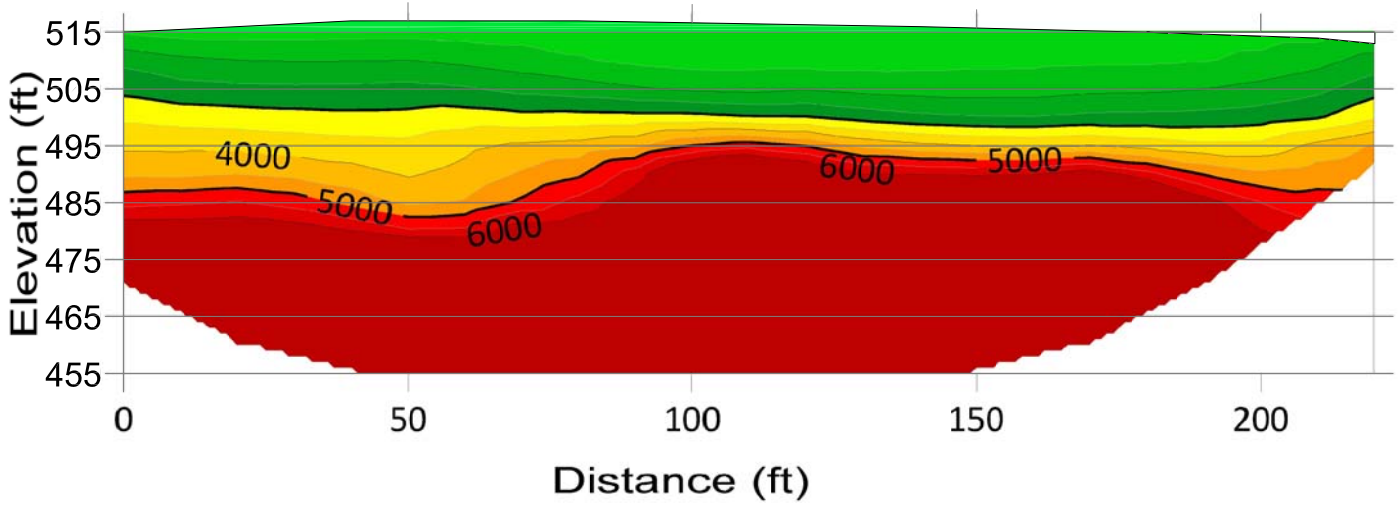
DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					(CL RESIDUAL) SANDY CLAY, reddish brown, very stiff		555	
	S-1	SS	18	18				5 8 12
					(ML) SANDY SILT, contains mica, grayish brown, moist, very hard to hard			
	S-2	SS	18	18				17 23 31
5							550	
	S-3	SS	18	18				11 16 26
					(SM) SILTY SAND, contains mica, grayish black, moist, very dense			
	S-4	SS	18	18				17 18 38
10							545	
					(PWR) PARTIALLY WEATHERED ROCK SAMPLED AS SILTY SAND, grayish black			
	S-5	SS	12	12				44 50/6
15							540	
	S-6	SS	3	3				50/3
					AUGER REFUSAL @ 19.0'			
20							535	
25							530	
30							525	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

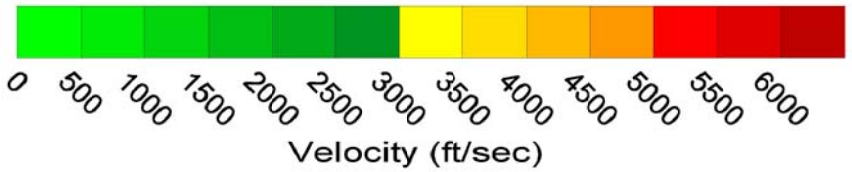
WL GNE WS ☐ WD ☒	BORING STARTED 01/14/19	CAVE IN DEPTH 14.7
WL(SHW) WL(ACR) GNE	BORING COMPLETED 01/14/19	HAMMER TYPE Manual
WL	RIG SIMCO 2400 FOREMAN Cody Presley	DRILLING METHOD 2.25 HSA

