NOTICE TO CONTRACTOR:
INTERIM GEOTECHNICAL STUDY FOR THE REPLACEMENT OF THE BOWERS STREET CULVERT AT AN UNNAMED TRIBUTARY TO STEELE BROOK:
March 31, 2016

Mr. Roy Cavanaugh, P.E.
Director of Public Works
Town of Watertown
Deport Square Business Center
51 Depot Street; Suite 110
Watertown, Connecticut 06795

Re: Interim Geotechnical Study for the Replacement of the Bowers Street Culvert at an
Unnamed Watercourse, Watertown, CT

Dear Mr. Cavanaugh

1.0 Herewith are the boring data pertaining to the subject culvert replacement project. One boring
(BS-11) was drilled at the north side of the culvert to auger refusal at a depth of 8.5 feet. The boring

was drilled by Clarence Welti Associates, Inc. and sampling was conducted by this firm solely to
obtain indications of subsurface conditions as part of a geotechnical exploration program. No
services were performed by Dr. Clarence Welti, P.E., P.C. to evaluate subsurface environmental
conditions.

1.1 Based on the proposed structure type and the shallow refusal depth on apparent bedrock at BS-
11, it is recommended that at least two supplemental borings be drilled at the culvert to better define
the soil/ rock profile within the new structure limits. The borings should be cored at least 5 feet into
the bedrock to evaluate the rock characteristics and estimate appropriate design and construction
parameters.

2.0 The Subject Project will include the replacement of the existing culvert on Bower Street. The
existing crossing apparently is a pipe culvert. The proposed new structure will be a precast, three-
sided culvert with an opening of 8'-6" by 5'-9". The engineer proposes to use precast footings, wing
walls and head walls.

3.0 The Geologic Origin of the natural inorganic soils is from shallow glacial lake deposits atop the
bedrock. These deposits consist generally of sand with little to some silt and gravel. The bedrock,
based on USGS geologic mapping, is Collonsville Formation of Schist, Amphibolite and Gneiss with
a dip of about 50 degrees to the north.
3.1 The **Soil/ Rock Cross Section** from boring BS-11 is generally as follows:

- Asphalt to 3"
- Fine to coarse SAND, little Silt and Gravel to 6.5 feet, loose to medium compact
- Fine to medium SAND, some silt to 7 feet, medium compact
- Weathered Rock to auger refusal on harder bedrock at 8.5 feet, very dense

*Note: there will be existing fills associated with the roadway pavement section and backfill at the culvert.*

3.2 The **Water Table** was evident at 6.5 feet below the road grade on completion of boring. It can be assumed that the groundwater levels at the culvert will be close to the level in the water course. The design flood elevations and scour depths were not available for this study. *The natural soils may be susceptible to remolding under equipment when wet.*

3.3 The **Estimated Properties of the Soils** are as follows:

<table>
<thead>
<tr>
<th>Natural Deposits*</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Weight:</td>
<td>125 pcf</td>
</tr>
<tr>
<td>Submerged Unit Weight:</td>
<td>65 pcf</td>
</tr>
<tr>
<td>Angle of Internal Friction: *</td>
<td>32°</td>
</tr>
<tr>
<td>Cohesion:</td>
<td>0 psf</td>
</tr>
</tbody>
</table>

* estimated from the SPT data

4.0 This study pertains to defining the geotechnical design parameters for the proposed culvert and foundations. The culvert and foundations will be designed in accordance with the AASHTO Load and Resistance Design method (LRFD) and with U.S. Customary Units.

4.1 The **Criteria for Foundation Type and Loading** are as follows:

1. The maximum total settlement shall not exceed 1” and the maximum differential settlement shall not exceed ½ the maximum settlement.

2. Regarding Seismic Assessments, the three sided culvert and retaining walls are exempt from detailed seismic analyses by AASHTO and ConnDOT specifications.

*The above criteria are generally applied to short span bridges and retaining walls similar in character to the subject structure. If the owner, the architect, the engineers find the criteria as unacceptable, the writer shall be informed to permit additional geotechnical input.*
4.2 Regarding Seismic Loading, the new structure will be exempt from a detailed seismic analysis according to the CT DOT and AASHTO Bridge design specifications. The CT DOT requires that bridge designs must satisfy specific criteria for horizontal restraint force and support length. The seismic site soil profile classification is “C”. This is based largely on the apparent shallow depth to bedrock. The mapped MCE spectral response acceleration values for Watertown, CT are $S_1 = 0.065$ for one second period and $S_s = 0.252$ for short period. The nominal (ultimate) friction factor for precast concrete on the crushed stone layer can be 0.60.

5.0 The Foundation Type for the new culvert, end walls and retaining walls can be with spread footings. The footing subgrades shall be on the natural inorganic sand deposits below any existing fills (assumed present as culvert backfill), or on the weathered or harder bedrock. The preliminary design plans from Ecodesign, LLC indicate the bottom of foundations at Elev.514±, which is about 9 feet below the existing road surface. From boring BS-11, it has been tentatively concluded that the subgrades for the culvert will fall predominantly on the bedrock. Dependent on the final soil/rock profile determined from supplemental test borings, it is possible that some subgrades might fall on the natural soils. It is recommended that there be a minimum 8" layer of 3/8" crushed stones beneath footings. The crushed stone layer can serve as a leveling course over an irregular rock surface and a medium to pump from during construction. The crushed stone layer could be placed on the accepted subgrades with some water present (up to 2”). The stone should extend at least 2 feet horizontally beyond the footings.

5.1 Regarding the establishment of a nominal bearing resistance on the crushed stone layer over hard bedrock, the final design resistance would be based on the rock parameters determined from rock cores, plus the AASHTO analysis method by Carter and Kulhawy. In absence of the actual rock parameters, the presumptive nominal bearing resistance can be 800 psi (115 ksf). The AASHTO LRFD resistance factor is $\phi_R = 0.45$. Thus, the tentative geotechnical factored bearing resistance at the Strength Limit State can be 50 ksf. This value on the rock will likely be substantially higher than required by the final factored design loads. The settlement at Service Limit State for the foundations on the rock will be less than the design criteria.

