Designation: C1821/C1821M – 16

Standard Practice for Installation of Underground Circular Precast Concrete Manhole Structures[1]

This standard is issued under the fixed designation C1821/C1821M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the procedures to be followed in the planning, site preparation, installation, testing and backfilling of underground vertical reinforced circular precast concrete manholes and components manufactured in accordance with Specification C478 (C478M) and used in sewer, drainage, and water works.

1.2 Concrete pipe and box culverts are not covered under this practice. Also, precast concrete utility structures covered in Specification C858 are excluded from this practice.

1.3 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C443 Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

C443M Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)

C478 Specification for Circular Precast Reinforced Concrete Manhole Sections

C478M Specification for Circular Precast Reinforced Concrete Manhole Sections (Metric)

C822 Terminology Relating to Concrete Pipe and Related Products

C858 Specification for Underground Precast Concrete Utility Structures

C881/C881M Specification for Epoxy-Resin-Base Bonding Systems for Concrete

C923 Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

C923M Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals (Metric)

C928/C928M Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs

C969 Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

C969M Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines (Metric)

C990 Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

C990M Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants (Metric)

C1107/C1107M Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

C1244 Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill

C1244M Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill (Metric)

C1478 Specification for Storm Drain Resilient Connectors Between Reinforced Concrete Storm Sewer Structures, Pipes, and Laterals

C1478M Specification for Storm Drain Resilient Connectors Between Reinforced Concrete Storm Sewer Structures, Pipes, and Laterals (Metric)

D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)

[1] This test method is under the jurisdiction of ASTM Committee C13 on Concrete Pipe and is the direct responsibility of Subcommittee C13.06 on Manholes and Specials.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

F2510/F2510M Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated High Density Polyethylene Drainage Pipes

2.2 *AASHTO Standard:*

AASHTO M145 Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes[3]

2.3 *Federal Standard:*

29 CFR Part 1926 Safety and Health Regulations for Construction[4]

3. Terminology

3.1 *Definitions*—For definitions of terms relating to concrete manholes, see Terminology C822. For terminology related to soil classifications, see Practices D2487 and D2488.

3.2 *engineer, n*—owner's representative, either designer of record or inspector, with responsible charge of the owner's interest during the installation phase of construction.

3.3 *installer, n*—prime contractor, subcontractor, or work crew assigned the responsibility to excavate, place, and backfill the furnished manhole structure.

3.4 *non-shrink grout, n*—a cementitious in accordance with Specification C1107/C1107M, or Specification C928/C928M, or polymer modified in accordance with Specification C881/C881M.

4. Significance and Use

4.1 This practice is useful as a reference by an owner and/or the engineer in preparing project specifications.

4.2 The practice is useful as a reference by an owner, engineer, or installing contractor to properly install precast concrete circular manholes.

5. Site Inspection

5.1 The construction area shall be carefully inspected by the installer using the project drawings and a checklist to identify the work to be done and to determine that the plans are correct.

5.1.1 The location of the circular manhole structure should be where it will cause minimal interference with traffic and shall be clearly defined on project documents.

5.1.2 All underground facilities and structures that are in possible conflict with the installation shall be located and identified. Location markings shall be placed by the affected utilities before the construction.

5.2 The jobsite inspection shall identify any obstacles that will interfere with manhole excavation, unloading or setting operations, product storage, work progress, or create a safety hazard. Precautionary arrangements shall be made before excavation begins.

5.3 The jobsite inspection shall give consideration to the soil structure and ground water table so that proper shoring or sloping or both may be planned in advance of the excavation work that will affect the installation of the manhole structure.

6. Planning

6.1 Permits required to do work in accordance with the detail plans and project construction schedule shall be secured before commencement of the manhole installation.

6.2 All utilities and owners of surface and subsurface facilities and structures in the area shall be given advance notification of proposed excavation directly by the installer or at a designated pre-construction meeting.

6.3 Planning shall include the coordination of all responsible parties, including the designated precast concrete manhole manufacturer to arrange for the delivery, distribution, and storage of required material. If such material cannot be stored on the site, other storage areas or delivery arrangements shall be provided.

