PennDOT LTAP
technical
INFORMATION
SHEET #163
WINTER/2014

PIPE CULVERT TRENCHING AND BACKFILL

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Among a municipality's important infrastructure assets is a wide range of pipe culverts for stormwater, subsurface drainage, and subsurface utility facilities, including sanitary sewers, water mains, gas lines, and electrical conduits. Although these facilities are basically out of sight and out of mind, eventually, they must be maintained, repaired, or replaced.

Municipal road crews are familiar with maintaining stormwater culverts, which often cross pavements perpendicular to the road. However, utility facilities are frequently situated in highway rights-of-way and through convenience are installed under the pavement surfaces. These facilities typically run parallel with the roads and shoulders. Excavating to maintain, repair, replace, or install new pipe culverts or utility facilities can result in disruption and inconvenience to the motoring public during construction.

This information sheet is intended to offer advice of the latest techniques and procedures in restoring pipe trenches to avoid long-term settlement of the pavement and costly and disruptive rework in the future.

Trench Backfill Requirements

PennDOT recently issued revisions to its specifications and construction documentation requirements in an effort to ensure the long-term stability of roadway restoration due to pipe culvert trenching and backfill. The SOL 481-13-03 gives direction on using PennDOT specifications (Section 601–Pipe Culverts) for trench backfill, including subsurface utilities. The requirements more specifically address already established practices for trench backfill to be all-inclusive in similar roadway restorations. PennDOT mandates that these revisions be followed on all such installations on state-owned roadways. However, it is recommended that the same procedures be followed on municipal streets to preserve the long-term integrity of the riding surface.

Many municipalities have their own municipal authorities that use private contractors to perform such work on underground utilities. Contract documents should be prepared with reference to standard requirements for utility trenching and backfill operations. Placing these requirements on the contractor and requiring proper documentation during construction will help to ensure a smooth road surface that is free of settlement over the long term.

Following is a summary of PennDOT's trench backfill requirements:

- All work under sidewalks, shoulders, and roadway should be performed in the presence of an authorized inspector.
- Backfill height is limited to 8 inches maximum per lift when using vibratory compaction equipment or 4-inch maximum layers for other compaction methods.
- Lift heights when using an excavator-mounted hydraulic plate compactor are limited to 8 inches.
- The inspector, in concert with the contractor or utility, documents and signs Form CS-6 for each run of pipe or conduit.
- The utility or authorized contractor certifies compliance of the installation with the provisions of the Publication 408 specifications, including obtaining 100 percent Standard Proctor Density (SPD) in the top 3 feet of fill.
- The inspector documents compaction density obtained by the utility or contractor on Form TR-4276A by Nuclear Method or Form TR-478A by Non-Movement Method.

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Construction Procedures

Due to the high cost of installing either stormwater or underground utility facilities, the following construction procedures are recommended to achieve long-term performance:

- After excavating the pipe trench, always compact the bottom of the open trench prior to placing bedding materials.
- If flowable backfill is being used, make sure the pipe is secured with suitable hold-down and alignment tie-downs to prevent floating.
- Pipe bedding should consist of 6 inches of uncompacted stone material. For concrete pipe, AASHTO No. 8 stone should be used, and for metal or thermoplastic pipe, 2A stone should be used.
- Shape pipe bedding to accommodate bells in the pipe joints if they exist.
- Lay pipe with bells or groves facing up grade starting at the outlet end and continuing to the inlet end of the pipe run.
- Place initial backfill around the pipe consisting of 2A stone to a height of 6/10 of the pipe diameter for concrete pipe. For metal and thermoplastic pipes, place the 2A to an elevation of 1 foot above the top of pipe. These compaction depths must follow the lift thickness guidance noted under the Summary of Trench Backfill Requirements of this report. Compaction density of the trench backfill for these limits must meet minimum 95 percent of SPD.
- Ensure that pipe alignment is maintained during the backfill operation.
- Backfill the remainder of the trench with suitable material. Suitable material is defined as material containing no debris, organic matter, frozen material, or stones greater than one-half the thickness of the lift being placed. Compact the suitable backfill at 97 percent SPD to a height of 4 feet above the top of pipe, and compact the top 3 feet of backfill material at 100 percent SPD. As an option, 2A material may be used in place of suitable material.

