

DIVISION 31 - EARTHWORK

SECTION 31 23 33 - TRENCHING, BACKFILLING AND COMPACTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes
1. Excavating trenches for utilities and site piping.
 2. Backfilling and compaction of utility and site piping trenches.

1.02 REFERENCES

- A. American Association of State Highway and Transportation Officials:
1. AASHTO T 99, Moisture-Density Relations of Soils, Using a 5.5-lb Rammer and a 12-inch Drop.
 2. AASHTO T 191, Standard Method of Test for Density of Soil In-Place by the Sand Cone Method.
- B. American Society for Testing and Materials:
1. ASTM D698 - Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
 2. ASTM D1556 - Test method for Density and Unit Weight of Soil in Place by Sand Cone Method.
 3. ASTM D 2216 - Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock
 4. ASTM D2321 - Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
 5. ASTM D2922 - Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
 6. ASTM D3017 - Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
 7. ASTM D4643 - Test Method for Determination of Water Moisture Content of Soil by the Microwave Oven Method
- C. Pennsylvania Department of Transportation:
1. PennDOT Publication 408, latest edition
 - a. PennDOT Section 703.2, Coarse Aggregate
 - b. PennDOT Section 703.3, Select Granular Material

- c. PENNDOT Section 220, Flowable Backfill
- d. PENNDOT Section 601, Pipe Culverts
- 2. PennDOT Chapter 459, Occupancy of Highways by Utilities, latest edition
- 3. PennDOT Chapter 203, Temporary Traffic Control Guidelines, latest edition

1.03 DEFINITIONS

A. Definitions:

- 1. **Unclassified Excavation:** Removal of materials of any kind in the excavation, including rock excavation.
- 2. **Miscellaneous Unclassified Excavation:** Unclassified Excavation required by the Engineer and not included in other items for payment.
- 3. **Miscellaneous Aggregate Backfill:** Aggregate backfill required by the Engineer and not included in other items of payment.
- 4. **Miscellaneous Earth Backfill:** Earth backfill required by the Engineer and not included in other items of payment.
- 5. **Subgrade:** Trench bottom prepared as specified to receive first class bedding, concrete cradle or concrete encasement or the bottom of excavations prepared to receive pipe line structures.
- 6. **Utility:** Any buried pipe, duct, conduit or cable.
- 7. **Final Surfacing Elevation:** Elevation of bottom of final surfacing operation such as bottom of topsoil depth or paving subgrade.

1.04 SUBMITTALS

- A. Submit in accordance with requirements of Section 01 33 00.
- B. **Product Data:** Submit data for each type of aggregate proposed.
- C. **Samples:** Submit aggregate samples when requested by the Authority and other required submissions to the Engineer's field office.
- D. **Test Reports:**
 - 1. Submit testing laboratory aggregate test reports based on requirements stated in Source Quality Control.
 - 2. Compaction density test reports based on method of density determination as specified in Reference Standards and the method as approved by the Authority.
- E. **Certificates:** Submit certificate from aggregate supplier based on requirements stated in Source Quality Control.
- F. **Bonds and Licenses:** Submit evidence of bonds, licenses, and experience prior to commencement of any blasting operations.

1.05 QUALITY ASSURANCE

- A. Source Quality Control:
 - 1. Laboratory Tests: Aggregate materials specified require advance examination or testing according to methods referenced, or as required by the Authority.
 - a. Testing laboratory shall furnish two copies of test result reports to the Authority. Same reports will be considered as sufficient evidence of acceptance or rejection of materials represented.
 - b. Conduct aggregate quality tests in accordance with requirements of appropriate Referenced Standard for such materials.
 - c. The Authority reserves the right to accept aggregate materials based on certification from supplier that the aggregate originates from a source approved by PennDOT and that the aggregate complies with specified PennDOT requirements.
 - d. The Contractor shall pay for all testing required by this section.
- B. Regulatory Requirements
 - 1. Work performed within Township rights-of-ways shall be completed according to all requirements of the Township.
 - 2. Work performed within PennDOT rights-of-ways shall be completed according to all requirements of PennDOT.