6.4 Prior to ordering of the manhole components the installer shall review all proposed manhole installation locations on the project with the design engineer and identify any potential conflicts or reasons for movement of the manhole to a more appropriate location. If a conflict is identified onsite prior to excavation or while performing layout, the engineer shall be notified immediately to propose alternative location and to provide the precast manhole producer opportunity to alter production of the manhole structure.

6.5 The installer shall notify the precast concrete manufacturer if any delays in permits, utility location, or other unforeseen conditions will alter the original agreed delivery schedule or revise a precast manhole structure configuration as shown in the project plans or approved fabrication drawings.

6.6 As required by the owner, engineer, installer or manhole manufacturer shop drawings shall be prepared for approval prior to fabrication. The shop drawings shall include, but not limited to detailed information describing each structure component to be fabricated and the associated assembly of the manhole structures by the installing contractor.

6.6.1 Shop drawings shall also include steel layout details of any specialty items including flattop slabs, flattop reducing slabs, base sections, special barrel section openings, reducer cones.

6.6.2 The shop drawings shall include certification of compliance to the project plans and specifications or clearly note any specific exceptions to the same.

7. Delivery

7.1 Manufacturer shall verify manhole components are in compliance to approved shop drawings prior to shipment to the project site.

7.2 The installer shall inspect the manhole components for damage during shipping and unloading, and any non-compliance to approved shop drawings.

7.2.1 If any damage or non-compliance is identified, the installer shall take corrective action by notifying the manufacturer. Upon inspection if the damage may affect the performance of the manhole structure, the area shall be repaired in

[3] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.

[4] Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, http://www.access.gpo.gov.

accordance with Specification C478. If the damaged manhole component cannot be repaired in accordance with Specification C478, that component shall not be installed.

7.2.2 The installer shall measure the received manhole components upon delivery to verify the products furnished are in compliance to the approved shop drawings. This includes but not limited to: pipe hole placement to confirm pipe entrance and exit angles are correct, the distance from the exterior bottom of the manhole base to the hole placement and corresponding pipe invert elevation to calculate and verify required excavation elevations to maintain pipe grade to project requirements. Verify the manhole components supplied can be constructed to the correct finished grade elevation with components furnished prior to installation. Any identified issues with any of these items shall be reported immediately to the precast manhole manufacturer.

7.2.3 Installer shall verify the delivered frames and covers/grates comply with the project requirements.

7.2.4 If manhole product(s) need to be stored onsite, it is the installer's responsibility to ensure the product is placed on level ground and free from unnecessary mud or debris to prevent damage to the manhole components. Special joint materials: gaskets, lubricant, mastic if furnished shall be stored securely and in accordance with manufacturer's recommendations.

7.2.5 The installing contractor should consult the manufacturer when storing manhole products for periods longer than 30 days.

8. Safety Requirements

8.1 Safety requirements for construction shall be in accordance with all national, regional, and local regulations.

8.2 Manhole components shall only be handled with appropriately rated handling equipment from the safe lift points designated by the manufacturer of the precast manhole sections. Manhole ladders, steps or appurtenances are not to be used as lifting points.

8.2.1 The manhole-lifting apparatus shall meet or exceed safe working load capacity with respect to the lifting points and the unit weight to be handled including all required safety factors as required by code and law within the jurisdiction of the manhole installation. All lifting points shall be used, and the product shall be handled with equal "picking" force on all lifting points.

8.2.2 When lifting manhole bases and risers, make sure the chain or cable lengths are long enough to prevent contact with the manhole joint area and are kept at appropriate lifting angles. Where safe lifting angles cannot be achieved, use appropriately rated spreader bars.

8.2.3 The weight of each section to be handled shall be clearly indicated by marking of the section or on the delivery documents provided to the installer by the precast manhole manufacturer.

8.2.4 Manhole components shall be lifted with equipment appropriate to the application and with sufficient capacity to safely handle the weight of the product.

8.2.5 When transporting manhole components on site it is the installers' responsibility to ensure the speed and mode of transporting the manhole components prevents any possible damage to the product.

