Manual of Procedures
For
Pipe Construction

January 1998

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Foreword

This manual is devoted to the proper inspection of pipe construction. It is to serve as a guide to the Project Engineers and the Inspectors in the performance of their duties in administering the contract for the Department. No training is required to receive this manual but personnel assigned to pipe inspection should have a thorough knowledge of the applicable specifications pertaining to pipe construction. The instructions herein are not intended to alter or replace the specifications but are to supplement them and to serve as a reference to fulfill the requirements for the inspection of pipe construction.

I would like to thank the following people for taking time out of their busy day to make comments to the draft copy of this manual; Tom Lefchik, FHWA, Gary Middleton and Ray Koch from District 8, Randy Over and John Murphy from District 12, Bruce Merry from District 1, John Kurdziel from Hancor Inc., North Star Concrete Company, Brad Fagrell, David Riley, Kevin White and Jim Barna of Structural Engineering, Joe Neidhardt from The Indiana, Kentucky and Ohio Concrete Pipe Association, James Goddard and John Hurd from Advanced Drainage Systems, and Joe Broschart from ODOT. A special thanks goes to Cynthia Lee from the Office of Highway Management who made forms, organized and edited the final version of this manual and who has help me tremendously on several WordPerfect and computer related problems.

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File: W: culvert:pipemanu:manualg

Introduction

Buried pipe structures may consist of concrete, metal, plastic, clay or a combination of these materials with other products. Pipe structures may be round, elliptical, boxed or three sided. The pipe structure for all pipe materials is a combination of the pipe, the foundation, the bedding and the backfill materials that work together to support the loads.

The proper installation is extremely important to the performance of these buried pipe structures. If pipe joints are not properly sealed, the backfill may filter through the pipe joint causing voids in the embankment. If the bedding or backfill materials are not properly compacted, the material may settle causing depressions in the roadway surface. If the trench widths are too narrow proper placement and compaction of the bedding and backfill material in the critical haunch zone below the spring line of the pipe cannot be achieved. If the trench is too wide the structural loads on rigid (concrete or clay pipe is different than the design load causing an overload on the pipe. If a thermoplastic pipe is punctured with a backhoe during installation, it cannot support the design loads and may fail during service. Any of these examples or other problems associated with the lack of proper installation will increase maintenance costs, shorten the design life of the pipe and may lead to the collapse of the pipe.

The Project Engineers and Inspectors are the last defense against future problems with buried pipe. These situations can be prevented by thoroughly inspecting the installation and insuring adherence to the plans and specifications. The specifications for this work may be found in Item 603, Pipe Culverts, Sewers, and Drains of the *Construction and Materials Specifications (CMS)*.

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101.0 General

Sound field changes to plan requirements necessitated by changes in insitu conditions can be made only if project personnel have an understanding of the pipe types shown in the plans. The types of pipe are specified in accordance with their application and intended usage. The following is a brief description of typical applications. If you need a more detailed description, see Section 1002.3 of Ohio Department of Transportation's (ODOT) *Drainage Design Manual* and the plans.

102.0 Type A Conduit

Type A conduits are sealed culvert cross drains under pavements, paved shoulders and embankments. These culvert cross drains are used to convey water from one side of the roadway to the other. These culverts can be either smooth lined or corrugated. Type A pipe are under pavements and open on both ends.

103.0 Type B Conduit

Type B conduits are storm sewers under pavements and paved shoulders and commercial or industrial drives. Storm sewers are used to convey water from one manhole or a catch basin to the other. Storm sewers are always smooth lined. Type B pipe are under pavements and with one or both ends closed.

104.0 Type C Conduit

Type C conduits are storm sewers not under pavements or paved shoulders and commercial nor industrial drives. Like the Type B conduits these conduits are connected to a manhole or catch basin and are always smooth lined. Type C pipe are beyond the limits of the roadway and shoulders.

105.0 Type D Conduit

Type D conduits are pipes under residential driveways or bikeways.

106.0 Type E Conduit

Type E conduits are farm drain headers in or outside the right-of -way or used for ditch elimination beyond the paved shoulder.

107.0 Type F Conduit

Type F conduits are other miscellaneous pipe where a butt joint or a short length jointed pipe would be undesirable. Outlets for underdrain or farm drains, house drain connections, pull box drains or for steep portions of a median outlet under an embankment are examples of Type F applications.

201.0 General

All pipe, including plant inspected and certified materials, shall be inspected for dimensions and condition after it is delivered to the project. Where the dimensions fail to comply with the specified tolerances or where the pipe includes defects described herein or in the specifications, the pipe shall not be approved for placement on the project.

201.1 TE-24 System

Concrete pipe and thermoplastic pipe are accepted under the TE-24 system. Under the TE-24 system, the pipes are randomly inspected by an ODOT Inspector at the plant. But not all the pipe pieces are inspected at the plant.

201.2 TE-215 System

Metal pipe are accepted under the TE-215 certification program. Under this certification program, the pipe is not inspected at the plant. The material is delivered with a certification card.

For further detail on the Certification Program contact the District Testing Engineer or refer to *Materials Managements Sampling and Testing Program Manual.*

201.3 Rejection and Checking of Pipe

All pipe should be inspected prior to the incorporation into the work. All pipe should be randomly checked for minimum diameters, spans, heights, or dimensions shown in the plans.