1.06 PROJECT/SITE CONDITIONS

- A. Classification of Excavated Materials: Unclassified excavation as defined herein this Section. No consideration will be given to the nature of the materials encountered in trenching operations or for difficulties encountered during excavating or handling of materials.
- B. Removal of Obstructions:
 - 1. Remove, realign or change the direction of above or below ground utilities and their appurtenant supports, if such is required in the opinion of the Authority. Perform work as extra work unless work is done by the Authority of the obstruction without cost to the Contractor. However, Contractor shall uncover and sustain the obstruction at own expense prior to the final disposition of obstruction. The Contractor is not entitled to claims for damage or extra compensation due to the presence of such obstruction or delay in the removal or rearrangement of same. Additional precautions concerning obstructions are as follows:
 - a. Do not interfere with persons, firms, corporations or utilities employing protective measures, removing, changing or replacing their property or structures, but allow said persons, firms, corporations or utilities to take such measures as they may consider necessary or advisable under the circumstances; which shall not relieve the responsibilities of the Contract.
- C. Environmental Requirements:
 - 1. Do not perform trenching, backfilling or compacting when weather conditions or the condition of materials, in the opinion of the Engineer, are not suitable for the

- work to be performed satisfactorily.
2. Do not use frozen materials as backfill nor wet materials containing moisture in excess of the amount necessary for satisfactory compaction.
 3. Prior to use, moisten dry backfill material not having sufficient moisture to obtain satisfactory placement or compaction.
 4. Plan work so as to provide adequate protection during storms with provisions available for preventing flood damage. Protect installed piping and other work against damage from uplift due to high ground water levels.
 5. Accommodation of Drainage: Keep gutters, storm sewers, drains and ditches open for surface drainage. No damming or ponding of water in gutters or other waterways will be permitted, except where stream crossings are necessary and then only to an extent which the Authority shall consider necessary. Do not direct water flows across or over pavements except through approved pipes or properly constructed troughs. When so required, provide pipes or troughs of such sizes and lengths as required, and place the same as required at no expense to the Authority. Perform grading in the vicinity of trenches so that the ground surface is properly pitched to prevent water running into the trenches.
 6. Pumping: Keep excavations free from water during the performance of the work. Build dams and other devices necessary for this purpose, and provide and operate pumps of sufficient capacity for dewatering the excavations. Provide for the disposal of the water removed from excavations in such manner as not to cause injury to the public health, to public or private property, to the work of others, to the portion of the work completed or in progress or produce an impediment to the use of streets, roads and highways. Comply with all requirements of the projects approved Erosion and Sedimentation Control Plan.
 7. When it is necessary to haul soft or wet soil material over roadways, use suitably tight vehicles to prevent spillage. Clear away spillage of materials caused by hauling on roadways.
 8. Provide effective dust and mud control.
 9. Do not dispose of water in trenches by draining through completed portions of utility piping.
- D. Protection: The Contractor assumes the risks presented due to the presence or proximity of overhead or underground public utility and private lines, pipes, conduits and support work, existing structures and property of whatever nature. Damages and expenses for direct or indirect injury to structures or to any person or property by reason of them or by reason of injury to them; whether such structures are or are not shown, by work of this Contract, rests solely with the Contractor.
1. Outside Rights-of-Way: Take necessary precautions to protect trees, shrubs, lawns and such other landscaping from damage. Complete restitution work for damages at no additional cost to Authority.
 2. Pipe Supports: Adequately support underground pipes or conduits exposed as a result of excavations. Provide adequate support along the entire exposed length. Install supports in a manner that backfilling may be performed without dislodging pipes or conduits. Place and carefully compact aggregate backfill around the supports and leave supports in place as a guard against breakage due to backfill settlement.

3. Temporary Protective Construction:
 - a. Temporary Fence Barricade: Erect and maintain substantial temporary fences surrounding excavation to prevent unauthorized persons from entering such areas.
 - b. Barricades: Furnish and erect substantial barricades at crossings of trenches, or along trenches, to protect the traveling public.
 - c. Excavation Covers: Cover open excavation when work is suspended or left unattended, including the end of a work day. For covers, use materials of sufficient strength and weight to prevent removal by unauthorized persons.
 - d. Remove temporary protective construction at the completion of work on the Project.
 - e. Comply with Township and PennDOT requirements.

