

TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 1. Trench, backfill, and compact as specified herein and as needed for installation of underground utilities located 5' outside the buildings.

1.02 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.
- B. Use equipment adequate in size, capacity, and numbers to accomplish the work in a timely manner.
- C. Comply with all requirements of governmental agencies having jurisdiction.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

- A. Fill and backfill materials:
 1. Provide backfill materials free from organic matter and deleterious substances, containing no rocks or lumps over 6" in greatest dimension.
 2. Fill material is subject to the approval of the Engineer, and is that material removed from excavations or imported from off-site borrow areas, predominantly granular, non-expansive soil free from roots and other deleterious matter.
 3. Do not permit rocks having a dimension greater than 2" within 2' of the outside of pipe.
 4. Cohesive material used for backfill: Provide sand free from organic material and other foreign matter, and as approved by the Engineer.

PART 3 - EXECUTION

3.01 PROCEDURES

- A. Existing Utilities:
 1. Unless shown to be removed, protect active utility lines shown on the drawings or otherwise made known to the Contractor prior to trenching. If damaged, repair or replace at no additional cost to the Owner.
 2. When existing underground utilities, which are not scheduled for removal or abandonment, are encountered in the excavation, they shall be adequately supported and protected from damage. Any damage to utilities shall be repaired promptly at no additional cost to the Owner.
 3. If the service is interrupted as a result of work under this section, immediately restore service by repairing the damaged utility at no additional cost to the Owner.
 4. If existing utilities are found to interfere with the permanent facilities being constructed under this section, immediately notify the Engineer and secure his instructions.
 5. Do not proceed with permanent relocation of utilities until written instructions are received from the Engineer.
- B. Protection of persons and property:
 1. Barricade open holes and depressions occurring as part of the work, and post warning lights on property adjacent to or with public access.
 2. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
 3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by operations under this section.
- C. Dewatering: The Contractor, at all times, shall conduct his operations so as to prevent the accumulation of water, ice, and snow in excavations or in the vicinity of excavated areas, and to prevent water from interfering with the progress of quality of the work. Under no conditions shall water be allowed to rise in open trenches after pipe has been placed.
- D. Accumulated water, ice, and snow shall be promptly removed and disposed of by pumping or other approved means. Disposal shall be carried out in a manner which will not create a hazard to public health, nor cause injury to public or private property, work, completed or in progress, or public streets, nor cause any interference in the use of streets and road by the public. Pipes under construction shall not be used for drainage of excavations.
- E. Maintain access to adjacent areas at all time.

3.02 TRENCHING

- A. Care shall be exercised by the Contractor to avoid disrupting the operation of existing facilities without prior written approval of the Engineer.
- B. Provide sheeting and shoring necessary for protection of the work and for the safety of personnel.
 1. Sheeting and bracing required for trenches shall be removed to the elevation of the pipe, but no sheeting will be allowed to be pulled, removed, or disturbed below the pipe.
- C. A trench shall be excavated to the required depth and to a width sufficient to allow for joining of the pipe and compaction of the bedding and backfill material under and around the pipe. Where feasible, trench walls shall be vertical.
- D. The completed trench bottom shall be firm for its full length and width.
- E. If indicated on the plans or directed by the Engineer, poor foundation material encountered below the normal grade of the pipe bed shall be removed and replaced with granular backfill.
- F. Where pipes are to be placed in embankment fill, the excavation shall be made after the embankment has been completed to a height of 3 feet plus the diameter of the pipe above the designed grade of the pipe.

Excavating for appurtenances:

1. Excavate for manholes and similar structures to a distance sufficient to leave at least 12" clear between outer surfaces and the embankment or shoring that may be used to hold and protect the banks.
2. Over-depth excavation beyond such appurtenances that has not been directed will be considered unauthorized. Fill with sand, gravel, or lean concrete as directed by the Engineer, and at no additional cost to the Owner.