ANY PIPE MAY BE REJECTED AT ANY TIME WHETHER APPROVED UNDER THE TE-24 SYSTEM, THE CERTIFICATION PROGRAM OR ANY OTHER PROGRAM. MATERIAL DAMAGED DURING SHIPMENT OR PLACEMENT MAY ALSO BE REJECTED AT ANY TIME.

The following is a list of reasons to reject the pipe in the field. Reference is made to the current edition of the *Materials Managements Sampling and Testing Program Manual.*

202.0 Inspection of 706.01 Non-Reinforced Concrete Pipe

1) Fractures or cracks passing through the wall or joints. Minor flaws such as a single crack not exceeding 51 mm (2") in length at either end of a pipe, or a single fracture or spall in the joints not exceeding 76 mm (3") around the circumference of the pipe or 51 mm (2") in length into the joint, shall not be considered cause for rejection unless these defects exist in more than 5% of the entire shipment.

202.0 Inspection of 706.01 Non-Reinforced Concrete Pipe (Continued)

2) Defects that indicate imperfect mixing and/or molding. (Honeycombed or open texture)

3) Cracks sufficient to impair the strength, durability or serviceability of the pipe. Any crack passing through the wall of the vitrified clay pipe would be sufficient to impair the strength of the pipe because it lacks the reinforcing to resist loading.

4) Damaged ends or manufacturers defects that would prevent making a satisfactory joint.

203.0 Inspection of 706.02 Reinforced Concrete Pipe

1) Fracture or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.

2) Defects that indicate imperfect mixing and/or molding. (Honeycombed or open texture)

3) Exposed reinforcing steel or reinforcing steel without minimum cover, except for spacers and vertical longitudinal wires in the bell and spigot of the pipe joint.

4) Damaged ends or a manufacture defect that would prevent making a satisfactory joint.

204.0 Inspection of Precast Reinforced Concrete Box, 3-sided Flat Top or Arch Sections

1) Accuracy of the span or rise dimensions with internal dimensions varying by more than 1 % or 38 mm (1 ½”), which ever is less. Haunch dimensions cannot vary by more than 19 mm (3/4") from plan. Wall thickness cannot be less than 6 mm (1/4") of the plan dimension.

2) Fractures or cracks greater than 0.25 mm (0.01") passing through the slab or walls.

3) Defects that indicate imperfections in proportioning, mixing or forming.

4) Unsound concrete or spalls can be determined by sounding or by visual inspection. Areas extending completely through the wall or surface area with more than 0.1 square meters (1 s.f.) of unsound concrete or spalls are cause for rejection. Smaller areas can be repaired (after inspection) with material meeting the requirements of 705.21 and on an approved list.

5) Honeycomb areas more than 0.2 square meters (2 s.f.) or any honeycombing which extends more than ½ through the wall thickness. Honeycombing less than 0.2 square meters (2 s.f.) can be repaired by grout rubbing.

6) Patching or repairs not authorized by the Department.

7) Exposed reinforcing steel or reinforcing steel lacking minimum cover.

8) Damaged ends or manufactures defects that would prevent making a satisfactory joint.

205.0 Inspection of Vitrified Clay Pipe

1) Fractures or cracks passing through the barrel or socket. A single crack at the spigot end of the pipe not exceeding 75 % of the depth of the socket, or a single fracture in the socket not exceeding 76 mm (3") around the circumference or 51 mm (2") lengthwise may be permitted.

2) Chips or fractures on the interior of the pipe exceeding 51 mm (2") in length, 25 mm (1") in width, and a depth of more than 1/4 of the thickness of the shell.

3) Cracks sufficient to impair the strength, durability or serviceability of the pipe. Any crack passing through the wall of the non-reinforced concrete pipe would be sufficient to impair the strength of the pipe because it lacks the reinforcing to resist loading.

206.0 Inspection of All Thermo Plastic Pipe (Includes All Polyethylene and Polyvinyl Chloride Pipe**)**

1) Any cuts, punctures, cracks, or separations in the interior or exterior of the pipe.

2) Deviation from true shape (usually out of round by more than 2% of the diameter) or deviation from straight centerline.

3) Any damaged ends or manufacturing defects that would prevent the sealing of the joints.

4) Non-uniform color or texture.

207.0 Inspection of All Metal Pipe

1) Any cuts, punctures, cracks, or separations in the interior or exterior of the pipe.

2) Uneven laps.

3) Deviation from straight centerline.

4) Deviation from true shape. (Usually out of round by more than 2% of the diameter of the pipe)

5) Ragged or diagonal sheared edges.

6) Loose, unevenly lined or spaced spot welds.

7) Unfinished ends.

8) Bruised, scaled or broken coating.

9) Excessive dents or bends in the metal.

10) Any damage or manufacturing defects that would impair the jointing of the pipe.

207.0 Inspection of All Metal Pipe (Continued)

Minor repairs such as minor bending of the metal, refinishing the galvanizing or re-rounding may be allowed. All repaired or replaced pipe shall be acceptable to the Project Engineer and shall conform to the requirements of the specifications. The Project Engineer should consult with the Testing personnel prior to rejecting suspect materials.

301.0 General

The construction of the pipe should always start at the outlet end of the pipe run. Only under special conditions should this procedure be changed. This means that the work will progress up grade, which makes the jointing of the pipe easier.

The Contractor's surveyor or foreman usually lays out the location and the grade of the pipe. The lay out and grade are maintained by using Standard Drawing MC-4.

MC-4 shows a method to layout the grade of the pipe by using batter boards and grade stakes. Alternate methods are allowed by MC-4 when approved by the Engineer.