- E. Structure Supports: Where passing buildings or any structure which by construction or position might bring a great pressure upon the trenches, the right is reserved by the Authority to require that buildings or structures be underpinned or supported and protected, or special sheeting be driven or that short lengths of trench be opened at one time. Failure of the Authority to recommend protection shall not relieve the Contractor of his responsibility to protect structures near the construction.

- F. Accommodation of Traffic: DO NOT OBSTRUCT FIRE HYDRANTS or FIRE FILL STATIONS, if existing in the project area. Employ traffic control measures in accordance with PennDOT, Title 67, Chapter 203, latest edition and in accordance with Township requirements.

- G. Explosives and Blasting:
 1. Blasting is only permitted with the written authorization of the Authority.
 2. Blasting will not be permitted in areas where the proximity of structures, underground facilities or public safety precludes the use of explosives.
 3. The use of explosives shall be governed by the "Regulations for the Storage, Handling and the Use of Explosives" of the Pennsylvania Department of Labor and Industry and any other applicable federal, state, local codes that may have jurisdiction, or utility company requirements.
 4. All blasts shall be properly matted and securely covered. The Contractor shall be solely responsible for injury to persons or property located within or beyond the area or scope of the project that may result from use of explosives.
 5. Blasting work shall be supervised by personnel licensed and experienced in this type of work.
 6. Explosives shall be stored in state-approved magazine off the job site and shall be delivered to the site in vehicles clearly marked to indicate cargo.
 7. The Contractor shall obtain any necessary federal, state, or local blasting permits or approvals and blasting bonds and/or insurance, as required. The Contractor shall be solely responsible for damage to streets located within or beyond the area or scope of the project that may result from the use of explosives.

- 8. All Blasting shall conform to the requirements of the adjacent applicable utilities, railroad and PennDOT requirements.
- 9. Blasting operations shall only be conducted during hours approved by the Authority and as conditioned through permits or approvals.
- H. Removal of Rock by Means Other Than Blasting: Where removal of rock by means other than blasting is required, in accordance with the requirements of State and local laws, rules and regulations, and utility owner requirements, remove by the use of mechanical surface impact equipment, or by drilling and hydraulic rock splitting equipment, or by other methods.
- I. Responsibility for Condition of Excavation: Condition and results of excavation are solely the responsibility of the Contractor. Remove slides and cave-ins at whatever time and under whatever circumstance they occur.
- J. Excess Materials: No right of property in materials is granted to the Contractor of excavated materials prior to backfilling. This provision does not relieve the Contractor of his responsibility to remove and dispose of surplus excavated materials.
- K. Borrow Material: When the required quantity of backfill material exceeds the quantity of suitable on site material, provide borrow material. If borrow material is needed, notify the Authority sufficiently in advance to permit validation of the need and to view the proposed borrow pit to determine the material suitability. Borrow excavation will be subject to the Authority's approval whose written consent shall be obtained prior to its use. Contractor shall be responsible for all sampling and testing required by the Authority to determine suitability.
- L. Change of Trench Location or Depth:
 - 1. Should a change in trench location from that indicated on the approved drawings be required due to the presence of an obstruction, or from other cause, the Authority shall be notified and a corrective action plan shall be submitted for review and approval. No work deviating from approved drawings shall proceed without the Authority's approval.
 - 2. Minor changes may be field approved provided that the resulting work complies with minimum design and construction standards established by the Authority.
- M. Advance Trenching: Where existing Utilities or other suspected underground obstructions as indicated on the Drawings are within close proximity of proposed pipelines, uncover and verify the exact location of Utilities and other underground obstructions far enough in advance of pipe laying to allow any changes in pipe alignment or grade required to bypass the obstructions to avoid removing sections of pipe already installed. If any sections of installed pipe must be removed and reinstalled as a result of not verifying Utilities or other underground obstructions far enough in advance, the Contractor shall remove and reinstall the pipe at no additional cost to Owner.
- N. The Authority reserves the right to order cessation of the work during inclement weather, if, in the opinion of the Authority, the safety of the workman is endangered or if the work quality is endangered.
- O. All work of this section is subject to inspection by the Authority or its representative. Full access shall be granted.