5.2 Regarding the establishment of an ultimate bearing capacity if footings fall on the natural sand, the ultimate loading is based on the internal friction angle, which is related to the soil density and overburden weight. Based on the sample blow counts in the natural soils, the angle of internal friction is at least 32°, which indicates nominal bearing resistance equal to at least 28,000 psf. The AASHTO LRFD resistance factor based on Meyerhoff method and friction angle estimated from SPT data can be $\phi_R = 0.55$. This indicates the geotechnical factored bearing resistance on the natural sand at the Strength Limit State is about 15,400 psf. This value is probably much higher than the actual factored design loads beneath the footings. The Service Limit State will probably govern the foundation design based on the estimated minimum stiffness modulus of 500 Tons/sf. The tentative

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$^1$Carter and Kulhawry 1988; nominal (ultimate) bearing capacity of foundation on rock is given by the equation: 

$q_{nom} = [ s^{0.5} + (m*s^{0.5} + s)^{0.5} ] * q_{ult}$
design bearing resistance on the natural sand at the Service Limit State is 4 ksf to maintain settlements within the design criteria.

5.3 Regarding construction dewatering, the requirements cannot be clearly defined without a topographic survey and hydraulic information for the water course. It is possible that some type of cofferdams may be needed for the footing excavations, which would presumably fall several feet below the water level. The apparent shallow bedrock conditions can facilitate pumping the water, but might also complicate cofferdam installations. The dewatering requirements for similar projects with high bedrock have at times been mitigated by brook diversions, by-passes and pumping from sumps. The crushed stone underlay can facilitate pumping. Cofferdams and dewatering are contractor provided items that must be designed by a Connecticut licensed professional engineer. The crushed stone underlay may allow for the presence of a few inches of still water on the rock subgrades as noted in section 5.0 above.

5.4 The Lateral Soil Loading on precast buried structures should be based on at-rest pressure. The at-rest pressure coefficient is $K_0 = 0.45$ (to be multiplied by the unit weight of the backfill). The design of free standing retaining walls can be based on normal active earth pressure using the active coefficient $K_A = 0.28$ for level backfill condition. LRFD design usually includes a lateral surcharge pressure on the culvert side walls and retaining walls to represent the effect of live load. The nominal (ultimate) sliding factor ($\tan \delta$) for concrete cast on the crushed stone can be 0.60. The LRFD resistance factor for sliding of precast concrete on crushed stone can be $\phi_r = 0.90$. The backfill material (section 6.0) shall extend horizontally behind the retaining walls for a distance equal to at least the height of the backfill, measured from the bottom of footing to the finished grade.

5.5 The recommended Frost Protection Depth for civil structures in Connecticut is 4.0 feet below finished grades.

5.6 The Foundation Design Parameters are summarized as follows:

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>LRFD FACTORED DESIGN RESISTANCE</th>
<th>LRFD NOMINAL (ULTIMATE) RESISTANCE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spread Footings on crushed stone over bedrock at Strength Limit State</td>
<td>50 ksf</td>
<td>115 ksf</td>
<td>Resistance Factor $\phi_r = 0.45$</td>
</tr>
<tr>
<td>Spread Footings on crushed stone over natural sand at Strength Limit State</td>
<td>15.4 ksf</td>
<td>28 ksf</td>
<td>Resistance Factor $\phi_r = 0.55$</td>
</tr>
<tr>
<td>Service Load for crushed stone on natural sand</td>
<td>4 ksf</td>
<td>-</td>
<td>Typical Value when Compacted to 95% MOD</td>
</tr>
<tr>
<td>Backfill Unit Weight</td>
<td>125 pcf</td>
<td>-</td>
<td>Typical Value when Compacted to 95% MOD</td>
</tr>
</tbody>
</table>
### Angle of Internal Friction $\varphi$, Backfill

<table>
<thead>
<tr>
<th></th>
<th>$34^\circ$</th>
<th>-</th>
<th>Typical Value when Compacted to 95% MOD</th>
</tr>
</thead>
</table>

### At-Rest Pressure Coefficient

|                          | 0.45 | - |

### Active Pressure Coefficient (level backfill)

|                          | 0.28 | - | Compacted Pervious backfill |

### Interface Friction Angle

| Backfill to Concrete     | $21^\circ$ | $30^\circ$ |

### Nominal; Sliding Factor, precast concrete on crushed stone

|                          | 0.60 | 0.60 | $\varphi_s = 0.90$ |

### Seismic Site Soil Profile Classification

|                          | C | - | AASHTO/IBC Value |

### Mapped MCE Seismic Spectral Response Acceleration for One Second Period, $S_1$

|                          | 0.065 | - | AASHTO/IBC Value |

### Mapped MCE Seismic Spectral Response Acceleration for Short Period, $S_S$

|                          | 0.252 | - | AASHTO/IBC Value |

### Frost Protection Depth for Spread Footings

|                          | 4.0 feet | CT DOT Value |

* The cited values are based on material conforming to Section 6.0 below

### 6.0 The Backfill for culverts, abutments and retaining walls is assumed to be free draining material conforming to CTDOT Form 816, section M.02.06, Grading B. All backfill shall be compacted to at least 95% of modified optimum density in accordance with ASTM D-1557. This material will have a unit weight of 125 pcf, a submerged unit weight of 66 pcf and an internal friction angle of $34^\circ$.

### 7.0 Regarding Earthwork, the excavations will be in soils classified as OSHA Type C, which will require sloping of unshored excavations exceeding 5 feet in height, to slopes less than $34^\circ$ from the horizontal (1.5H:1V).

### 7.1 Long Term Slopes in earth cuts and fills shall be 2:1, or flatter. Slopes along the channel may require cladding for erosion protection. The cladding would be designed based on the channel hydraulics.
8.0 This report has been prepared for specific application to the subject bridge in accordance with generally accepted soil and foundation engineering practices. This study addresses the geotechnical requirements for the bridge foundations, only. No other warranty, express or implied, is made. In the event that any changes in the nature, design and location of structures are planned, the conclusions and recommendations contained in this report should not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing.