In all of the grading methods the same basic principles apply. The starting elevation is usually established at the outlet end of the pipe run and carried forward to the inlet end of the pipe run. The pipe grade or slope is established by using a string line, batter boards or lasers.

302.0 Using Batterboards and String Line

When a string line or batter boards are used the following procedure is followed. The plan pipe grade is roughly established by using grade stakes at the surface of the pipe trench or at the bottom of the trench. The grade stakes are placed at 7.5 m (25') or 15 m (50') intervals.

The grade stakes by themselves do not offer sufficient control for the Contractor to place the pipe. The stakes are generally offset too far from the pipe installation to be used directly. Longer grade stakes are used to establish the string line or batter board height to establish the actual construction grade line. The Contractor will place batterboards across the pipe trench and then pull a string line over the batterboards. The string line is set in place directly over the pipe centerline at the same slope as the trench bottom and pipe flow line.

A level rod or a marked rod is used to measure the correct distance between the string line and the pipe flow line or trench bottom. This rod is used to keep the pipe or trench bottom on grade throughout the pipe run.

See MC-4 for further details.

303.0 Using a Laser

The method described above and shown in the standard drawing is rarely used in the field. On most construction projects a laser is used to maintain the pipe grade. A laser light beam is used in the trench or above the pipe trench. The laser light beam is established at grade directly over the pipe as the string line was used when using batterboards in the example above.

303.0 Using a Laser (Continued)

Once this grade is established measurements are made to the pipe invert or the trench bottom to hold the grade throughout the construction. This method is the most convenient and is preferred by most Contractors.

304.0 Final Grade and Alignment of Large Pipe Structures

304.1 Final Grade

Particular attention should be taken into consideration when placing large pipe structures such as concrete boxes. The final grade should be accomplished by screeding the granular material. The screed board should be as long as the width of the box (Span + 2 times the wall thickness). Then attach a 1.2 m (4 foot) long level to the top of the screed board. Starting at the outlet end, the workers should screed the granular material, filling in low spots and leveling off the high spots. This special attention will expedite the setting of the box sections.

304.2 Alignment

Once the center line of the box sections is established a string line or laser should establish the outside of the box sections. The string line or laser is established about 50 mm (2") from the outside of one of the edges of the box sections. Alignment can easily be monitored by measuring over from this line. If a string line is used, then it is usually attached to the footer re-steel.

305.0 Common Problems Associated with Box Culvert Placement

305.1 Improper Preparation of the Bedding

Most joint annular spaces are 6 mm (1/4") to 12 mm (½"). If the bedding is irregular, lining up the tongue into the receiving bell will be difficult. Because boxes are wide and flat, any irregularities in the bedding can cause the tongue of the box not to be properly started into the bell. If this is apparent before attaching the winches and anchors, pull the box out of the way and check the bedding again.

305.2 Unstable and Saturated Trench Conditions

If the trench conditions are unstable, the line and grade cannot be held and the area must be stabilized by drainage or the removal of unstable subsoils.

Standing water in the trench makes it difficult to determine the unevenness of the bedding.

305.3 Boxes Do Not Hang Plumb

This may be caused by improper anchorage location. If using a four part sling, longer or shorter clevises may help alleviate the problem. Be consistent in hooking the rigging to the box culvert.

305.4 Pulling the Box into its Home Position Unevenly

Care should be taken to ensure that both vertical portions of the tongue get started evenly into the bell of the box previously set.

305.5 Not Allowing for Joint Creep

If footers or head walls are specified consult the supplier to determine if the actual lay length of the individual boxes plus joint creep will be greater than the culvert length shown in the design plans.

306.0 Responsibility of the Contractor

The Contractor is responsible for the accuracy of the pipe alignment and the grading. The Engineer should ensure the work is progressing in accordance with the plan.

401.0 Cut and Fill Situations

The trench widths discussed in this section shall be in reference to *CMS 603.03* and deal with cut situations. For simplicity, a cut situation shall be defined as a field situation where the top of the trench is above the top of the pipe. This is where the existing ground is above the top of the pipe. The trench (backfill) widths may change in fill situations. For simplicity, a fill situation shall be defined as a field situation when the top of the pipe is above the top of the trench. In this situation the fill or new embankment is constructed to the spring line of the pipe and then the trench cut to the bottom of the trench. See Figure 400-4.

401.1 Minimizing the Loads on the Pipe

Minimum trench widths are specified to assure that adequate room is provided for the proper placement and compaction of bedding and backfill material below the springline of the pipe and to allow for the proper joining of the pipe sections. Maximum trench widths are specified to minimize the stress or weight on rigid or metal pipe. Spot checks of the trench width are required to ensure adequate working room to install the pipe and that the load on the pipe is not compromised and that the specifications are being observed.

401.2 Minimum and Maximum Trench Widths

The minimum and maximum trench widths change for different pipe types and diameters. These changes are discussed and summarized below.

All trench walls shall be as vertical as practical. In all of the figures, the trench width ‘W’ is the total trench width and the distance between each side of the pipe and the trench wall, ‘T’, is measured between the outside diameter of the pipe and the trench wall.

402.0 Minimum and Maximum Trench Widths for all Pipe in a Cut (Except for Type B and C Thermoplastic)

For pipe less than 1500 mm (60") in diameter, the trench width, ‘T’, shall be 150 mm (6") to 380 mm (15") on each side of the conduit. A typical trench section is shown on Figure 400-1.