1.07 SEQUENCING

- A. Verify work associated with lower elevation Utilities is complete before placing higher elevation Utilities.

PART 2 - PRODUCTS

2.01 FILL MATERIAL

- A. Backfill
 - 1. Suitable Trench Backfill Material: On site excavated soil or soil-rock mixed materials free of topsoil, vegetation, lumber, metal and refuse; and free of rock or similar hard objects larger than six inches in greatest dimension. Rock to soil ratio shall not exceed one part rock to three parts soil.
 - 2. Clean Organic Material Backfill: One site excavated material free of vegetation, lumber, metal and refuse, and free of rocks or similar hard objects larger than one inch in greatest dimension. Rock to soil ratio shall not exceed one part rock to three parts soil.
 - 3. Aggregate Backfill: PennDOT 2A Coarse Aggregate conforming to PennDOT Publication 408, Section 703.
 - 4. Flowable Backfill: Type A or B: In accordance with PENNDOT Section 220 – Flowable Backfill
- B. Pipe Bedding
 - 1. First Class Bedding: Coarse Aggregate conforming to PennDOT Publication 408, Section 703.2
 - a. For piping having a diameter of 24 inches and less use AASHTO No. 8 Coarse Aggregate.
 - b. For pipes having a diameter greater than 24-inches use AASHTO No. 57 Coarse Aggregate.
 - 2. Initial Backfill: Coarse Aggregate conforming to PennDOT Publication 408, Section 703.2
 - a. For piping having a diameter of 24 inches and less, use AASHTO No. 8 Coarse Aggregate.
 - b. For pipes having a diameter greater than 24-inches use AASHTO No. 57 Coarse Aggregate.
- C. Concrete Cradle, Encasement and Backfill: Conforming to PennDOT 408 Section 704, Class A Concrete with a 28-day compressive strength of 3,000 psi.
- D. Unsuitable Bearing Replacement Material: AASHTO No. 3 Coarse Aggregate conforming to PennDOT Publication 408, Section 703.2.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Protect plant life, lawns, rock outcropping and other features remaining as a portion of final landscaping.
- D. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- E. Maintain and protect above and below grade utilities which are to remain.

3.02 EXCAVATING

- A. Perform soil erosion and sedimentation control work in accordance with the approved Erosion and Sedimentation Control Plan.
- B. General:
 - 1. Excavation shall be performed to the lines and grades indicated on the Drawings or as directed by the Authority.
 - 2. Perform excavation and backfilling using machinery except where hand excavation and backfilling is required or is necessary to protect existing structures, utilities, or other private or public properties.
 - 3. Begin excavation in trenches at the control point having the lower invert and proceed upward.
 - 4. Remove pavement according to requirements of Section 32 12 00 – Flexible Paving and Surfacing.
 - 5. Remove rock to subgrade at least twenty-five (25) feet in advance of pipe laying.
 - 6. Do not interfere with 45 degree bearing splay of foundations.
- C. Subgrade Preparation:
 - 1. Do not excavate below depths indicated or specified except where unsuitable material is encountered at subgrade.
 - 2. Remove unsuitable material found below subgrade to a depth determined by the Authority and backfill with Suitable Bearing Replacement Material or as directed by the Authority to required Subgrade.
 - 3. Remove rocks or other hard matter protruding through trench bottom at Subgrade which could damage pipe or impede consistent backfilling or compaction. Backfill with first class bedding to required Subgrade. Compact in four (4) inch lifts.
 - 4. Remove rock below subgrade if shattered due to excessive drilling impact or

splitting operations and in the opinion of the Authority is unfit for foundations.
Backfill to Subgrade with Concrete or other material acceptable to the Authority.

D. Excavated Material Storage:

1. Separate and stockpile in designated area, excavated materials suitable for use as backfill. Remove from the site, excess materials and excavated materials not suitable for backfill.
2. In no case shall excavated materials be stockpiled outside of the construction easements or the permanent right-of-way if construction easements are not in place.