NOTE 1—Excessive travel bouncing of the product can introduce unanticipated loadings, cause damage or disassembly of the lifting device to the lifting points.

9. Excavation and Shoring

9.1 The excavation size shall allow for the overall assembled height of the manhole structure including any fabricated sump, plus the height of any grade ring sections, a manhole frame and cover, and any bedding material required. The excavation shall have sufficient width and length, in accordance with local, state, and federal regulations, to ensure safe installation and when compaction of the backfill is required.

9.2 When material unsuitable for installing the manhole components is encountered during excavation it shall be removed to the requirements on the project drawings or as specified by the engineer. Over-excavated areas shall be backfilled with engineer approved materials specified for the leveling course.

9.3 The contractor shall make such provisions as required to ensure adequate drainage of the trench to protect the leveling course during the construction operations. Where surface water or groundwater conditions exist, the site and trench shall be dewatered to a level that will provide satisfactory installation.

9.4 Shoring if utilized for construction shall be in accordance with all national, regional and local regulations.

9.5 If shoring is to be removed it shall be done in accordance with the shoring manufacturer's recommendations or approved safe construction practices. The installer shall use the appropriate lifting equipment to safely remove the shoring and to prevent any disturbance or damage to the manhole.

9.6 Voids in the sidefill that are created by movement of the shoring shall be filled and compacted in accordance with 12.7.

10. Foundation

10.1 The foundation shall be moderately firm to hard in situ material, stabilized soil, or compacted fill material with adequate bearing capacity to support the manhole structure as specified by the engineer or project requirements.

10.2 When unsuitable or unstable material is encountered, the foundation shall be stabilized or removed and replaced with firm and stable foundation material with adequate bearing capacity to support the manhole structure.

NOTE 2—In the presence of high ground water encountered during excavation the installer may choose to excavate to depths greater than required for a dry installation for the purpose of water control. The purpose is for the placement of open graded course aggregate within the soil bedding area, and possibly the use of mechanical pumps to vacate the excess water. When groundwater flow is anticipated, consideration shall be given to the potential of migration of soil fines from the adjacent materials into the open graded course aggregate, which can lead to the loss of manhole structure support. Methods to prevent soil migration shall be provided.

10.3 Manhole sections installed over an unyielding foundation, including concrete, shall be cushioned so as to prevent non-uniform bearing in accordance with Section 11.

11. Leveling Course

11.1 After the required elevation of the excavation has been reached and a stable foundation, as required by the project specifications, has been achieved, the area where the manhole structure is to be located shall be levelled evenly across the excavation.

11.2 A minimum 3 in. [75 mm] thick leveling course in an area not less than manhole base area but preferably 6 in. [150 mm] beyond the outside radius of the manhole base, as shown in Fig. 1, shall be constructed of clean coarse grained soils: USCS SW, SP, GW, GP or any soil beginning with one of those symbols and with 12 % or less passing a #200 [75 µm] sieve (AASHTO M145, A-1, A-3). The nominal maximum aggregate size within the leveling course shall not be greater than 1 in. [25 mm] (#57 aggregate). In the event that the leveling course consists of layers with the upper layer being clean, uncompacted sand, that layer shall be a maximum thickness of 2 in. [50 mm] to prevent non-uniform settlement from personnel and equipment during the installation process.

11.3 In situ materials that provide(s) a suitable leveling course in accordance with this practice or approved by the engineer shall be acceptable.

11.4 Any and all in situ materials not meeting the requirements of the project specifications shall be removed and replaced with approved materials.

11.5 The soil levelling area under the manhole structure shall be of uniform stiffness and thickness to the project specifications with even compaction throughout. Local ground conditions may require additional leveling course thickness per project specifications, the engineer's recommendations, or the installers judgment.

11.6 The soil foundation area or bedding under incoming and outgoing pipes should be treated the same as the manhole base section to prevent settlement or shearing of pipes and to provide proper alignment for the watertight connector/pipe interface if resilient rubber connectors are being used.