The first step to determine the required total trench widths (W) (minimum or maximum) is to determine the outside diameter of the pipe. This is easily measured in the field with a ruler. Once the outside pipe diameter is known the total trench width (W), may be calculated. The following example illustrates the calculation for the total trench width. Refer to Figure 400-1 for this example.

402.1 Example of a Trench Width Calculation in a Cut

Given:

OD = Outside Diameter of the pipe is 960 mm (38")

T = Distance from the OD to the outside wall of the trench is 150 mm (6") to 380 mm (15")

W(min) = Minimum Total Trench Width = OD+2(150 mm(6"))

W(max) = Maximum Total Trench Width = OD+2(380 mm(15"))

Answer:

W(min) = 960 mm+ 2(150 mm)= 960 mm +300 mm = 1260 mm

= 38"+ 2(6") = 38"+12" = 50"

W(max) = 960 mm+2(380 mm) = 960 mm+760 mm = 1720 mm

= 38" +2 (15") = 38" +30" = 68"

Total Trench Width is between 1260 mm (50") and 1720 mm (68")

For pipe with an outside diameter of 1500 mm (60") or more, the maximum trench width (T), is 600 mm (24") on each side of the pipe. The minimum trench width (T), is 150 mm (6"). This can be calculated and measured in the field.

403.0 Minimum Trench Widths for Type B & C Thermoplastic Pipe in a Cut

Type B and C thermoplastic trench widths are different than all other pipe. There is not a maximum trench width but only a minimum trench width. Type B and C thermoplastic pipe shall have a minimum width of the “greater” of the following: Outside Diameter plus 400 mm (16"), (200 mm (8") on each side of the pipe) or the outside diameter times 1.25 plus 300 mm (12"). See Figure 400_2 for a summary of the minimum trench widths for most thermoplastic pipe diameters. The example below uses the same outside diameter pipe as the above example; but, as expected, the results are different.

403.1 Example of a Thermoplastic Pipe Trench Width Calculation in a Cut:

Given:

OD	=	Outside Diameter of the pipe is 960 mm (38").
T	=	Distance from the OD to the trench wall.
W(1)	=	Trench Width = OD + 400 mm (16")
W(2)	=	Trench Width = 1.25(OD) + 300 mm(12")

Answer:

W(1)	=	960 mm + 400 mm = 1360 mm
	=	38" + 16" = 54"
W(2)	=	1.25(960 mm) + 300 mm = 1200 mm + 300 mm = 1500 mm
	=	1.25(38") + 12" = 47" + 12" = 59"

W(1) = 1360 mm (54") < W(2) = 1500 mm (59")

Use W(2)=1500 mm (59") The Minimum Trench Width

The minimum required width of Granular Material changes for fill situations for Type B thermoplastic pipe but not for Type C thermoplastic pipe, in a fill. See Figures 900-2 and 900-5.

404.0 Minimum Trench Width for Large Structures in a Cut

The requirements for larger pipe structures such as concrete boxes, three-sided culverts, precast arches, and corrugated aluminum and steel box culverts are different than normal pipe installations. In a cut or trench situation, the minimum trench width (W), for these large pipe structures is the outside diameter or span plus 0.6 m (2 feet) from each side of the structure to the trench wall (T). See the example below and Figure 400-3. In a fill situations, Granular Material is required for 1.2 m (4'), (T), from outside of the structure to the trench wall. See Chapter 900 Backfill Requirements.

404.1 Example of the Minimum Trench Width for a Large Pipe Structure in a Cut:

Given:

A large pipe structure with a horizontal outside dimension of W=1520 mm (5').

T = Minimum (each side) = 600 mm (2')

Answer:

Minimum Trench Width = W= OD + 2(T)

W = 1520 mm +2(600 mm) = 1520 mm + 1200 mm = 2720 mm

W = 5' +2(2') = 9'

Use a Minimum Trench Width = W= 2720 mm (9')

501.0 General

The foundation of a conduit must uniformly support pipe during construction and for the life of the pipe. The soft conditions and rock conditions are two situations that are important to evaluate in the field.

502.0 Soft Conditions

Soft conditions are the most common situations that come up in the field. In general, if the workers can stand and work in the trench, the foundation is adequate for construction. If the material is too soft, then the Project Engineer should investigate to find the cause of the problem. A review of the soil borings in the area or the use of test pits to find the extent of the soft material would help evaluate the situation. Sand or well graded aggregate may be used to replace the soft material. If water is a problem, then an open graded material such as # 57's or # 67's may be used as a last resort. See Chapter 600 for further information concerning water problems. It is rare that there is a need to undercut more than ½ meter (2 feet) of material to restore support for the pipe.

Corrections of soft conditions within 300 mm (12") below the bottom of the trench are at the Contractor's expense except for undercuts shown in the plans. The corrections made below this 300 mm (12") depth is the Department's responsibility.

503.0 Rock Foundation

When rock boulders are encountered, they should be removed to at least 150 mm (6") below the pipe. When rock is found under the full length of the pipe, the rock should be removed to a 150 mm (6") average depth below the pipe. This is important when a very hard rock is encountered.

The key to a good pipe foundation in soft or hard conditions is to provide firm and uniform support. If there is any doubt, contact the Project Engineer or the District Construction Administrator.

600.0 General

The specifications require the Contractor to remove the ground water from the trench. This can usually be accomplished by using pumps, deep wells or diversion ditches or pipes. In some cases, pumping operations will not remove sufficient ground water to construct the project. As a last resort, the Projects Engineer may allow the Contractor to place Type 3 Granular Materials (# 57's or 67's) below the pipe to help relieve the water flow. When permitted, the # 57's and # 67's are only placed below the bottom of the pipe. This material is very porous and should relieve the water problems in most cases. This work is performed at no additional cost to the Department.