E. Trench Width:

1. From subgrade elevation to an elevation at least twelve inches above the top of the outside barrel of the pipe, excavate trench banks to vertical lines and not less than the minimum nor more than the maximum widths specified in Table A. If shoring is required, the following Table A dimensions apply to the inside face of sheeting.

TABLE A		
Diameter of Pipe	Minimum Trench Width (Outside Diameter of Pipe at the Barrel Plus)	Maximum Trench Width (Outside Diameter of Pipe at the Barrel Plus)
4 through 24 inches	12 inches	16 inches
27 through 36 inches	20 inches	24 inches
42 through 72 inches	26 inches	30 inches
Larger than 72 inches	30 inches	36 inches

2. From a point twelve inches above the top of the outside barrel of the pipe, maintain trench banks as follows:
 - a. Vertical as possible for trenches in paved or unpaved roadways.
 - b. In open areas, trenches may be sloped at angles required to make trench stand; however, in no case shall angle exceed one-half horizontal to one vertical.
 - c. Top of trench shall not exceed limits of right of way or construction easement if such is in place.
 - d. Maintain trenches such that there is no conflict with State or OSHA regulations.

F. Length of Open Trench:

1. Complete trench excavation at least twenty-five (25) feet but not more than one hundred (100) feet in advance of pipe laying and keep trenches free from obstructions, except that at the end of a work day or at the discontinuance of work, the pipe laying may be completed to within five feet of the end of the open trench.

2. The Contractor shall limit all trench openings to a distance commensurate with all rules of safety.
3. If the work is stopped either totally or partially, the Contractor shall refill the trench and temporarily restore over the same at his expense. The trench shall not be opened until he is ready to proceed with the construction of the pipeline.
4. The Authority reserves the right to request trench refilling over completed pipe if in its judgement, such action is necessary.

3.03 PIPE BEDDING

- A. Place First Class Pipe Bedding and Initial Backfill as specified unless otherwise approved in writing by the Authority. Place material in trench for full width. Place on each side of pipe and fittings simultaneously.
- B. First Class Bedding: Carefully place on undisturbed subgrade or compacted subgrade as approved by the Authority, pipe bedding material from six (6) inches below outside of pipe barrel to pipe springline. Work pipe bedding material by hand under pipe haunching to provide adequate side support. Place in three (3) inch layers.
- C. Initial Backfill: From pipe springline to twelve (12) inches above outside of pipe barrel carefully place initial backfill in four (4) inch layers. Place carefully so as not to disturb pipe.

3.04 BACKFILL

- A. Unless otherwise required, backfill trenches to existing contours and elevations. The Contractor should record existing contours prior to starting work. A copy of this information should be forwarded to the Authority for record purposes
- B. Maintain optimum moisture content of fill materials to attain required compaction density.
- C. Do not use frozen backfill materials or place backfill on frozen subgrades or trench subgrades.
- D. Perform backfilling by methods which will result in thorough compaction of backfill material.
- E. Backfill to Final Restoration Elevation: Backfill from one (1) foot above the top of pipe to Final Restoration Elevation using backfill materials specified in Schedule at end of this Section. Consolidate backfill materials evenly from center to side of trench to prevent arching.
- F. If there is a deficiency of backfill material, provide borrow material as required at no additional cost to Owner

3.05 FLOWABLE BACKFILL

- A. Provide Flowable Backfill for abandonment of existing sanitary sewer facilities and for backfill material within PennDOT right-of-way where required by PennDOT.
 1. Do not place Flowable backfill at a material temperature below 10°C (50° F).

3.06 AGGREGATE BACKFILL

- A. Provide Aggregate Backfill material under all paved services, where required by the Authority, in accordance with Section 459.8 (G)(2) and Section 703.2 of PennDOT Publication 408, and as required by conditions of a PennDOT highway occupancy permit.

3.07 CLAY DIKES

- A. Clay Dikes shall be installed at the midpoint of all gravity sewer runs, where indicated on the Contract Drawings, and where directed by the Authority based on field conditions.