The analyzes and recommendations submitted in this report are based in part upon data obtained from referenced explorations. The extent of variations between explorations may not become evident until construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations of this report.

Dr. Clarence Welti, P.E., P.C., shall perform a general review of the final design and specifications in order that geotechnical design recommendations may be properly interpreted and implemented as they were intended. The existing topography, the bridge type and potential scour depths have not been determined. This report will require supplemental input to address specific areas of concern, when the information is available. Special conditions may only be apparent when the above information is available for review by the writer.

If you have any questions please call me.

Very truly yours,

John J. Bear, P.E.                       Clarence Welti Ph.D., P. E.
                                      President, Dr. Clarence Welti P.E., P.C.
APPENDIX

BORING LOCATION PLAN
+
BORING LOGS
<table>
<thead>
<tr>
<th>DEPTH</th>
<th>SAMPLE NO.</th>
<th>BLOWS/6&quot;</th>
<th>DEPTH</th>
<th>STRATUM DESCRIPTION + REMARKS</th>
<th>ELEV.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>ASPHALT</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>BR. FINE-CRS. SAND, LITTLE SILT &amp; GRAVEL</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>3-2-5-30</td>
<td>5.0'-7.0'</td>
<td>BR. FINE-MED. SAND, SOME SILT</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>WEATHERED ROCK</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>AUGER REFUSAL @ 8.5'</td>
<td>8.5</td>
</tr>
</tbody>
</table>

**LEGEND: COL. A:**

- D=DRY
- A=AUGER
- C=CORE
- U=UNDISTURBED PISTON
- S=_SPLIT SPOON

**SAMPLE TYPE:** TRACI=0-10% LITTLE=10-20% SOME=20-35% AND=35-50%

**PROPORTIONS USED:**

**DRILLER:** J. BREWER

**INSPECTOR:**

**NTC-GEOTECHNICAL INFORMATION**

**CLIENT:** TOWN OF WATERTOWN

**PROJECT NAME:** CULVERT REPLACEMENT

**LOCATION:** BOWERS STREET, WATERTOWN, CT

**HOLE NO.:** BS-11

**DATE:** 8/23/13
ITEM #0204A - HANDLING WATER

Description:

This work shall consist of the construction of such cofferdams, flow diversion dams, barriers or other such protective facilities and methods as are necessary for the conduction of water beyond the limits of construction; the dewatering of the site on which work is to be constructed; and the removal of all such temporary structures and facilities upon the completion of the permanent work or as required. The handling of water shall be in accordance with the requirements of Section 1.10 and the Inland Wetlands and Watercourses Permit. For the purposes of this specification, such work shall be understood to mean any temporary type of protective facility which the Contractor elects to build or use to satisfy, and which does satisfy, the condition that the work be built in the dry. The handling of flood flows, the protection of any or all of the finished construction during high water, and maintaining the operation of the existing structure until it is abandoned are included in the scope of the work under this item.

Construction Methods:

The Contractor shall investigate and verify existing stream conditions, and evaluate the need for, and the type of protection and facilities required. The suggested method of controlling water during construction consist of a temporary by-pass pipe and temporary flow diversion dams as shown on the plans. The Contractor shall submit his plans and methods for handling water for review and approval in accordance with the requirements of Section 1.10 of the Standard Specifications. The furnishing of such plans and methods shall not serve to relieve the Contractor of any part of his responsibilities for the safety or the successful completion of this work.

The minimum height of any cofferdams, flow diversion dams and barriers shall be in accordance with the information shown on the plans and sizes of pumps shall be as designed by the Contractor to provide reasonable protection from flooding. All such temporary structures or facilities shall be safely designed, extended to sufficient depth and be of such dimensions and water-tightness to assure construction of the permanent work in the dry. They shall not interfere with proper performance of the work. Their construction shall be such as to permit excavation for the permanent work to the limits shown on the plans. Interior dimensions shall give sufficient clearance for construction. Movements or failures of the temporary protection facilities, or any portions thereof, which prevent proper completion of the permanent work, shall be corrected at the sole expense of the Contractor.

Any pumped water must be discharged in accordance with the requirements of Section 1.10 of the Standard Specifications.

Unless otherwise provided, or directed, all such temporary protective work shall be removed and disposed of in an approved manner when no longer required.
The Contractor will be responsible for the scheduling of work so as not to interfere with any sequence of operations developed for this project. Delays as a result of work required under this item will not constitute a claim for an extension of contract time.

In addition to the requirements set forth in these specifications, this work shall conform to the applicable requirements described in the Inland Wetlands and Watercourses Permit. A copy of the approved permit is included elsewhere in this contract.

**Method of Measurement:**

This item, being paid for on a lump sum basis, will not be measured for payment.

**Basis of Payment:**

This work will be paid for at the contract lump sum price for “Handling Water” completed and accepted, which price shall include all materials, tools, equipment, labor and work incidental to the construction; reconstruction if required; dewatering, including pumping; handling the stream flow during construction; the removal and disposal of all protective works or facilities; disposal of water removed from the construction area; damages incurred by the Contractor; and any damages to existing facilities and to the work in progress, materials or equipment from flows or high stages of the stream.

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handling Water</td>
<td>L.S.</td>
</tr>
</tbody>
</table>
ITEM #0213A - GRAVEL STREAMBED MATERIAL

Description:

Gravel Streambed Material shall consist of a well-graded, heterogeneous mixture of material placed within watercourse channel and culvert walls and wing-walls to simulate natural streambed material. Work under this item shall consist of excavating existing channel bottom material in areas where the channel bottom is to be re-graded or disturbed to create a work area for a culvert placement and cofferdam installation. This item shall also include stockpiling and protecting the excavated material on the project site, subsequent placement of the stockpiled material in the channel, removal and proper disposal off-site of all unused material.

Materials:

The material for this item shall consist of the existing naturally formed cobbles, gravel, soils and clean natural sediment from within the channel.