H. Excavation shall not interfere with normal 45° bearing slope of foundations.

I. All trenching shall be in accordance with the latest OSHA requirements.

J. Where utility runs traverse public property or are subject to governmental or utility company jurisdiction, provide depth, bedding, cover, and other requirements as set forth by legally constituted authority having jurisdiction, but in no case less than the depth shown in the Contract Documents.

K. Where trenching occurs in existing lawns, remove turf in sections and keep damp. Replace turf upon completion of the backfilling.

3.03 BEDDING

- A. Pipe Bedding Area: Prior to laying pipe, bedding material shall be placed to the limits of the excavation and to a depth beneath the pipe as specified. This material shall be either sand, gravel, or crushed stone and shall not contain large lumps and stones over one inch in diameter. As the pipe is laid, bedding material shall be extended to 6" above the pipe and leveled along the width of the trench.

3.04 BACKFILLING

- A. Backfilling shall not be done in freezing weather, with frozen materials, or when materials already placed are frozen.
- B. Unless otherwise specified or indicated on the plans, material used for backfilling trenches above the bedding area shall be suitable material which was removed during excavation or obtained from borrow and when compacted shall make a dense stable fill. The material shall not contain vegetation, porous matter, masses of roots, individual roots more than 18 inches long or 1/2 inch thick, or stones greater than 50 pounds or larger than six inches in the widest dimension.
- C. If additional material is required, it shall be furnished from approved sources.
- D. Backfill material shall be evenly spread and compacted in lifts not more than 12 inches thick or as approved by the Engineer. Previously placed or new materials shall be moistened by sprinkling, if required, to ensure proper bond and compaction.
- E. Reopen trenches which have been improperly backfilled, to a depth as required for proper compaction. Refill and compact as specified, or otherwise correct to the approval of the Engineer.
- F. Should any of the work be so enclosed or covered up before it has been approved, uncover all such work and, after approvals have been made, refill and compact as specified, all at no additional cost to the Owner.
- G. Take special care in backfilling and bedding operations to not damage pipe and pipe coatings.
- H. No compacting shall be done when the material is too wet to be compacted properly. At such times the work shall be suspended until the previously placed and new materials have dried out sufficiently to permit proper compaction, or such other precautions are taken as may be necessary to obtain proper compaction.
- I. Backfill material shall be compacted to the following percentages of maximum dry density and the in-place moisture content shall not be more than 2% above the optimum moisture content, as determined by Standard Proctor ASTM D698.
 1. Around all structures, under roadway paving, shoulder and embankments - 95%.
 2. All other areas - 90%.

EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 1. All utility and sitework excavation (unless covered in other sections of these specifications), removal and stockpiling of topsoil, stabilization fabric, and other miscellaneous and appurtenant work.
 2. Site filling.
 3. Roadway/parking lot structural sections.

1.02 REFERENCES

- A. ANSI/ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- B. ANSI/ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.

1.03 PROTECTION

- A. Protect bench marks and existing structures.
- B. Protect above and below grade utilities which are to remain.

1.04 SUBMITTALS

- A. Testing laboratory reports indicating that material for backfill meets requirements of this Section.
- B. Field density test reports of site fill in place.
- C. Field density test reports for roadway structural sections in place.
- D. Stabilization Fabric: Submit copies of manufacturer's specifications and installation instructions.

PART 2 - PRODUCTS

2.02 CRUSHED GRAVEL

- A. All materials shall be secured from approved sources. This gravel shall consist of angular and round fragments of hard durable rock of uniform quality throughout, reasonably free from thin elongated pieces, soft or disintegrated stone, dirt, organic or other objectionable matter. This material shall meet the following grading requirements:

Sieve Designation	Percent by Weight Passing Square Mesh Sieve
Fine:	
2"	100
1 1/2"	90 - 100
No. 4	30 - 60
No. 100	0 - 12
No. 200	0 - 6
Course:	
4"	95 - 100
No. 4	25 - 50
No. 100	0 - 12
No. 200	0 - 6

2.03 AGGREGATE SURFACE COURSE

- A. Aggregate for surface course and shoulders shall consist of clean, hard gravel, crushed gravel or crushed stone. It shall be reasonably free from silt, loam, clay or organic matter. It shall be obtained from approved sources.