3.08 COMPACTION

- A. Solidly tamp each layer of bedding around the pipeline and above pipeline using proper tamping tools made especially for this purpose. Compact each layer to the densities specified in the Schedule contained at the end of this Section using ASTM D698 Standard Proctor Test Methods determined at maximum density at optimum moisture content as determined by AASHTO T 99.
- B. Do not use rolling equipment or heavy tampers to consolidate backfill until at least two (2) feet of backfill is placed over the top of the pipe.
- C. The use of HYDRA- HAMMER for compacting backfill in trenches is prohibited.
- D. The use of puddling or jetting for compacting backfill in trenches is prohibited.
- E. Compaction Tests: During the course of backfilling and compacting, the Authority may at various locations and depths of trenches request that the Contractor make field tests to verify that specified compactions are being achieved. Perform field density tests according to AASHTO T 191 or ASTM D2922 and ASTM D3017. Payment for testing will be responsibility of the Contractor. At a minimum, the following will apply:
 - 1. Conduct compaction tests within the PennDOT right-of-way as required by PennDOT.
 - 2. One compaction test shall be performed at every two vertical feet of backfill every 200 linear feet in roadways, paved areas, and driveways, etc.
 - 3. One compaction test shall be performed at every four vertical feet of backfill every 2,000 linear feet in all other areas.
- F. If compaction tests indicate that Work does not meet specified requirements, remove Work, replace, compact and retest.

3.09 CLEAN-UP AND MAINTENANCE

- A. General: During construction, the surfaces of all areas including, but not limited to, roads, streets, and driveways shall be maintained on a daily basis to produce a safe, desirable, and convenient condition. Streets shall be swept and flushed after backfilling, and re-cleaned as dust, mud, stones and debris caused by the work, or related to the work again accumulates.

- B. Remove surplus excavated materials, rubbish and other construction debris from the site after backfilling is completed.
- C. Construction site shall be left clean at end of each working day to satisfaction of the Authority.

3.10 RESTORATION SCHEDULE

				SURFACING PER SECTION 32 12 00				
				Temporary		Permanent		
Surfacing ID. No.	Description	Backfill and Compaction per Section 31 23 33		Base	Surface	Sub-Base (Note 4)	Base (Note 4)	Surface (Note 4)
		Type	Compaction % (Note 1)					
1.00	Vegetation							
1.01	Roadside, Mowed	Suitable	90	(Note 2)	(Note 2)	N/A	(Note 3)	(Note 3)
1.02	Lawns	Suitable	90	(Note 2)	(Note 2)	N/A	(Note 3)	(Note 3)
1.03	Open Fields, Pasture	Suitable	90	(Note 2)	(Note 2)	N/A	(Note 3)	(Note 3)
1.04	Woods	Suitable	90	(Note 2)	Note (2)	N/A	(Note 3)	(Note 3)
2.00	Private							
2.10	Paved							
2.11	Paved Driveway	Aggregate	100	N/A	Note 6	N/A	Note 6	Note 6
2.20	Improved							
2.21	Improved Surface	Suitable	90	N/A	N/A	N/A	N/A	6" 2A
2.31	Concrete Driveway	Aggregate	100	N/A	N/A	N/A	Note 5	Note 5
2.41	Stream Bottom	Aggregate	100	N/A	N/A	N/A	Note 5	Note 5
3.00	Municipal							
3.11	Paved Street	Aggregate	100	2A	Note 6	6" 2A	Note 6	Note 6
3.21	Improved Surface, Road	Aggregate	95	N/A	N/A	N/A	N/A	6" 2A
4.00	PennDOT							
4.01	Paved Road	Aggregate	100	2A	Note 6	6" 2A	Note 6	Note 6
4.02	Paved Shoulder	Aggregate	100	2A	Note 6	6" 2A	Note 6	Note 6
4.03	Improved Shoulder	Aggregate	100	N/A	N/A	6" 2A	N/A	Oil and Chip
4.04	Outside Existing Shoulder	Suitable	95	N/A	N/A	N/A	N/A	(Note 3)
Note 1	Percent (minimum) of maximum dry density as determined by Standard Proctor Test.							
Note 2	Comply with requirements of Erosion & Sedimentation Section.							
Note 3	Comply with requirements of Section 32 92 00.							
Note 4	Minimum depths required or match existing depth if greater.							
Note 5	Restore to original condition.							
Note 6	Comply with restoration details shown on drawings.							

END OF SECTION