601.0 Preventing Piping

When using Granular Material Type 3 backfill material, the material on top of the Type 3 Material should be Type 1 Granular Material (304 material) to prevent piping after construction. The other alternative is to flood Granular Material Type 2 into the Granular Material 3. A geofabric may also be used.

602.0 Water at a Higher Elevation

When the water coming into the trench is higher than the bottom of the pipe, it may be necessary to extend the open-graded material to a higher elevation. The cost of this work is the responsibility of the Department.

603.0 Shutting off the Water Flow

Another alternative to relieving the water to construct the pipe as stated above, using Item 613 Low Strength Mortar Backfill(LSM) to cut the water off is an allowable alternative. Sheet piping can also be used to cut the water off. The value of both of these methods should be carefully evaluated because of the expense. Unless designate in the plans the cost of the LSM or sheet piling should be at the Department’s expense.

701.0 Soil and Granular Embankment

The bedding and the backfill material requirements are listed in *CMS 603.02, 203.02* and *703.11*. The soil and granular embankment (Optional Backfill in all of the Figures) requirements are listed in *CMS 203.02*. In general any material that can be incorporated in a 200 mm (8") lift and is not classified as unsuitable in *CMS 203.08* is acceptable material. Recycled asphalt is not allowed for use as bedding and backfill material. If there is any doubt about the suitability of the proposed soil or granular embankment, send a sample to the district laboratory for classification.

702.0 Granular Materials Type 1, 2 and 3

When Granular Materials Type 1, 2, or 3 are used, see *CMS 703.11* for a detailed description of the requirements. A brief description follows:

The Type 1 material is Item 304 material without the fracture count requirement. The Type 2 material is a sand material. The Type 1 and 2 materials are allowed for all bedding and backfill operations. The Type 3 material is an open graded # 57 or #67 and is allowed to control severe ground water problems only. (See Chapter 600, Dewatering)

703.0 Low Strength Mortar Backfill (LSM)

In some cases, the plans designate the use of LSM as bedding and/or backfill material. The requirements for LSM can be found in *CMS* Item 613.

There are three Type of mixes that can be used under Item 613 in *CMS*. The Type 1 mix is a mixture of cement, fly ash, sand and water. The Type 2 mixture substitutes an entrained air additive for the fly ash. The Type 3 mixture is a mixture of fly ash and water.

All three mixes may be used or alternative mixes may be submitted for approval by the Contractor. The alternate mixes shall meet the criteria in *CMS 613.05*. Changes in the material type or amount or sand gradation is allowed, as long as the final mix has the required strength, fills the voids and sets up.

801.0 General

There are three different classes of bedding: Class A, B, and C. The class of bedding depends on the type of specified conduit. See Figures 800-1, 800-2, 800-3, 800-4 and the below descriptions.

802.0 Class A Bedding

The Class A bedding consists of a concrete cradle. This type of conduit is rarely specified. When it is specified, the details are usually found in the plans and/or on Standard Drawing MC-4. See Figure 800-1 for a general detail.

803.0 Class B Bedding

Class B bedding is required for all Type A, B and C conduits and for all Type B, C and D thermoplastic conduits. See Figure 800-2.

803.1 Bedding Placement

Class B bedding consists of the placement of Granular Material Type 1 or 2 for a minimum depth of 150 mm (6") below the flow line of the conduit. This material is then compacted or flooded in place except for the middle one third of the bedding (See Figure 1000-1).

803.2 The Next Layer

The pipe is then placed to the proper line and grade and the second layer of bedding material is shoveled, spudded or flooded (with Type 2 material) under the pipe.

It is absolutely critical that the material in this haunch zone (between the flow line of the pipe and the 30% diameter elevation) be compacted to a maximum density and all the voids are filled. The structural performance of a pipe relies significantly on the compaction of the haunch material. See Chapter 1000 for the compaction requirements.

803.3 Bedding for Concrete Boxes

Class B bedding is required for all reinforced concrete box sections. See Figure 800-4. The bedding shall consist of constructing the bedding of 150 mm (6") of Granular Material Type l or 2.

804.0 Class C Bedding

Class C bedding consists of shaping the existing or natural ground to place the pipe. See Figure 800_3. Class C bedding is required for all Type D, E, and F conduits. Except for Type D thermoplastic pipe which requires a Class B bedding.

805.0 Foundation for Large Pipe Structures

Large Pipe Structures are defined as Precast Reinforced Concrete Boxes (*CMS 706.05*), Precast Reinforced Concrete Flat Topped Three-sided Culvert (*CMS 706.051*) or Precast Reinforced Concrete Arch (*CMS 706.052*) structures.

The bedding for the concrete box sections was discussed in section 803.4. For the Precast Reinforced Concrete Flat Topped Three-sided Culvert (*CMS 706.051*) or Precast Reinforced Concrete Arch (*CMS 706.052*) structures a footer is provided in the plans. A generalized figure is shown in Figure 800-4 with the footer being substituted for the bedding.

901.0 General

Backfill materials are defined as all materials above the bedding material and below the subgrade of the pavement structure or the ground elevation. Detailed requirements for backfill materials are specified in section 603.08 of *CMS*. The backfill materials may be Granular Materials Type 1 or 2, or soil or granular embankment. These backfill materials are required or an option depending on which type pipe is specified and whether the field situation is a cut or fill.