- B. Grading: This material shall be uniformly graded from coarse to fine and shall meet the following grading requirements:

Sieve Designation	Percent by Weight Passing Square Mesh Sieve
1 1/2"	100
1"	90 - 100
No. 4	45 - 65
No. 100	0 - 15
No. 200	0 - 12

2.04 COMPACTED FILL/GRANULAR BORROW

- A. This material shall be free of shale, clay, friable material, debris, and organic matter, graded in accordance with ANSI/ASTM C136 within the following limits:

Sieve Designation	Percent by Weight Passing Square Mesh Sieve
6"	100
3/4"	75 - 100
No. 4	20 - 100
No. 100	0 - 20
No. 200	0 - 12

2.05 GEOTEXTILE STABILIZATION FABRIC

- A. This work shall consist of furnishing and placing an approved stabilization fabric on a prepared surface within the limits shown on the plans. The fabric shall meet, or exceed the following properties:
 1. Grab tensile strength (ASTM D-4632) - 200 lbs.
 2. Grab tensile elongation (ASTM D-4632) - 15%.
 3. Puncture strength (ASTM D-4833) - 120 lbs.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Identify known below grade utilities. Stake and flag locations.
- C. Maintain and protect existing utilities remaining which pass through work area.
- D. Upon discovery of unknown utility or concealed conditions, discontinue affected work; notify Engineer.

3.02 EROSION CONTROL

- A. Erosion control must be installed prior to beginning any earthwork operations.

3.03 TOPSOIL EXCAVATION

- A. Excavate topsoil from areas to be excavated, re-landscaped or regraded and stockpile in areas designated on site or as directed by the Engineer.
- B. Maintain the stockpile in a manner which will not obstruct the natural flow of drainage.
 1. Maintain stockpile free from debris and trash.
 2. Keep the topsoil damp to prevent dust and drying out.

3.04 SUBSOIL EXCAVATION

- A. Excavate subsoil from areas to be regraded in accordance with plans.
- B. Excavate subsoil required to accommodate building foundations, slabs on grade, site structures, construction operations, roads, and parking areas.
- C. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- D. Notify Engineer of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
- E. Correct areas over-excavated by error as directed by the Engineer at no cost to the Owner.

3.05 DITCHES

- A. Cut accurately to the cross-sections, grades, and elevations shown.
- B. Maintain excavations free from detrimental quantities of leaves, sticks, trash, and other debris until completion of the work.
- C. Dispose of excavated materials as shown on the drawings or directed by the soils Engineer; except do not, in any case, deposit materials less than three feet from the edge of a ditch.

3.07 COMPACTION REQUIREMENTS

- A. All backfills and fills shall be compacted in even lifts (12" maximum) to attain the required densities as follows:
- | Location | Standard Proctor ASTM D-698 |
|--|-----------------------------|
| Subgrade and Gravel for Roads and Parking Lots | 95% |
| General Embankments | 90% |

3.08 MAINTENANCE

- A. All earthwork should be checked periodically to see that slopes are in good condition. Any rills or damage from erosion and animal burrowing should be repaired immediately to avoid further damage. If seeps develop on the slopes, the area should be evaluated to determine if the seep will cause an unstable condition. Subsurface drains or gravel mulching may be required to solve seep problems. Diversions, berms, and waterways in the land grading area should be checked to see that they are functioning properly. Problems found during the inspections should be repaired promptly.

SANITARY SEWER SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 1. Gravity Sewer Pipe
 2. Manhole Structures and Appurtenances
- B. Related Sections:
 1. Section 02225 - Utility Trenching and Backfilling

1.02 SUBMITTALS

- A. Product Data: Submit published data from manufacturers of products and accessories specified, indicating compliance with requirements.