If an insufficient quantity of material is available from the existing channel bottom at this site, the Contractor shall furnish supplemental material meeting the approval of the Engineer from other sources within the project limits, or from another approved source. A minimum notice of 2 weeks must be given to the Engineer for inspection and approval.

The gradations shall consist of a well-graded, heterogeneous mixtures containing a wide range of sizes falling within the gradation ranges of natural streambed material in the immediate vicinity of the crossing. The stone shall consist of sound and tough material, be non-angular (rounded) and uncut, similar in mineral composition and color to the on-site materials.

Bank run gravel, if approved for use as supplemental material, shall be uncrushed, conforming to the requirements of Section M.02.02-1.

Rock excavated from ledge (bedrock) formations, or broken from larger boulders, will not be accepted. Broken concrete will not be accepted.

Construction Methods:

Prior to placing Gravel Streambed Material, the area shall be accurately shaped. The material shall be placed to its full course thickness in one operation in such a manner to produce a reasonably well-graded mixture. The material shall then be compacted. The compacted course shall be of the specified thickness and/or to the lines and grades as shown on the plans or as ordered by the Engineer.

Method of Measurement:

Gravel Streambed Material will be measured in place after compaction within the payment lines shown or as specified by the Engineer.
**Basis of Payment:**

This work will be paid for at the contract unit price per cubic yard for “Gravel Streambed Material,” complete in place, including all materials, equipment, tools, and labor incidental thereto.

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravel Streambed Material</td>
<td>C.Y.</td>
</tr>
</tbody>
</table>
ITEM #0651A  8’-6” X 5’-9” PRECAST CONCRETE 3-SIDED CULVERT, FOOTINGS, HEAD-WALLS & WING-WALLS

**Description:**

Work under this item shall consist of designing, furnishing and installing a precast concrete 3-sided culvert constructed of three-sided, reinforced, monolithically cast sections with open ends and precast head-walls, wing-walls on precast footings of the type, size and length as shown on the plans. Reinforcing, threaded rods, lifting and seating inserts, fixtures or devices, non-shrink grout, and all other necessary materials and equipment to complete the work shall also be included in the work.

**Materials:**

Materials shall conform to the following requirements:

1. Concrete for the precast concrete 3-sided culvert with precast headwalls, precast wing-walls and precast footings: Concrete shall conform to the requirements of Subarticle M.14.01-1 of the Standard Specifications, as applicable. Concrete shall be air-entrained composed of portland cement, fine and coarse aggregates, admixtures and water. The air-entraining feature may be obtained by the use of either air-entraining portland cement or an approved air-entrained admixture. The entrained-air content shall be not less than 4 percent or more than 6 percent.

   The Contractor shall design and submit to the Engineer a concrete mix which shall attain a minimum 28-day strength ($f'_{c}$) of 4000 psi. The Contractor shall further provide a certificate stating that the mix submitted shall meet this strength.

2. Coarse Aggregates shall consist of broken stone, having a maximum size of ¾ inch.

3. Type III or Type IIIA portland cement may be used at no additional cost to the Town.

4. Water-Reducing Admixture: The Contractor may submit, for approval of the Engineer, water-reducing admixture for the purpose of increasing workability and reducing the water requirement for the concrete.

5. Calcium Chloride: The addition to the mix of calcium chloride or admixtures containing calcium chloride will not be permitted.

6. Concrete Form Liners: The concrete form liners shall conform to pattern #1203 “New England Dry Stack” with 1¾” relief from Custom Rock International, Inc., St. Paul, Minnesota, as distributed by Connecticut Bomanite Systems, Inc., Newtown, Connecticut or approved equal. The concrete form liners and color stain used for the precast concrete headwalls on the precast concrete 3-sided culvert shall be coordinated to match the concrete form liners and color stain used for precast concrete wing-walls and the texture and appearance of the cast in place or masonry walls for the project.
A. **Form Liners** – The form liners shall be reusable, made of high strength urethane and not compress more than ¼” when concrete is placed at a rate of 10 vertical feet per hour. Form liners shall be removable without causing deterioration of surface or underlying concrete.

B. **Release Agent** - The release agent shall be compatible with the form liners, simulated stone masonry and with the color stain system, as recommended by the manufacturer.

C. **Form Ties** - The form ties shall be designed to separate at least one inch back from the finished surface, leaving only a neat hole that can be plugged with patching material.

D. **Color Stain** - Special penetrating stain mix as provided by the manufacturer, shall achieve color variations present in the natural stone being simulated by the pattern selected for the project. Town shall select a color pattern from photos of completed projects. The stain shall create a surface finish that is breathable (allowing water vapor transmission), and that resists deterioration from water, alkali, fungi, sunlight or weathering. The stain shall be a water borne, low V.O.C. material less than 11.25 lb/cf and shall meet requirements for; weathering resistance - 2000 hours accelerated exposure in accordance with the 3-bulb test of ASTM G23, scrub test - 100 revolutions, abrasion resistance (Tabor CF-10) - 500 cycles, adhesion – 0.04” cross cuts on glass pass 3 or higher on a scale of 1 to 5 in accordance with ASTM D3359, chemical resistance - ASTM D1308.

7. **Reinforcing Steel, Welded Wire Fabric and Tie Wire**: All deformed bars, stirrups, welded steel wire fabric, dowels, threaded dowels and tie wires shall conform to the requirements of Article M.06.01.

8. **Lifting Hooks and Seating Fixtures**: Each culvert section shall contain a suitable number of reinforced lifting and/or seating fixtures to insure safe and level handling and to prevent structural damage during installation. Devices and attachments shall be of a design satisfactory for the purpose intended. All fixtures cast into the concrete for the purpose of lifting or seating the 3-sided sections shall have a corrosive resistant coating.

9. **Nuts, Washers and All Other Miscellaneous Hardware**: Nuts, washers and all other miscellaneous hardware: shall be galvanized in accordance with ASTM Designation A153. Any hardware on the inside surface of the culvert shall be recessed into the wall and grouted over after assembly in order to maintain a smooth, unbroken inside wall surface.