901.1 General Granular Material Backfill Requirements

Granular Materials Type 1 and 2 are allowed for all backfill applications. There is an option to switch to a soil or granular embankment at certain heights above the pipe depending whether the pipe is located in a cut or fill. Cut and Fill situations are defined in Chapter 800.

Granular Material Type 1 or 2 is required for specific width ‘T’ as measured from the outside diameter of the pipe or structure to the trench wall.

The above is a general explanation for specific cases see the following sections and figures.

901.2 Minimum Granular Material Height Requirements

The Figures in Chapter 900 are not intended to represent design standards. The minimum height above the pipe for the Granular Material represents the location where the material may change to soil or granular embankment. The height of the Granular Material may be less than shown in the Figures, if the subgrade is closer to the top of the pipe than the minimum shown in the Figures.

Example: The minimum Granular Material height shown in Figure 900-1 is 1.2 m (4'). If the subgrade elevation was only 0.9 m (3') above the pipe, then that would eliminate the need for the optional Backfill and the height of the Granular Material would be 0.9 m (3').

This applies to Figures 900-1, 900-2, 900-5, 900-6, and 900-7

901.3 Protection of the Pipe

There are minimum distances above the top of the pipe and lateral distance clearances from the pipe which the Contractor’s Equipment is not allowed to operate. This is stated in *CMS 603.08*. The pipe shall be covered with at least 1.2 m (6') of fill before heavy equipment can operate over the pipe. Light dozers may operate over the pipe with a minimum of 0.6 m (2') cover over the pipe. No heavy equipment is allowed to operate to within a lateral clearance of 1 diameter of the pipe or 1.8 m (6') which ever is less. See Figure 900-8.

902.0 Type A, B and Type B Thermoplastic Conduits

902.1 Cut Situations

In a cut, Granular Material Type 1 or 2 is required for Type A and B conduits for a height of 1.2 m (4') above the pipe and for a distance 'T' (from the outside diameter of the pipe to the trench wall on each side of the pipe) as defined in *CMS 603.03* or Chapter 4. See Figure 900-1.

902.2 Fill Situations

In a fill, Granular Material Type 1 or 2 is required for Type A and B conduits for a height of 0.6 m (2') above the pipe and for a distance 'T' equal to 1.2 m (4') or one diameter of the pipe whichever is less (measured from the outside diameter of the pipe to the trench wall on each side of the pipe). See Figure 900-2.

902.3 Optional Backfill

In the cut and fill situations described above, Granular Material may be substituted with soils and/or granular embankment above these heights to the subgrade or ground elevation. See Optional Backfill in Figures 900-1 and 900-2.

Optional Backfill in Figures 900-1 and 900-2 is defined as Granular Material Type 1 or 2, or soil or granular embankment.

903.0 Type C, D, & F Conduits

903.1 Cut or Fill Situation

For Type C, D, or F conduits (Except for thermoplastic pipe) the backfill may be granular material Type 1 or 2, or soil or granular embankment (Optional Backfill). For these type pipe there is no change in the width requirement for the granular material between cut and fill situations. See Figures 900-3 and 900-4.

Optional Backfill in Figures 900-3 and 900-4 is defined as Granular Material Type 1 or 2, or soil or granular embankment.

904.0 Type E Conduit

Type E conduit is the same dimensions as Figure 900-4 except the backfill requirements are slightly different. See *CMS 603.08*.

905.0 Type C and D Thermoplastic Pipe

905.1 Cut or Fill Situations

For Type C and D thermoplastic pipe, Granular Materials Type 1 and 2 are required for 300 mm (12") above the pipe for cuts or fill situations. Type C thermoplastic pipe is required to have at least 150 mm (6") of soil over the 300 mm (12") of granular material. For Type C and D thermoplastic pipe, there is no change in the width requirement for Granular Material between cut and fill situations. See Figure 900-5.

905.2 Optional Backfill

The Granular Material may be substituted with soils and/or granular embankment above the 300 mm (12") height to the subgrade or ground elevation. See Optional Backfill in Figure 900-5.

Optional Backfill in Figure 900-5 is defined as Granular Material Type 1 or 2, or soil or granular embankment.

906.0 Large Conduit Structures

Large Conduit Structures are defined as Precast Reinforced Concrete Boxes (*CMS 706.05*), Precast Reinforced Concrete Flat Topped Three-sided Culverts (*CMS 706.051*) or Precast Reinforced Concrete Arches (*CMS 706.052*) structures.

The following are trench specifications for new construction. Reconstruction plans may indicate other trench configurations.

906.1 Cut Situations

In cuts, Granular Material Type 1 or 2 is required for Precast Reinforced Concrete Boxes (*CMS 706.05*), Precast Reinforced Concrete Flat Topped Three-sided Culverts (*CMS 706.051*) or Precast Reinforced Concrete Arches (*CMS 706.052*) for 1.2 m (4') above the top of the structure and a distance ‘T’ equal to 0.6 m (2') width (measured from the outside of the structure to the trench wall). See Figure 900-6

906.2 Fill Situations

In a fill, Granular Material Type 1 or 2 is required for Precast Reinforced Concrete Boxes (*CMS 706.05*), Precast Reinforced Concrete Flat Topped Three-sided Culvert (*706.051*) or Precast Reinforced Concrete Arch (*CMS 706.052*) for 0.6 m (2') above the top of the structure and for a distance ‘T’ equal to 1.2 m (4') (measured from the outside of the structure to the trench wall). See Figure 900-7

906.3 Optional Backfill

In a cut or fill Granular Material above the minimum heights specified may be substituted with soils and/or granular embankment.