1.03 QUALITY ASSURANCE

- A. All sanitary sewer materials and construction of same shall be as shown on the Contract Plans and shall meet the requirements of the State of Vermont Agency of Natural Resources (Department of Environmental Conservation) and the Public Works Standards and Specifications of the local municipality.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Furnish elbows, tees, reducing tees, wyes, couplings, increasers, crosses, transitions and end caps of the same type and class of material as the conduit, or of material having equal or superior physical and chemical properties as acceptable to the Engineer to provide a complete and operable system.

2.02 PVC GRAVITY SANITARY SEWER PIPE

- A. PVC sewer pipe shall conform in all respects to the latest revision of ASTM Specifications D-3034 or F679, Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings, SDR 35 pipe. All pipe and fittings shall be clearly marked as follows:
 - Manufacturer's Name and Trademark
 - Nominal Pipe Size (as shown on plans)
 - Material Designation 12454-C-PVC
 - Legend "Type PSM SDR 35 PVC Sewer Pipe" or "PS 46 PVC Sewer Pipe"
 - Designation ASTM D-3034 or F679

- B. Joints shall be push-on type using elastomeric gaskets and shall conform to ASTM D-3212. The gaskets shall be factory installed. The pipe shall be furnished in nominal 13 foot lengths. Sufficient numbers of short lengths and full machine fittings shall be provided for use at manholes and connections. All connections will require the use of manufactured fittings. Field fabricated, saddle-type connections will not be considered acceptable.

2.03 MANHOLES

- A. Manholes shall be sized as indicated on the plan and shall be precast concrete with a monolithic base and shall conform to the latest version of ASTM Specification C478.
- B. Shelves shall be constructed with concrete having a minimum compressive strength of 3,000 psi at 28 days. Inverts for sewer manholes shall be as shown on the plans and details and shall be constructed with concrete or brick, as per the local municipality's standards. Inverts shall have the exact shape of the sewer to which they are connected, and any change in size of direction shall be gradual and even.
- C. All manholes are to be provided with copolymer polypropylene plastic steps with steel reinforcement 12 inches on center.
- D. All manholes shall be provided with rough, gray, cast iron manhole frames and covers. All iron castings shall be thoroughly cleaned and then coated with hot tar before being delivered. Frames and covers shall be LeBaron LC 266, or an approved equal, and have a minimum weight of 400 pounds.
- E. Precast risers and bases for manholes shall conform to ASTM Specification C-478. The pipe opening in the precast manhole system shall have a cast-in-place flexible gasket or an equivalent system for pipe installation as approved by the Engineer. Joints between manhole risers shall be 1" minimum width flexible gasket or approved equals.

2.04 CLEANOUTS

- A. Cleanouts for gravity sewers and force mains shall be provided at locations indicated on the plans or as directed by the Engineer. Cleanout frames and covers shall be of tough gray cast iron. Castings shall be true to pattern and free from flaws. The bearing surface of cleanout frames and covers against each other shall be machined to give continuous contact throughout their circumference.

PART 3 - EXECUTION

3.01 GENERAL

- A. Care shall be exercised by the Contractor to avoid disrupting the operation of existing sanitary sewer facilities without prior written approval of the Engineer.
- B. When existing underground utilities not scheduled for removal or abandonment are encountered in the excavation, they shall be adequately supported and protected from damage. Any damage to utilities shall be repaired promptly at no additional cost to the Owner.
- C. Installation of pipe shall be in accordance with Section 02225 - Utility Trenching and Backfilling and as specified by this section.

3.02 BEDDING FOR PIPE

- A. The bedding material shall be shaped to fit the pipe for a depth of not less than 10 inches to its total height and shall have recesses to receive the bell.