11.7 A concrete slab is not an appropriate leveling course.

12. Manhole Installation and Joining

12.1 *General:*

12.1.1 Consult the detailed plan for the correct orientation of the precast concrete manhole to ensure proper alignment with steps, entering pipes, or conduits.

12.1.2 Do not place damaged precast concrete sections unless approved by the engineer.

12.1.3 Do not field modify the structure unless it is determined that such modifications (for example, cuts to form slots or holes) will not adversely affect the strength of the structure. Field modifications shall be reviewed and approved by the engineer.

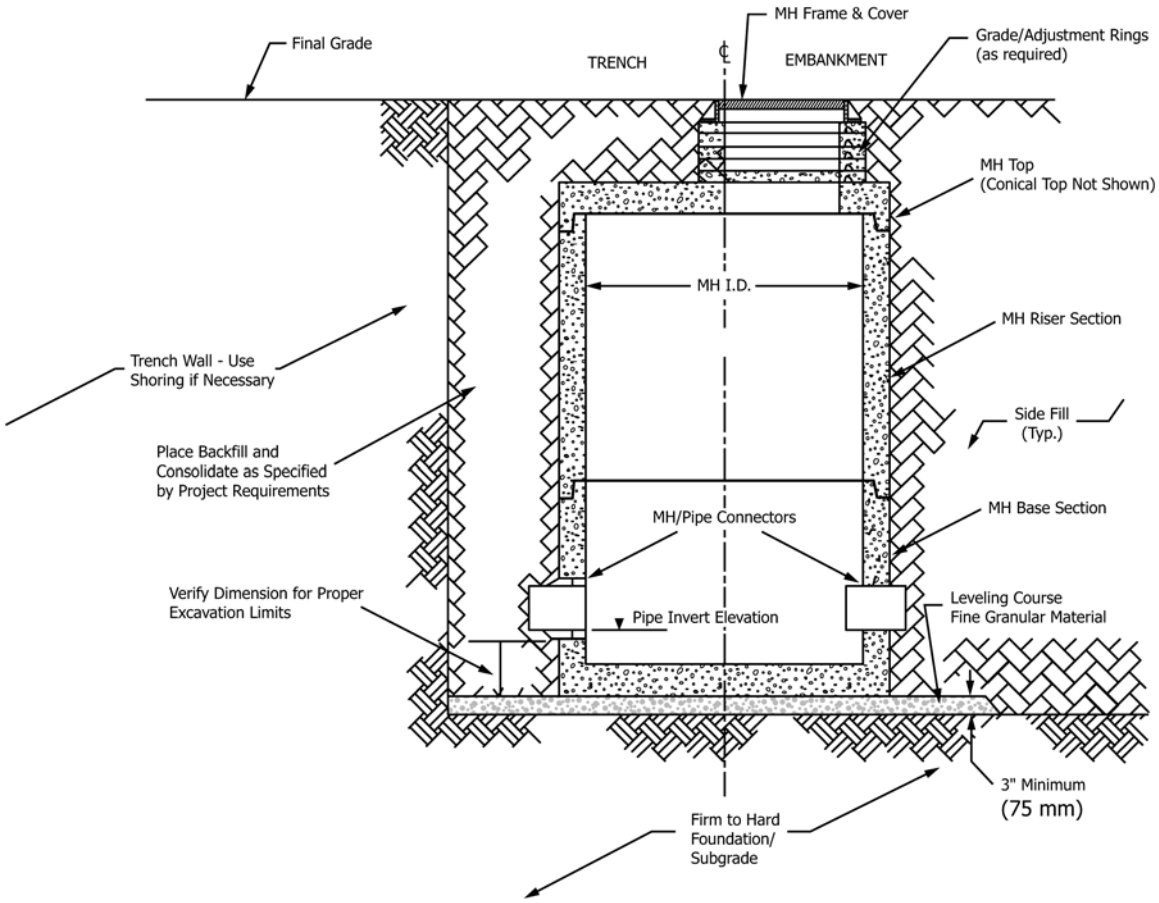

FIG. 1 Manhole Installation Details

12.2 *Structural Considerations:*

12.2.1 Do not install structures under conditions known to result in loads heavier than that for which the structure was designed and/or shop drawings approved.