Line 1

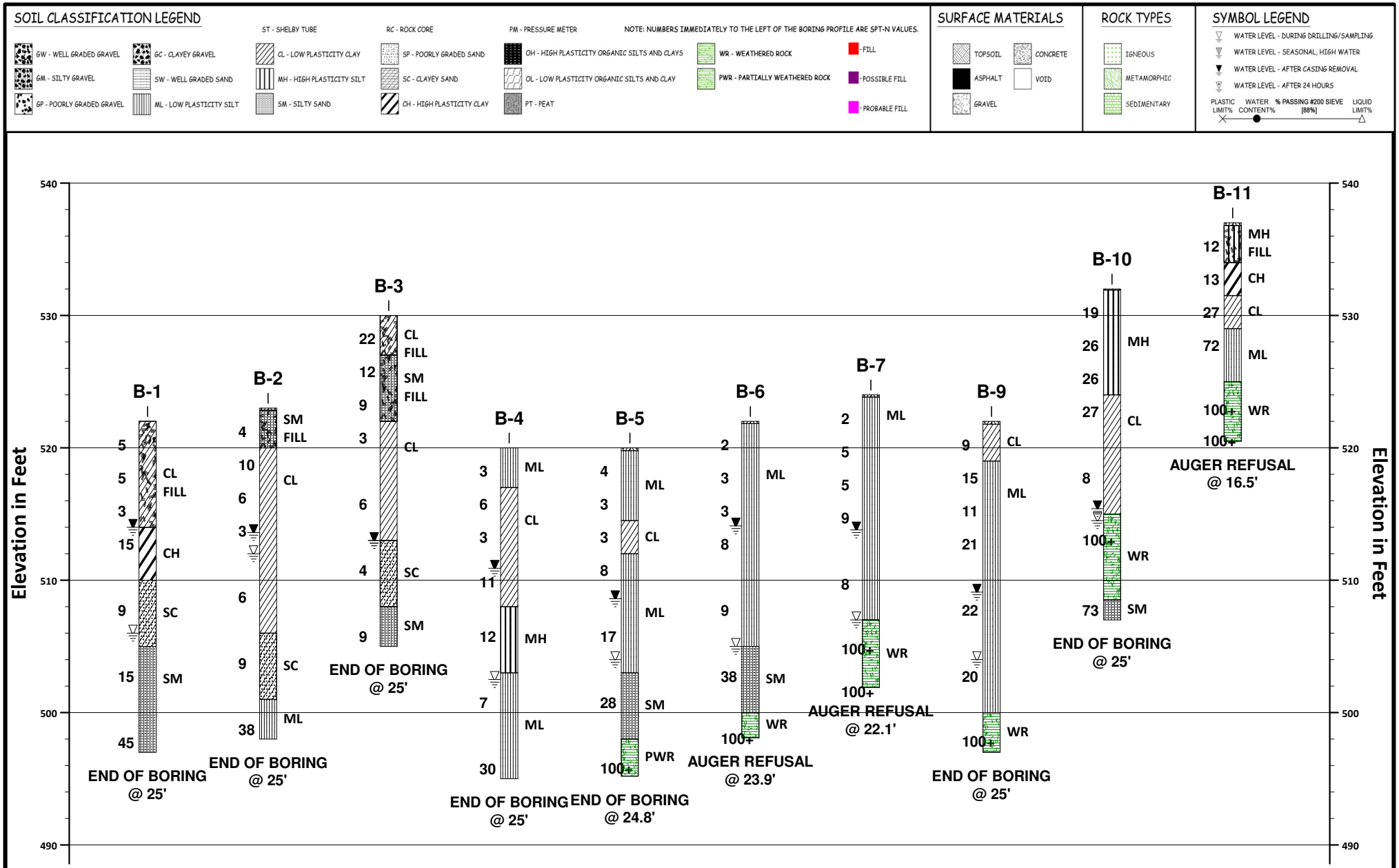


LEGEND

- Soil / Rippable
- Weathered Rock / Rippable
- Marginally Rippable Weathered Rock or Intermediate Geomaterials
- Bedrock / Non-Rippable



Project No.: 08-12831 Date: 01/18/2019 Scale: NTS Line 1	**York County Gravity Sewer Extension** **Fort Mill, South Carolina**	ECS	**Seismic Refraction** **P-Wave Velocity Profile** Michael Baker International, Inc.	Notes Data Acquisition: -10 Hertz Geophones -20 Foot Spacing -Acquisition Time = 0.128 Seconds -Sample Interval = 0.125 Milliseconds