3.03 LAYING PIPE

- A. In general, sewer pipe shall be installed in accordance with the latest detailed instructions of the manufacturer.
- B. The laying shall begin at the outlet end and the lower segment of the pipe shall be in contact with the shaped bedding throughout its full length. Bell or grooved ends of rigid pipes and the circumferential laps of flexible pipe shall be placed facing upstream.
- C. All pipe and fittings shall be carefully examined for defects and no pipe or fittings shall be laid which are known to be defective. If any defective pipe is discovered after laying, it shall be removed and replaced at the Contractor's expense. All pipes and fittings shall be cleaned before they are laid and shall be kept clean until accepted in the completed work.
- D. The pipe shall be laid to conform to the lines and grades indicated on the drawings or given by the Engineer. Each pipe shall be so laid as to form a close joint with the next adjoining pipe and to bring the inverts continuously to the required grade.
- E. The Contractor shall take all necessary precautions to prevent flotation of the pipe in the trench.
- F. When pipe laying is not in progress, the open ends of the pipe shall be closed with temporary watertight plugs. If water is in the trench when work is resumed, the plug shall not be removed until all danger of water entering the pipe is eliminated.

3.04 GRAVITY SEWER PIPE TESTING

- A. The Contractor shall provide all necessary equipment and instrumentation required for proper completion of the flushing and testing. Quality of water, test procedures, and method of disposal of water shall be approved by the Engineer. Prior to testing, flush with water to remove construction debris.
- B. All tests shall be made in the presence of the Engineer. Preliminary tests made by the Contractor without being observed by the Engineer will not be accepted. The Engineer will be notified at least eight hours before any work is to be inspected or tested.
- C. The maximum sewer length to be tested at one time shall be that length between any two manholes.
- D. Air Testing: Low pressure air testing shall be conducted in accordance with the following procedures:
 1. Each end of the test section shall be plugged, capped and braced. Necessary safety precautions shall be taken to prevent blowouts and possible injury.
 2. An air hose shall be connected to a tapered plug used for an air inlet. The hose will be connected to the air control equipment, which shall include valves and pressure gauges. These shall allow air to enter the sewer test line, monitor air pressure in the sewer, shut off air, and provide pressure reduction and relief. The monitoring pressure gauge shall have a range of 0-10 psi with divisions of 0.10 psi and accuracy of 0.05 psi.
 3. The air compressor and air supply shall be connected to the test line and the test section filled slowly until a constant pressure of 4.0 psig is maintained.
 4. A pressure above 3.0 psig shall be maintained for at least five minutes to allow the temperature to stabilize. A check for leaks shall be made and if any are found, the pressure shall be released and the fitting replaced or repaired.
 5. After the stabilization period, the pressure shall be adjusted to 3.5 psig and the air supply disconnected.
 6. Measure and record the time interval for the test line pressure to drop from 3.5 psig to 2.5 psig.
 7. If the groundwater table is above the pipe, increase above test pressure 0.5 psig for each foot the groundwater is above the invert of the pipe.
 8. The requirements of this specification shall be considered satisfied if the time required in seconds for the pressure to decrease from 3.5 to 2.5 psi greater than the average back pressure of any groundwater that may submerge the pipe is not less than that computed according to the following table:

Depth of 4' Manhole	Time	
	Minutes	Seconds
0' - 10'	2	0
10' - 15'	3	30
15' - 20'	3	0
20' - 25'	3	30

f. If the vacuum drop exceeds 1" Hg during the specified time periods, the manhole shall be resealed and Steps 2 through 5 above repeated until the vacuum holds for the specified time.

g. After the manhole passes the vacuum test, it shall be backfilled carefully so that no leaks are created. If the manhole is disturbed in any way during backfill, it shall again be vacuum tested according to Steps 1 through 5 above. If the manhole fails the vacuum test, the Contractor shall test the manhole using the manhole exfiltration test.

h. The Contractor shall provide the Engineer with a written log of each manhole leakage test result.

i. Manholes shall be tested and accepted prior to building manhole inverts.