Optional Backfill in Figures 900-7 and 900-8 is defined as Granular Material Type 1 or 2, or soil or granular embankment.

1001.0 General

The compaction requirements have changed in the 1997 version of *CMS* to account for the varied trench conditions and material changes. Trench conditions can change from location to location. The bottom and trench walls may change from rock to soft clay or silt. The compaction equipment used by the Contractor may change from the bedding to the backfill material.

The compaction inspector should be thoroughly versed in the compaction procedures in Chapters 3 thru 9 in *The Earthwork Manual of Procedures Volume 1 and 2*. The basic concept is the same with a few variations as stated below.

1002.0 Soils and Granular Embankment Compaction Requirements

1002.1 General

For soils and granular embankment, the density requirements are in accordance with section *CMS 203.09* in the specifications. These are the same requirements as in granular embankment in *CMS 203*. The Test Section Method, Moisture Density Curve or the One-Point Proctor Curves may be used to determine the compaction requirements.

Controlling the compaction of granular embankment by using the Test Section Method is superior over any other method. See Chapter 9 of the *Earthwork Manual of Procedures* for further details. The Test Section Method allows for the adjustment of the density requirements to meet the material, compaction equipment and the trench condition changes.

1002.2 Use of the One-Point Proctor Method

For soils that meet the requirements of *CMS 203.02* and *CMS 203.08*, the One-Point Proctor Method by using the Ohio Typical Density Curves may be used to establish the compaction requirements. The one point proctor and the moisture content of the proctor soil are used to find the curve that represents the tested soil. Once the curve is found, only 96% of the maximum dry density is required. The detailed procedures for compaction testing are explained in the *Earthwork Manual of Procedures* Chapters 4 and 6.

1002.3 Soft Trench Bottom or Walls

When the trench bottom or the trench walls are too soft, fixed density requirement may not be physically achievable. This may not be a result of Contractor negligence but a result of field conditions. It is difficult to obtain fixed density in soft foundation conditions. A test section is used to establish the compaction controls if the 96% criteria of the one point proctor curve cannot be achieved. The Contractor is required to compact the material with adequate compactive effort and equipment in order to consider a change in the compaction acceptance criteria. When a test section is used, there is no waiver of the moisture requirements. The material should be at or near optimum.

1002.4 Coarse Material

When the material is too coarse, the One-Point Proctor Method should not be used. In general, if the material needs an aggregate correction of more than 25 %, you should consider changing to a Field Moisture Density Curve Method or a Test Section Method to establish the density requirements. See Chapter 4 of the *Earthwork Manual of Procedures.*

1002.5 Granular Embankment

When granular embankment (in accordance with *CMS 203.02*) is used, the density requirements are usually established using a Field Moisture Density Curve. A test section should be made to maximize the density. Adjustments for the aggregate correction and soft trench conditions may be used as stated above. See Chapter 9 in the *Earthwork Manual of Procedures.*

1003.0 Granular Material Type 1, 2, & 3

When using Granular Materials Type 1, 2 and 3, the compaction controls are similar but different than soils and granular embankments. Due to physical differences between Type 1, 2, and 3, the compaction controls are different. Maximum densities are achieved with Type 1 material (*CMS 304*) when they are compacted using mechanical devices such as vibratory plates. Higher densities are achieved with Type 2 material (sand) when the material is flooded in place. The Type 3 material (#57's or 67's) is not conducive to compaction testing, it is controlled by using a procedural method. All of these are further discussed below.

1004.0 Compaction Requirements for Type 1 Granular Material (304)

1004.1 General

The Test Section Method is required for the compaction of Type 1 Granular Material. Before the work begins a field density curve is made to determine the initial optimum moisture and the potential maximum density. If this curve is not available, a representative starting moisture content is 6%. See Chapter 9 in the *Earthwork Manual of Procedures.*

1004.2 Constructing a Test Section

At the beginning of the work (usually on the bedding), a test section is made using the compaction equipment (usually vibratory plates). The material is seated in place by using 2 to 4 passes with the compaction equipment. Compaction tests are then taken between 2 consecutive passes. When the density between the 2 tests are less than 32 kg/c.m. (2 lb/cu ft) a maximum density is then achieved. The number of passes to achieve this maximum density is recorded and the same equipment and the number of passes are used to achieve the required density for the remaining pipe bedding or backfill sections. See section 9.6 of the *Earthwork Manual of Procedures* or Item 304 of the specifications for more details.

1004.3 Using Average Densities

The compaction specifications in *CMS 603.081* requires that the Contractor achieve an average of 96% of the test section density. If the density is consistently greater than 96% of the test section, then the average values do not kick in. There are going to be situations when the average values are used; such as when the trench side walls or bottom are soft, at the spring line of the pipe or just on top the pipe. An occasional value below 96% is allowed to account for these situations. If the tests are constantly falling below 96%, at no fault of the Contractor, then a new test section is constructed.

The specifications allow for a minimum value of 92 % of the test section value before the material must be re-compacted. If 96% cannot be achieved, then a new test section to be constructed.

1004.4 Changing Conditions and Methods

When the pipe type, backfill material, compaction equipment or trench conditions change, a new test section is constructed. If the compaction method or compaction equipment is misaligning or damaging the pipe, then alternate compaction methods are required.