10. **Gaskets**: Gaskets shall be flexible, expanded rubber conforming to the requirements of ASTM D 1056, and shall form and maintain a water tight and flexible joint.

11. **Non-Shrink Grout**: Non-shrink grout shall conform to Subarticle M.03.01-12.

12. **Geotextile**: Shall be “Separation (High Survivability)”, as listed in the Connecticut Department of Transportation’s Approved List for Geotextiles. Torn or punctured geotextiles shall not be used.

13. **Dampproofing**: Materials shall conform to the requirements of Section 7.08 - Dampproofing.
14. Corrosive Resistant Coating: This coating shall be either an epoxy material or zinc coating deposited mechanically or by hot-dipping or electroplating.

15. Threaded Inserts: Threaded inserts shall have a corrosive resistant coating and shall provide adequate resistance to pull-out for location and purpose for which they are to be used. The following threaded inserts have been approved for use in concrete 3-sided culverts.

- Dayton Superior, Type f-57
- Richmond Screw Anchor Company, Type LF
- Star Expansion Industries Corporation, Type P-25-T

**Construction Methods:**

**Preformed or Cored Utility Holes in Culvert Walls:** Prior to initiation of 3-sided culvert fabrication, the Contractor shall perform sufficient number of utility test pits to establish and record precise horizontal and vertical locations of the underground utilities to be accommodated through the walls or precast footings of the proposed culvert. In particular, the precise location of the existing gravity flow sanitary sewer and the existing water main are critical since they cannot be offset without adversely affecting the integrity of the systems. The locations of the preformed or cored holes in the walls and footings of the proposed culvert for the relocated utilities shall be coordinated with the locations of the joints in the culvert sections in accordance with the plans.

**Calculations, Working Drawings & Shop Drawings:** Before fabrication, the fabricator shall prepare and the Contractor shall submit full size shop drawings and working drawings, as well as complete design calculations, to the Engineer for approval in accordance with Article 1.05.02 (b). The length of each 3-sided culvert section is dependent upon the size and skew angle and shall be determined by the manufacturer, as long as the final length including joints is that length as shown on the contract drawings or as otherwise approved in advance. These drawings shall include complete details of the methods, materials, and equipment that are proposed to be used. All culvert sections shall be designed for HL93 vehicle loading using the AASHTO LRFD design method. Drawings and calculations shall be stamped by a Professional Engineer registered in the State of Connecticut. No fabrication is to commence on the precast units until the shop drawings and design calculations are approved by the Engineer.

Furthermore, working drawings shall include the following unless otherwise approved in advance:

- Layout plan of 3-sided culverts.
- Typical cross-sections showing length, width, height and thickness of walls and slabs.
- Type, size, location and spacing of steel reinforcing and inserts for anchoring threaded deformed steel bars. Bending diagrams, material lists and catalog cuts for inserts shall be provided.
- Type, size and location of lifting holes and seating fixtures. All fixtures (inserts, etc.) cast permanently into the sections shall be recessed a minimum of ¾ inches. No more than four lifting holes or fixtures shall be located in each 3-sided section.
- Location, spacing, type, and size of all inserts cast into the 3-sided culvert.
Complete details of the lap joints at the end of the 3-sided sections, which shall include the type, size and location of gaskets and additional steel reinforcement. Except where shown otherwise, the ends of the 3-sided sections shall have lap joints with not less than 1½ inches of concrete overlap. Each joint shall be provided with a pre-placed gasket.

The type and application method of the corrosive resistant coating.

Limits of dampproofing.

Material designations.

**Load Rating:** The fabricator of the 3-sided culvert shall submit load rating calculations, signed by a professional engineer licensed in the State of Connecticut, to the Town. The Town will forward the load rating calculations to the Connecticut Department of Transportation’s Bridge Safety & Evaluation Unit for review. Load ratings shall be performed using the AASHTO LRFR method, and shall include a summary sheet, as well as back-up calculations, in accordance with the requirements of the Department's Consulting Engineer's General Memorandum 12-01 dated March 16, 2012. *All inventory and operating ratings shall be greater than or equal to 1.0.*

**Forms:** The forms in manufacture shall be sufficiently rigid and accurate to maintain the 3-sided section dimensions within the permissible variations given below under “Quality Control”. All casting surfaces shall be of smooth non-porous material. Forms shall be mortar tight and strong enough to prevent misalignment of adjacent 3-sided sections. They shall be constructed to allow their removal without damage to the concrete. A positive means of supporting reinforcing cages in place during forming shall be required.

The forms shall not be removed until the concrete is strong enough to avoid possible injury from such removal. All forming materials used for casting cylindrical openings for lifting holes or holes for grouting deformed steel bars shall be removed. All non-plastic material used as forms for casting weepholes (where called for) shall also be removed.

Void forms shall be held in place against uplift or lateral displacement during the pouring and vibrating of the concrete by substantial wire ties or other satisfactory means as approved by the Engineer.

**Mixing and Placing Concrete:** The concrete mix as designed and submitted by the Contractor shall be proportioned and mixed in a batch mixer to produce a homogeneous concrete conforming to the requirements. The transporting, placement and compaction of concrete shall be by methods that will prevent the segregation of the concrete materials and the displacement of the enforcement steel from its proper position in the form. There shall be no interruption in the pouring of any unit. Truck-mixed or transit-mixed concrete will not be allowed.

Concrete shall not be deposited into the forms when the ambient temperature is below 40°F or above 100°F, unless adequate heating or cooling procedures have been previously approved by the Engineer. The concrete temperature shall be 60°F to 90°F at the time of placement. At no time will truck-mixed or transit-mixed concrete be allowed.
Production during the winter season, from November 15 to March 15 inclusive, will be permitted only on beds located in a completely enclosed structure of suitable size and dimension that provides a controlled atmosphere for the protection of the casting operation and the product. Outside operations will not be permitted during rainfall unless the operation is completely under cover.

Vibrating shall be done with care in such a manner as to avoid displacement of reinforcing steel, voids, forms, or other components. There shall be no interruption in the pouring of any of the sections. Concrete shall be carefully placed in the forms and vibrated sufficiently to produce a surface free from imperfections such as honeycombing, segregation, cracking, or checking. Any deficiencies noted in the sections may be cause for rejection.