12.3 *Manhole Placement:*

12.3.1 Set the manhole base on the leveling course making sure the manhole base section is firmly in place and the connectors or pipe openings match design orientation. Verify the top of the manhole base is level in two directions perpendicular to each other.

12.3.2 Verify the manhole base section pipe openings and/or connectors are at proper grade for pipe inverts to match design elevations.

12.3.3 Assemble multi-section manhole structures by lowering each section into the excavation. As they are installed verify each additional riser section is plumb and the joint homed, before installing the next riser, conical top, or flat slab top.

12.3.4 Install the conical top or flat slab top as shown on the approved shop drawing plumb and in alignment similar to the preceding barrel or base section.

12.3.5 Adjacently placed manhole sections shall be aligned to match the step placement of the preceding section if steps are provided. Tolerance of step alignment shall be in accordance with Specification C478 (C478M).

12.3.6 Place adjusting grade rings (if required) along with mastic sealant and frame with cover/grate to achieve specified finished grade.

12.3.6.1 If required by project specifications place internal or external sealant systems within the adjustment area in accordance with specific manufacturer's requirements.

12.3.7 During installation where the possibility exists of a watertight structure becoming buoyant in a flooded excavation, take necessary steps to avoid flotation of the structure.

12.4 *Joints and Joining:*

12.4.1 To ensure joint integrity when assembling the manhole structure the installation contractor is responsible to maintain clean joint surfaces, removing all foreign materials that could damage or impair the jointing surfaces or gasket materials.

12.4.2 All joints shall be installed in accordance with the manhole manufacturer's recommendations using only the materials supplied with the manhole structures.

12.4.3 Manhole joints that utilize resilient rubber gaskets shall be in accordance with Specification C443 (C443M). Additionally, the installation of the gasketed joints shall be in agreement with the manufacturer's recommendations.

12.4.4 Manhole joints that utilize mastic sealing material shall be in accordance with Specification C990 (C990M) and installed in agreement with the manufacturer's recommendations.

12.4.5 If a non-shrink grout is to be used as a seal the material shall be in accordance with Specification C881/C881M, Specification C928/C928M, Specification C1107/C1107M or other approved material by the engineer. Clean and moisten all surfaces to be grouted. The grout should be of a consistency so that it will not flow when applied. Apply the non-shrink grout in a manner to ensure filling of all voids in the joint being sealed.

12.4.5.1 Apply the non-shrink grout in an amount to provide a minimum of ⅜-in. [10-mm] thickness of grout on all joint surfaces. After assembly, dress the interior joints to remove excess grout.

12.4.6 If a misalignment of sections occurs during installation, remove the appropriate section. If the sealing material is damaged, clean the joint surfaces before repairing or placing new sealing material. To a void misalignment of sections the contractor is not prohibited from using guide devices attached to the lower section to position the upper section into place. The guide devices shall be removed after manhole installation.

12.5 *Lift Hole Sealing:*

12.5.1 Lifting holes (full penetration, "see through") shall be sealed by inserting into the hole a rubber or plastic plug, precast plug with mastic sealant or with an approved cementitious material (or filling the opening with non-shrink grout from inside, or outside, or both).

12.5.2 Lifting holes (full penetration, "see through") when employed as weep holes by design shall be sealed by securing outside placement of an approved non-woven geotextile fabric over the opening to eliminate soil migration, but permit water flow.

12.5.3 If required by project specifications, embedded or cast in lift anchors ("non-see through"), shall have the exposed small pocket volumes filled with non-shrink grout or with an impervious mastic material.

12.6 *Pipe-to-Manhole Connections:*

12.6.1 When resilient pipe-to-manhole connectors are furnished, they shall be furnished as follows unless prohibited by project specification:

12.6.1.1 *Sanitary Sewer, Water Reclamation or Reuse Applications*—Specification C923 (C923M), Specification F2510/F2510M.