Minimum Test Time for Various Pipe Sizes Diameter (Inches)	Time (Sec./100 Ft.)	
	4	18
6	45	
8	75	
10	90	
12	110	

3.05 MANHOLES

- A. The excavation shall be to the depth indicated on the plans or ordered by the Engineer, and carefully shaped and graded.
- B. Manhole sections shall be precast concrete and shall conform to the dimensions indicated on the plans or ordered by the Engineer.
- C. Channels, inverts and floor areas for sewer manholes shall be constructed of brick and mortar or concrete. Inverts shall have the exact shape of the sewer to which they are connected and any change in size or direction shall be gradual and even. All construction of sewer manholes must be carried out to insure watertight work.
- D. The required courses of brick shall be placed on top of the concrete to the elevation indicated on the plans or ordered by the Engineer. Brick shall be laid in an appropriate manner by a competent mason. After the bricks are laid, the joints on the inside of the brick masonry shall be neatly pointed. The outside surface of the brick shall be covered with mortar of the same quality as used for laying the bricks so that a reasonably smooth surface is obtained.
- E. The cast iron frame shall be set as indicated on the plans in a full mortar bed. The grade or cover shall be properly placed in the frame.

3.06 MANHOLE TESTING

- A. Manholes shall be tested separately by one of the following two procedures:
 1. Exfiltration Leakage Test: All pipes and other openings into the manhole shall be suitably plugged and the plugs braced to prevent blowout.

The manhole shall then be filled with water to the top of the cone section. A period of time may be permitted, if the Contractor so wishes, to allow for absorption. At the end of this period, the manhole shall be refilled to the top of the cone, if necessary, and the measuring time of at least four hours begun. At the end of the test period, the manhole shall be refilled to the top of the cone, measuring the volume of water added. This amount shall be converted to gallons per vertical foot depth for 24 hours. The leakage for each manhole shall not exceed one gallon/vertical foot/day. If leakage exceeds the allowable rate, repairs shall be made as approved by the Engineer and the manhole retested.

If the Contractor elects to backfill prior to testing, the testing shall be at his own risk, and it shall be incumbent upon the Contractor to determine the reason for any failure of the test. No adjustment in the leakage allowance will be made for unknown causes such as leaking plugs, absorption, etc. It will be assumed that all loss of water during the test is a result of leaks through the joints or through the concrete. Furthermore, the Contractor shall take any steps necessary to assure the Engineer that the water table is below the bottom of the manhole throughout the test.

2. Vacuum Test: This method of testing manholes for leakage involves the use of a device for sealing the top of the manhole cone section and pumping the air out of the manhole, creating a vacuum and holding this vacuum for a prescribed period of time. The procedure for this test is as follows:
 - a. All lifting holes and exterior joints shall be filled and pointed with an approved non-shrinking mortar. The completed manhole shall not be backfilled prior to testing. Manholes which have been backfilled shall be excavated to expose the entire exterior prior to vacuum testing or the manhole shall be tested for leakage by means of the exfiltration leakage test.
 - b. All pipes and other openings into the manhole shall be suitably plugged in a manner to prevent displacement.
 - c. A plate with an inflatable rubber ring the size of the top of the manhole shall be installed by inflating the ring with air to pressure adequate to prevent leakage of air between the rubber ring and the manhole wall.
 - d. Air shall then be pumped out of the manhole through an opening in the plate until a vacuum is created inside of the manhole equal to 10 inches of mercury or an approved vacuum gauge. The removal of air shall then be stopped and the test begun.
 - e. The manhole shall pass this test if the vacuum holds at 10" Hg or drops no lower than 9" Hg within the following times:

Depth of 4' Manhole	Time	
	Minutes	Seconds
0' - 10'	2	0
10' - 15'	3	30
15' - 20'	3	0
20' - 25'	3	30

f. If the vacuum drop exceeds 1" Hg during the specified time periods, the manhole shall be resealed and Steps 2 through 5 above repeated until the vacuum holds for the specified time.

g. After the manhole passes the vacuum test, it shall be backfilled carefully so that no leaks are created. If the manhole is disturbed in any way during backfill, it shall again be vacuum tested according to Steps 1 through 5 above. If the manhole fails the vacuum test, the Contractor shall test the manhole using the manhole exfiltration test.

h. The Contractor shall provide the Engineer with a written log of each manhole leakage test result.

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TOWN OF SHELBURNE SEWER LINE RELOCATION SPECIFICATIONS

Shelburne NH EGC 019-4 (27)
Sheet 491 of 537



Date	Ch'kd	Revision
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