**Curing:** Precast units shall be cured by a method or combination of methods approved by the Engineer, that will give satisfactory results. Curing shall be for a sufficient length of time so that the concrete will develop the specified compressive strength at 28 days or less.

**Patching:** No patching of the complete units will be allowed unless permitted by the Engineer. The Contractor’s proposal for methods and materials to be used in the patching operation shall be submitted to the Engineer for his approval.

**Reinforcing:** Top reinforcing steel in the top slab of the Concrete 3-Sided Culvert shall be epoxy-coated.

**Joints:** The precast reinforced concrete 3-sided sections shall be produced with male and female ends except as shown otherwise on plans. The ends shall be of such design and so formed that when the sections are laid together, they will make a continuous line of 3-sided sections with a smooth interior face free of irregularities.

**Test Cylinders:** During the casting of the units, the Contractor shall make test cylinders under. A minimum of four (4) cylinders shall be taken during each production run. Cylinders shall be cured under laboratory control conforming to the requirements of ASTM C 192 and shall be used to determine the 28-day compressive strength requirements (f’c). Failure of any of the 28-day test cylinders to meet 90 percent of the minimum compressive strength requirements may be cause for rejection. The Engineer also reserved the right to request and test core specimens from the units to determine their adequacy.

**Quality Control:** The dimensional tolerance of the units shall conform to the following:

(a) **Internal Dimensions and Finish:** The internal dimensions shall not vary more than 1 percent from the design dimensions. The haunch dimensions shall not vary more than ¼ inch from the design dimensions. The interior shall be smooth and free of irregularities.

(b) **Slab and Wall Thickness:** The slab and wall thickness shall not be less than that shown in the design by more than 5 percent or \( \frac{3}{16} \) inch, whichever is greater. A thickness more than that required in the design will not be a cause for rejection.
(c) Length of Opposite Surfaces: Variations in laying lengths of two opposite surfaces of the 3-sided section shall not be more than \( \frac{1}{8} \) inch/foot of span with a maximum of \( \frac{3}{8} \) inch in any 3-sided section except where beveled ends are specified.

(d) Length of Section: The underrun in length of a section shall not be more than \( \frac{1}{8} \) inch/foot of length with a maximum of \( \frac{1}{2} \) inch in any 3-sided section.

(e) Position of Reinforcement: The maximum variation in the spacing of reinforcement shall be \( \pm \frac{1}{4} \) inch. Cover shall be 1-\( \frac{1}{2} \) inches minimum.

Finishing: Formed surfaces shall not be finished in any specific manner except as noted below. All fins, runs, or mortar shall be removed from surfaces which will remain exposed. Form marks on exposed surfaces shall be smoothed by grinding as needed. The following surfaces shall be finished as follows:

Top surfaces: Where 3-sided sections are to be covered with membrane waterproofing, the top surface of the roof slab shall be given a float finish in accordance with Sub-article 6.01.03-21. All exposed top surfaces of the head-walls and wing-walls shall be given a grout clean-down finish in accordance with Subarticle 6.01.03-21

Exposed vertical surfaces: All exposed, outside vertical surfaces of the end sections, head-walls and wing-walls shall be given a form liner finish, except for 8" top margin which shall be given grout clean-down finish in accordance with Subarticle 6.01.03-21. The surfaces of the wing-walls where concrete will be field cast against shall be given a float finish in accordance with Sub-article 6.01.03-21.

Marking: The following information shall be clearly marked on each section by indentation, waterproof paint or other approved means:

A. 3-sided section and rise.
B. Date of manufacture.
C. Name or trademark of manufacturer.
D. An identification number or letter on the TOP of each section (to insure proper placement).

Handling and Storage: Handling devices shall be provided in each 3-sided section for the purpose of handling and placing. Care shall be taken during storage, transporting, hoisting and handling of all units to prevent cracking or damage. Units damaged by improper storage, transporting or handling shall be replaced by the Contractor at his expense.

Inspection and Rejection: The quality of materials, the process of manufacture, and the finished units shall be subject to rejection on account of failure to conform to any of the specification requirements. Individual units may be rejected because of any of the following:
A. Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.
B. Defects that indicate imperfect proportioning, mixing and molding.
C. Honeycombed or open texture.
D. Damaged ends, where such damage would prevent making a satisfactory joint.

Installation: The installation of the precast concrete 3-sided culvert sections shall proceed as required by the sequence of construction.

The precast footings, 3-sided culvert sections and wing-walls shall be placed in a manner to best accommodate and facilitate the construction of the concrete headwalls, wing-walls, etc. No 3-sided sections shall be set on precast footings without the approval of the Engineer. The 3-sided culvert sections shall fully bear on the precast footing.

The 3-sided culvert sections shall be set to the line and grade indicated on the plans or as directed by the Engineer. Placement of the sections shall not start until the Engineer has approved the depth of excavation and the suitability of the foundation material.

The lap joints shall be securely seated together to achieve a silt-tight joint all around. A silt-tight joint is defined as a joint in which the gasket is compressed to a minimum of one half of its uncompressed width. The gasket shall be uniformly compressed along all vertical and horizontal surfaces. A positive means, through the use of seating devices, shall be used for pulling one section against another to assure an adequate silt-tight joint.

Details for the seating method shall be submitted to the Engineer for review. The lap joints shall be seated such that they make a continuous line of sections with a smooth interior free from irregularities in the invert line.

The top portions of the horizontal lap joints for the roof and the outside face of the vertical lap joints (full height on each side) for the 3-sided culvert shall be neatly filled with non-shrink grout after seating the sections. The exposed portions of the lap joints within the haunches or fillets shall also be neatly filled with non-shrink grout. The finished surface shall be smooth and level with the adjacent concrete.

Geotextile shall be placed over all vertical joints. Geotextile shall also be placed over the roof joints of culverts not receiving woven glass fabric. The geotextile shall extend 6” to each side of the joint and be attached to the culvert using silicone caulk.