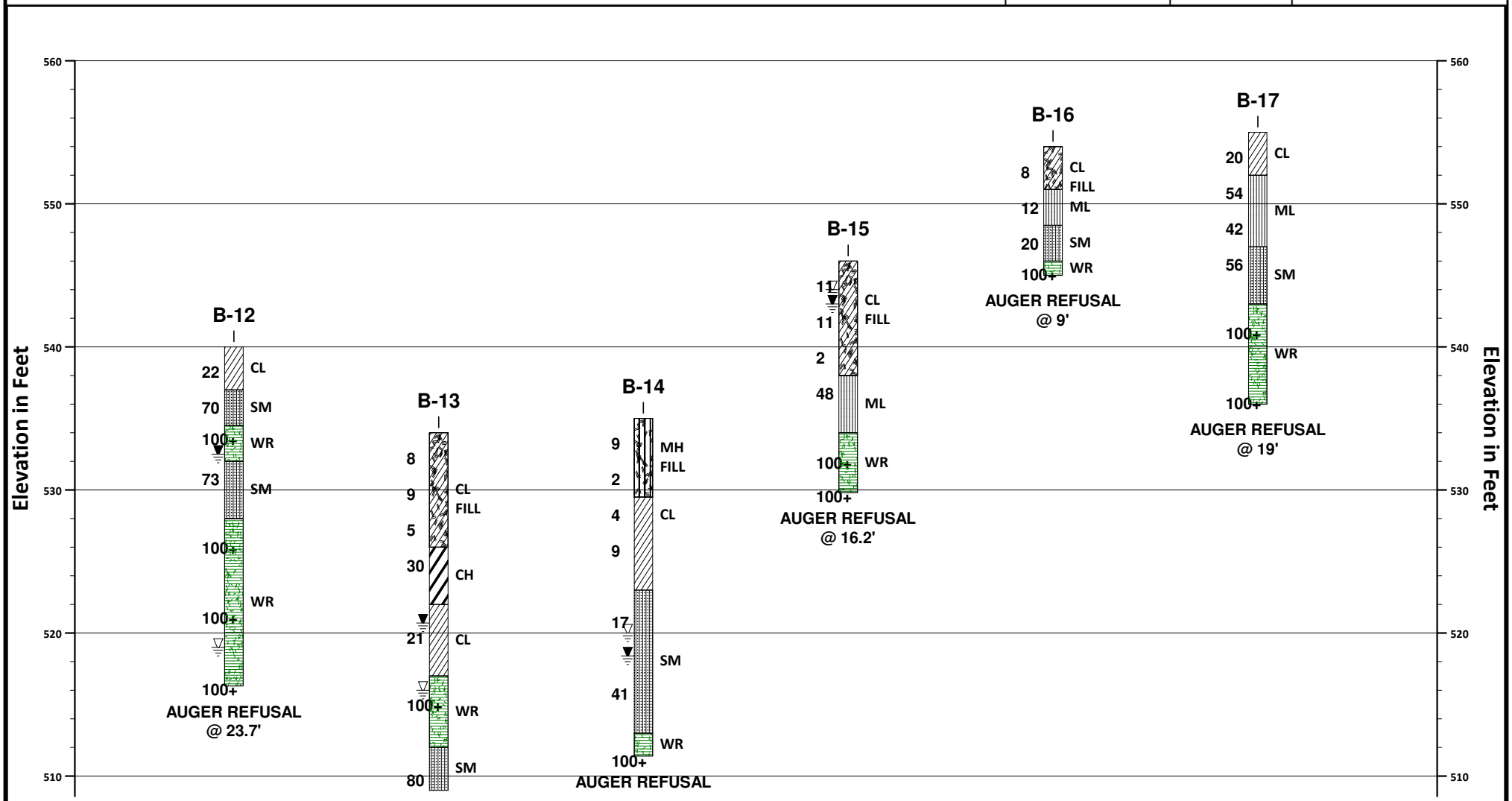


NOTES:
1 SEE INDIVIDUAL BORING LOG AND GEOTECHNICAL REPORT FOR ADDITIONAL INFORMATION.
2 PENETRATION TEST RESISTANCE IN BLOWS PER FOOT (ASTM D1586).

Subsurface Soil Profile

York County Gravity Sewer Extension - GEO
Michael Baker Jr. Inc.
Regent Pkwy, Fort Mill, York County, SC

PROJECT NO.12831 | DATE: 2/28/2019 | VERTICAL SCALE: 1"=10'



NOTES:
1 SEE INDIVIDUAL BORING LOG AND GEOTECHNICAL REPORT FOR ADDITIONAL INFORMATION.
2 PENETRATION TEST RESISTANCE IN BLOWS PER FOOT (ASTM D1586).

Subsurface Soil Profile

York County Gravity Sewer Extension - GEO
Michael Baker Jr. Inc.
Regent Pkwy, Fort Mill, York County, SC

PROJECT NO.12831 | DATE: 2/28/2019 | VERTICAL SCALE: 1"=10'

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one - not even you* - should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from alight industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes - even minor ones - and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ-sometimes significantly from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the express purpose of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in-this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely on Your ASFE-Member Geotechnical Engineer For Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone:' 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

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