Testing and Documentation

During the backfill operation, density testing must be closely monitored. Compaction density is performed by the **Nuclear Method** when the backfill gradation is such that this method is appropriate. Documentation of Nuclear Density testing by the contractor or utility is performed using PennDOT's "Report on Compaction Density by Nuclear Method," Form TR-4276A. Material must be maintained to within minus 3 percent of the optimum moisture content during compaction.

If backfill material is coarse (with more than 20 percent retained on the ¾ sieve and less than 35 percent passing the 200 sieve) or if more than 30 percent passes the ¾ sieve, compaction testing may be performed by using the **Non-Movement Method**. The inspector may use PennDOT's "Report on

TR-4276A (5-92)

REPORT ON COMPACTION DENSITY BY NUCLEAR METHOD

(Reference: P.T.M. No. 402)

FILL OUT COMPLETELY
Original to be retained with project records.
Mail Copy to District Office.

S.R. _____ Sec. _____ County _____ District _____ Date _____

Type of Const.: Embankment _____ Pipe Bkfill. _____ Str. Bkfill. _____

Subgrade _____ Subbase _____ Bit. Material _____

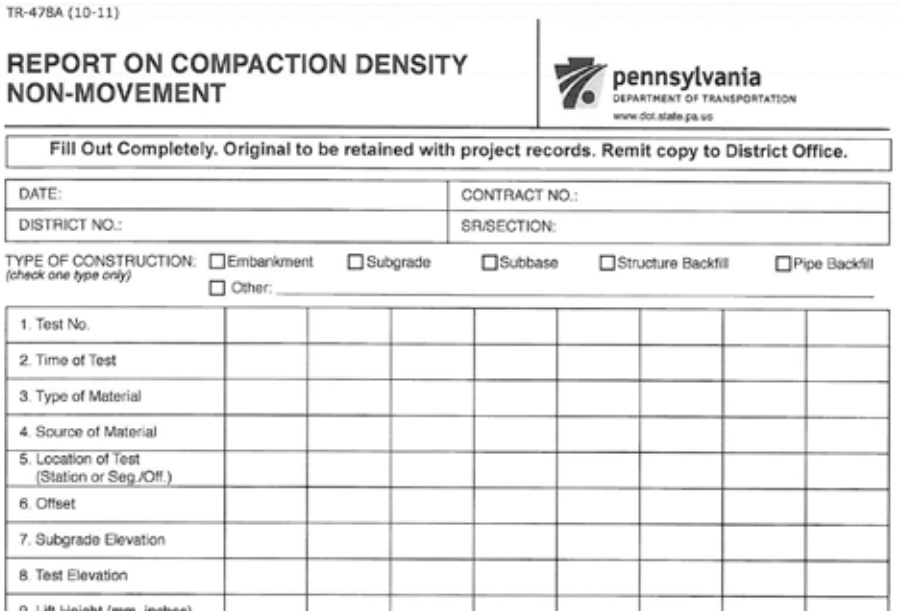
1. Test No.					
2. Time of Test					
3. Type of Material					
4. Station					
5. Offset					
6. Subgrade Elevation					
7. Test Elevation					
8. Source Rod Position					
9. Density Count					
10. Wet Density (PCF)					
11. Mositure Count					
12. Moisture (PCF)					
13. % Moisture					
14. Dry Density (PCF)					
15. Target Density ☐ PTM 740 ☐ Proctor					
16. Optimum Moisture					
17. % of Compaction					
18. Minimum Compaction Requirement					
19. Does Zero Air Voids Formula Check					
20. % of 3/4 Material					
21. PASS/FAIL					

Compaction Density Non-Movement, Form TR-478A." Basically, the backfill must be compacted until it does not rut under a fully loaded triaxle (gross vehicle weight of 75,000 pounds).

In addition to the Report on Compaction Density, PennDOT had developed a new form titled "Pipe Installation Inspection Form," Form CS-6. This form is intended to be used by the inspector to document field installations of all stormwater and underground utility pipes and conduits. The form serves as the source document for pipe and conduit installations and is used for identifying the work description, location, date, and materials. A convenient sketch is used for documenting field measurements and locations of trench and bedding checks. Also, a remarks area and a sketch area are included on the second page to describe and note any field problems or any additional pipes or conduits encountered. The form is available on PennDOT's website in a writable format.