After its installation, any 3-sided section or joint that is, as determined by the Engineer, not acceptable in vertical or horizontal alignment for any reason, including but not limited to settlement, displacement, excess camber or misfit, shall be removed by the Contractor and correctly installed, as directed by the Engineer and at no additional cost to the Town.

All fixtures or holes cast into the sections for lifting or seating shall be neatly filled with non-shrink grout. The finished surface shall be smooth and level with the adjacent concrete.
The surface preparation, mixing, placing, curing, and finishing of the non-shrink grout shall conform to the written instructions provided by the manufacturer of the grout. The Contractor shall furnish the Engineer with copies of the instructions. The grout shall be cured at least 3 days unless determined otherwise by the Engineer.

**Backfilling:** Methods of backfilling shall be in conformance with the requirements of the plans and Section 2.16 except that fill placed around the three sided culvert sections shall be deposited on both sides to approximately the same elevation at the same time.

**Method of Measurement:**

This work will be measured for payment by the actual number of linear feet of precast concrete 3-sided culvert sections and wing-walls on precast footings, of the size indicated and layout, completed, accepted and measured in place along the top slab at the centerline of the culvert.

Work associated with furnishing and installing concrete form liners and color stain to simulate stone masonry facing for the precast concrete headwalls and wing-walls of the precast concrete 3-sided culvert will not be measured for separately, but shall be included in the item for “8’-6” x 5’-9” Precast Concrete 3-Sided Culvert”.

**Basis of Payment:**

Payment for this work will be made at the contract unit price per linear foot for “8’-6” x 5’-9” Precast Concrete 3-Sided Culvert”, of the size indicate, as shown on the plans, complete and accepted, which price shall include precast wing-walls and precast footings, concrete form liners and color staining of concrete surfaces to simulate the stone facing on the precast concrete headwalls, threaded inserts, dampproofing, threaded dowels, pipe sleeves, void forms, non-shrink grout, gaskets and all other materials, equipment, tools and labor incidental thereto.

The contract unit price per linear foot for “8’-6”x 5’-9” Precast Concrete 3-Sided Culvert” shall also include the costs of preparing and furnishing design calculations, load ratings, working drawings, and shop drawings.

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ITEM #1401A - REPLACE SANITARY SEWER MAIN
ITEM #1402A - RECONNECT SANITARY SEWER LATERAL

Description:

Work under these items for sanitary sewer excavation and sanitary sewer pipe construction shall conform to the requirements of Section 2.05 and 6.51 respectively as supplemented and amended as follows:

This section includes all pipe, labor, equipment, appliances and materials required for the construction of sanitary sewer main or connection of service lateral at the locations and to the lines and grades indicated and/or as directed, including all pipe, pipe fittings and accessories, connections to the existing piping, testing of pipelines and material tests, bypass pumping, excavation, installation, bedding materials, backfilling, services of manufacturer's representatives and all other related and appurtenant work, complete in place and accepted, in accordance with the drawings and specifications, and as directed by and to the satisfaction of the Watertown Fire District. This also included notification of property owners and residents affected by the work.

This work shall consist of the installation of a ductile iron pipe sanitary sewer through the openings in the walls or footings of the three sided culvert as a replacement of the existing sanitary line in conflict with the proposed culvert at the existing location and to the existing lines and grades indicated on the plans and/or as directed.

Materials:

Materials shall conform to the following requirements:


Construction Methods:

Sewer flows shall be maintained throughout the work. Earthwork shall conform to Section 2.05. as amended by Section 14.00.

The Contractor shall furnish to the Watertown Fire District notarized test reports from the pipe and gasket manufacturers including methods of tests by an approved independent testing laboratory to show compliance of all materials furnished under this section of the specifications.

A copy of each test report is to be attached to the shipping list of each shipment itemizing by size; class and wall type, serial number and date of manufacture. All required testing of pipe materials furnished under this section of the specifications shall be provided by the Contractor at no additional expense to the Watertown Fire District.
The Contractor shall furnish to the Watertown Fire District a certified statement indicating all on-site testing procedures have been completed and met the specification requirements.

The Contractor shall investigate and verify sanitary sewer flows with the Watertown Fire District to evaluate the scope of facilities required for the proper conveyance and maintenance of said flows. Sanitary sewer service and flows shall remain fully operational during construction. The plan shall indicate all equipment, personnel and materials with suitable backup pumping capacity stored on site.

Shop drawings, if required by the Watertown Fire District, shall be submitted for all pumps, piping, and appurtenances for all types and sizes of equipment required to perform the flow diversion and/or bypass pumping work as required herein. A detailed proposal of noise prevention measures for bypass pumping operations shall be submitted. Emergency contact information shall also be supplied.

The Watertown Fire District will review the Contractor’s plan and once found to be acceptable, approve it prior to implementation. The Contractor shall make revisions to plan as needed in order to provide an acceptable plan for the Watertown Fire District’s approval.

The Contractor shall furnish, at no additional expense to the Watertown Fire District, the services of any manufacturer's representatives for such lengths of time as may be necessary to properly instruct the Contractor’s personnel in the proper handling and installation of materials in accordance with the printed recommendations of the manufacturer.

Notifications: Property owner and resident notifications shall be submitted and approved by the Watertown Fire District prior to distribution.

**Project Conditions:**

Maintain flow of wastewater throughout duration of the Work. Notify property owners and residents affected by sewer main or service operations of approved installation schedule two (2) weeks before start of anticipated construction; identify potential periods of interrupted service in notice. Provide an additional 2-business day written notification to owners and residents of buildings immediately before scheduled interruption to service. Coordinate with other project work occurring within the project area.