12.6.1.2 *Storm Sewer Applications*—Specification C1478 (C1478M), Specification F2510/F2510M.

12.6.1.3 Installation of the pipe utilizing the resilient pipe-to-manhole connectors is to be in accordance with the furnished manufacturer's recommendations. When completed, the pipe inverts shall meet the required elevations.

12.6.2 If permitted by project specification or engineer, the installer may choose to use a cementitious non-shrink grouted pipe connection.

12.6.2.1 Cast or cored openings of cementitious grouted connections shall not exceed pipe outside diameter plus 6 in. [150 mm], unless a larger opening is permitted by the engineer.

12.6.2.2 Any pipe ends to be grouted into place shall have a waterstop assembly or material applied on the pipe end, which will be encased within the grouted connection.

12.6.2.3 If a non-shrink cementitious grout is to be used as a seal the material shall be in accordance with Specification C881/C881M, Specification C928/C928M, Specification C1107/C1107M or other approved material by the engineer. Clean and moisten all surfaces to be grouted. The grout should

be mixed in accordance with the grout manufacturer's recommendations and be of a consistency so that it will not flow when applied, unless the grouted area is to be contained by formwork. Apply the cementitious grout in a manner to ensure filling of all voids in the joint being sealed.

12.6.2.4 Permit the cementitious grout to set and cure in accordance with the manufacturer's recommendations before backfilling.

12.6.3 *Field Cut Pipe Openings:*

NOTE 3—Some manhole steel designs such as permissible hoop steel for 48 in. [1200 mm] diameter manholes do not permit pipe openings within the barrel sections. Unanticipated field cuts may require additional design analysis.

12.6.3.1 Any field cut of the manhole structure required for a pipe opening shall be approved by the engineer.

12.6.4 *Pipe Stubs*—Purchaser shall require that all pipe stubs installed, to allow for future connection to the manhole, be mechanically restrained from movement by means other than and in addition to, the resilient connectors.

12.7 *Backfilling and Restoration:*

12.7.1 The installer shall commence backfilling as soon as possible after the manhole structure has been placed and, when required, tested.

12.7.2 Excavations shall be backfilled with an approved or specified soil material free from large stones, rocks, pavement, and other items that could damage the installed manhole structure. Expansive soil material shall not be used as backfill around the structure.

12.7.3 If required by site specifications, when a precast concrete manhole structure is placed in an unpaved area, slope the area around the entrance frame and cover to provide drainage away from the entrance cover. Slope the final grading upward to within 1 in. [25 mm] of the top surface of the frame and cover.

12.7.4 *Backfill Procedures*—Backfilling shall be achieved by using lifts (layers) and compactive effort or flooding (jetting) the excavation to meet the required soil density requirements. Backfill shall be placed around all sides of the installed section in lifts that shall provide adequate densification and not induce a lateral load shifting the manhole sections. If required by project specification, backfill lifts shall be placed uniformly around all sides of the installed section in lift thickness and with compaction to densities specified.

12.7.4.1 The installer is to provide special care and placement of bedding and backfill material under and surrounding pipe connections to manholes to provide firm, uniform support of the pipe at these junctions. This compactive effort is to reduce the potential of pipe shear at the manhole interface due to differential settlement of the surrounding soil.

12.7.5 When prohibited by specification or the engineer, backfill material shall not contain deleterious materials, such as but not limited to; wood, frozen soil, organic soil, trash, soil or items considered hazardous.

12.8 Restoration of the area where the circular manhole structure was installed shall meet the requirements of the project requirements or the engineer.

12.9 Follow-up inspections for settlement are required. Should settlement occur, the contractor shall be responsible for the necessary repair to restore the area to its original condition in accordance with the terms of the project requirements. If settlement is observed at the surface level, pipe connections should be inspected to ensure soundness.

13. Testing

13.1 When required by the owner or designated by the project specification, the installer shall successfully test the completed manhole structure in accordance with the following methods:

13.1.1 Practice C969 (C969M)

13.1.2 Test Method C1244 (C1244M)

14. Keywords

14.1 installation; manhole