Remember that when installing a variety of pipe materials, the maintenance crews or the contractor must be aware that pipes are designed to meet specific limitations for underground placement. Ensure that maximum backfill heights are not exceeded for the pipe installation and that minimum fill cover of the pipe is met. Failure to pay attention to this detail may result in damaged pipes due to dead load pressures or in shallow installations live loads from vehicles traveling over the pipe installation. Remember that all utility work must follow the requirements of the permit.

Finally, follow all applicable federal, state, and local laws and regulations, provisions, and policies governing safety and health including the Occupational Safety and Health Act (OSHA) to protect the life, health, and general occupational welfare of personnel employed on the project.



TR-478A (10-11)

REPORT ON COMPACTION DENSITY NON-MOVEMENT

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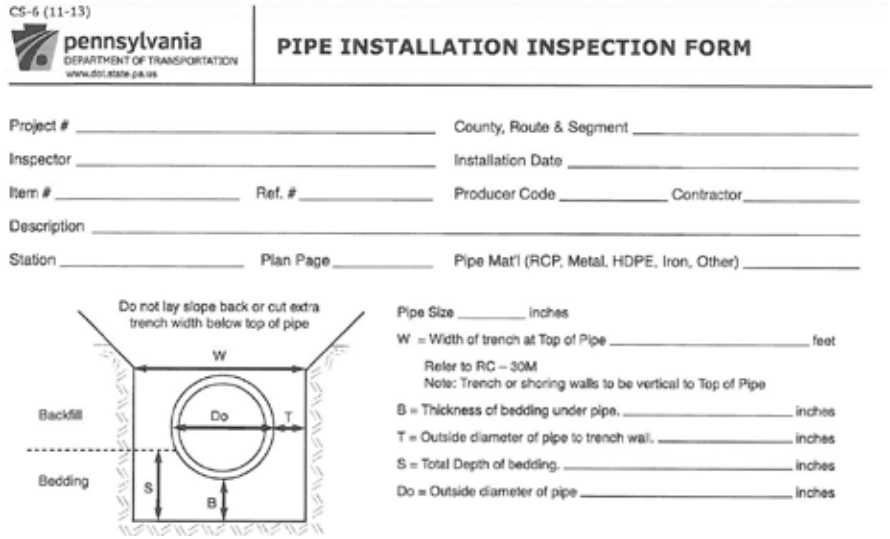
Fill Out Completely. Original to be retained with project records. Remit copy to District Office.

DATE:	CONTRACT NO.:
DISTRICT NO.:	SR/SECTION:

TYPE OF CONSTRUCTION: (check one type only) ☐ Embankment ☐ Subgrade ☐ Subbase ☐ Structure Backfill ☐ Pipe Backfill ☐ Other: _____

1. Test No.								
2. Time of Test								
3. Type of Material								
4. Source of Material								
5. Location of Test (Station or Seg./Off.)								
6. Offset								
7. Subgrade Elevation								
8. Test Elevation								



CS-6 (11-13)

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PIPE INSTALLATION INSPECTION FORM

Project # _____ County, Route & Segment _____

Inspector _____ Installation Date _____

Item # _____ Ref. # _____ Producer Code _____ Contractor _____

Description _____

Station _____ Plan Page _____ Pipe Mat'l (RCP, Metal, HDPE, Iron, Other) _____

Pipe Size _____ inches

W = Width of trench at Top of Pipe _____ feet

Refer to RC – 30M
Note: Trench or shoring walls to be vertical to Top of Pipe

B = Thickness of bedding under pipe. _____ inches

T = Outside diameter of pipe to trench wall. _____ inches

S = Total Depth of bedding. _____ inches

Do = Outside diameter of pipe _____ inches

References/Resources

PennDOT Home Page: Forms, Publications & Maps
http://www.dot.state.pa.us:

- Publication 408 Specifications
- Publication 72 Standards for Roadway Construction, RC-30M (Subsurface Drains, Pipe Placement, Excavation, Bedding, Backfill)
- Form CS-6 Pipe Installation Inspection Form
- Form TR-4276A Report on Compaction Density by Nuclear Method
- Form TR-478A Report on Compaction Density Non-Movement