**Sewage Flow:**

Protect against surcharging of sewer system upstream of the work area by installing adequate temporary by-pass facilities to handle dry weather and wet weather wastewater flows. Do not allow wastewater to discharge to storm drainage systems surface, or surface or ground water bodies. If by-pass pumping is required to handle dry weather flows also provide stand-by pump(s) for each pump size capable of pumping equivalent wastewater flows and stand-by power that may be required for emergency use. This stand-by equipment shall be provided on site prior to beginning sanitary construction.
Indefinite dry-running sewage pumps are to be provided that shall adequately handle sewage, slurry, and liquids. The contractor shall use plan and profile sheets with allowable contingencies for his determination of Total Dynamic Head (TDH), control systems and pipe bypass lengths. Reduced noise level pumps (63 dBA at 30' or less) and/or attenuating noise structures shall be utilized. Coordinate with the Watertown Fire District for appropriate time of by-pass. Provide personnel on site at all times during bypass pumping operations. Provide power source to operate bypass pumps at no additional cost.

Inclement Weather Forecasts: Take additional and appropriate measures to protect the Work and to prevent release of wastewater when weather reports forecast potential conditions that may increase flow exceeding bypass pump capacity. By-pass configuration shall be based upon the construction phasing and Contractor operations.

**Installation:**

Install piping beginning at low point, true to the existing grade and existing alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions or installation requirements. Install and support pipes and fittings with bedding material. Do not use saddles, blocking or stones as pipe supports. When work is not in progress, close open ends of pipe to prevent entry of groundwater, earth, or foreign materials. Arrange for installing green warning tapes directly over pipe.

Arrange for inspection by the Watertown Fire District prior to backfilling. All sewer construction is to be constructed and tested, in accordance with the Watertown Fire District requirements, prior to backfilling.

**Sanitary Sewer Laterals:**

The Contractor shall verify all lateral locations potentially affected by the sanitary sewer main replacement and connect them to the new relocated sanitary sewer.

**Method of Measurement:**

Replace Sanitary Sewer Main: This item, being paid for on a lump sum basis, will not be measured for payment.

Re-connect Sanitary Sewer Laterals: The existing sanitary sewer laterals connection to the replaced sanitary sewer main shall be measured for payment by number of laterals reconnected.

No separate measurement will be made for marking tape; and fittings including bends, reducers, couplings, adaptors. This work shall be included as part of the associated work.
Handling of Sanitary Sewage: The cost of the satisfactorily handling of sanitary sewage will not be measured for payment but shall be included in the associated work.

**Basis of Payment:**

“Replace Sanitary Sewer Main”: This work will be paid for at the contract lump sum price completed and accepted, which price shall include all materials, tools, equipment, labor and work incidental to the construction; reconstruction if required; dewatering, including pumping; handling the sewer flow during construction; the removal and disposal of all protective works or facilities; disposal of water removed from the construction area; damages incurred by the Contractor; and any damages to existing facilities and to the work in progress.

“Reconnect Sanitary Sewer Lateral”: This work will be paid for at the contract unit price each, complete in place, which price shall include all materials, equipment, labor, tools, and work incidental thereto.

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<tr>
<td>Re-connect Sanitary Sewer Lateral</td>
<td>each</td>
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ITEM #1501A - REPLACE WATER MAIN

Description:

Work under this item for water main excavation and water main pipe construction shall conform to the requirements of Section 2.05 and 6.51 respectively as supplemented and amended as follows:

This Section includes all pipe, labor, equipment, appliances and materials required for the replacement of water main in a steel sleeve at the locations and to the lines and grades indicated and/or as directed, including all pipe materials, valves, pipe fittings and accessories, connections to the existing piping, testing of pipelines and material tests, excavation, installation, bedding materials, backfilling, services of manufacturer's representatives and all other related and appurtenant work, complete in place and accepted, in accordance with the drawings and specifications, and as directed by and to the satisfaction of the Watertown Fire District. This also included notification of property owners and residents affected by the work.

This work shall consist of the installation of a ductile iron pipe water main through the openings in the walls of the three sided culvert as a replacement of the existing water main in conflict with the proposed at the existing location and to the existing lines and grades indicated on the plans and/or as directed.

Materials:

Materials shall conform to the following requirements:

Watertown Fire District Standard Specifications for Water Main and Service Line Materials.

Construction Methods:

The Contractor shall furnish to the Watertown Fire District notarized test reports from the water pipe, water valve, and gasket manufacturers including methods of tests by an approved independent testing laboratory to show compliance of all materials furnished under this section of the specifications.

A copy of each test report is to be attached to the shipping list of each shipment itemizing by size; class and wall type, serial number and date of manufacture. All required testing of pipe materials furnished under this section of the specifications shall be provided by the Contractor at no additional expense to the Watertown Fire District.

The Contractor shall furnish to the Watertown Fire District a certified statement indicating all on-site testing procedures have been completed and met the specification requirements.

The Contractor shall coordinate with the Watertown Fire District to evaluate the scope of facilities required for the proper performance of work.
The Contractor shall furnish, at no additional expense to the Watertown Fire District, the services of any manufacturer's representatives for such lengths of time as may be necessary to properly instruct the Contractor's personnel in the proper handling and installation of materials in accordance with the printed recommendations of the manufacturer.

Notifications: Property owner and resident notifications shall be submitted and approved by the Watertown Fire District prior to distribution.

**Installation:**

Install piping true to the existing grade and existing alignment indicated. Install valves at the ends of the relocated pipe, and couplings according to manufacturer's written instructions or installation requirements. Install and support pipes and fittings with bedding material. Do not use saddles, blocking or stones as pipe supports. When work is not in progress, close open ends of pipe to prevent entry of groundwater, earth, or foreign materials. Arrange for installing blue warning tapes directly over pipe.

Arrange for inspection by the Watertown Fire District prior to backfilling. All water main replacement work is to be constructed and tested, in accordance with the Watertown Fire District requirements, prior to backfilling.

**Method of Measurement:**

Replace Water Main: This item, being paid for on a lump sum basis, will not be measured for payment.

**Basis of Payment:**

“Replace Water Main”: This work will be paid for at the contract lump sum price completed and accepted, which price shall include all materials, tools, equipment, labor and work incidental to the construction; reconstruction if required; dewatering, including pumping; the removal and disposal of all protective works or facilities; disposal of water removed from the construction area; damages incurred by the Contractor; and any damages to existing facilities and to the work in progress.

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