1004.5 Leave the Middle 1/3 Uncompacted

The middle 1/3 of the pipe bedding is left uncompacted (or lightly compacted to hold the grade of the pipe). If you divide the span or the diameter of the pipe into 3 parts; the bedding below the middle 1/3 of pipe is left uncompacted or lightly compacted. See Figure 1000-1.

1005.0 Compaction Requirements for Type 2 Granular Material (Sand)

1005.1 General

When the Type 2 material (sand) is used, the specifications require the material to be flooded in place. The flooding ensures that the voids are filled and maximizes the density in most cases.

The Contractor should place the material in 200 mm (8") lifts. Prior to the application of water, a sand wall approximate 200 mm (8") high is built to hold the water. Water is flooded in the trench by usually using a fire hose connected to a pump or water truck. The material is allowed to drain before the next layer is placed. The Contractor is responsible for removing the excess water.

When the water will not dissipate through the sand, compaction methods and testing may be used by the appropriate Test Section Method stated above.

At the beginning of the work, the Project Engineer may require the compaction of the sand material after the flooding operation to see if the compaction effort will increase the density of the sand. This compaction is performed to maximize the bedding and backfill densities.

1005.2 General Procedure

1) A density test is taken after the material is flooded.

   Hint: Sand is always loose at the surface. Test the sand at 100 mm (4") below the surface and by using the direct transmission mode on the nuclear gauge at the 300 mm (12") depth. See Chapter 6 in the *Earthwork Manual of Procedures.*

2) The material is compacted by using vibratory compaction equipment or other approved equipment.

3) A density test is taken again.

4) If the density goes down, then the remainder of the material may be placed by flooding alone.

5) If the density goes up significantly (by more than 64 kg/cu m (4 lbs/cu ft)), then a test section should be constructed to find the maximum density.

6) The Test Section Method described above for the Type 1 material is used.

7) For the remainder of the material, a combination of flooding and compaction shall be used.

In general, the combination of flooding and compaction will be required only on coarse grained sands. This is an effective tool to maximize densities, but the combination of flooding and compaction will be rarely used in the field.

1006.0 Compaction Requirements for Type 3 Granular Material (# 57 or #67)

1006.1 General

There are not any compaction testing requirements for the placement of the Type 3 material. The material is placed at a maximum lift thickness of 300 mm (12"). The material is then compacted to approximately 85% of the original lift thickness. The compaction should consist of vibratory plates, jumping jacks, or hand tamps.

1006.2 Compactive Effort Effectiveness

Although it may not seem like the compactive effort is accomplishing very much, it seats the material in place. To demonstrate the effectiveness of this compactive effort, fill a concrete mold with type 3 material and then weight the filled mold. Then fill a second concrete mold using three equal lifts of type 3 material. Compact with a flat device after each lift. Then weight the second mold. The difference in weight will be about 20 %. The same conditions exist in a pipe trench.

1101.0 General

The following are brief descriptions of the general procedures for pipe placement, joint sealing and sealing of the outside surfaces. For simplicity, the sections are broken down into different pipe types. Further details may be available from the manufacturer's handbooks.

Type A, B, C, D, and F conduits are required to have sealed, banded, bell and spigot, tongue and groove or bolted joints. Type E conduits are permitted to have open joints.

1102.0 Concrete Box and Pipe and Clay Pipe

1102.1 Placement of Concrete Box and Pipe and Clay Pipe

The setting of the pipe or box starts at the outlet end of the trench and the construction continues to the inlet end (upgrade). It is easier to work upgrade with the help of gravity to hold the pipe or box sections together than to work downgrade. The tongue or spigot (male) end of the pipe or box is always downgrade. The bell or grooved (female) end of the pipe is always upgrade. The construction proceeds this way to minimize the bedding material getting trapped in the pipe joint and to maximize the hydraulic flow into the pipe or box.

The pipe or box construction may use chains, cables, spud bars, wooden blocks, or pipe pullers to place the sections of pipe together. The type of equipment used will depend on the size of the pipe. The Contractor is responsible for placing the pipe or box at the required grade. The final position of the sections of pipe must form a smooth grade. See Section 304.0 "Final Grade and Alignment of Large Pipe Structures". If the Contractor cannot place the box sections together to within +/_ 25 mm (+/_ 1"), then the Project Engineer should require the use of winches.

When it is necessary to field cut this pipe, the section cut must have a concrete cradle or collar. The cut section of pipe must not be an end piece. The final joint must be stable. The inlet end must have the groove or bell intact to maximize the hydraulic flow into the pipe or box.

1102.2 Jointing Sealing of Concrete Box and Pipe and Clay Pipe

Concrete box and pipe and clay pipe are required to have sealed joints with one of the following:

- Sealed bituminous pipe joint filler (*CMS 706.10*), commonly known as bear grease, is placed to completely fill the joints. After the joint filler is placed, the material is troweled with a trowel or board and smoothed in place. The outside of the pipe is completely sealed. It is common for this material to drip off top surfaces. This should be kept to a minimum.

1102.2 Jointing Sealing of Concrete Box and Pipe and Clay Pipe (Continued)

- Preformed butyl rubber material, (*CMS 706.14*), may be used for a concrete pipe. The joint is required to be primed on both sides prior to the installation of the butyl material. The joint is sealed but is not required to completely fill the joint. The joint must be sealed from water and fine infiltration.

- Resilient and flexible gasket joints (*CMS 706.11*, for concrete pipe, or *CMS 706.12*, for clay pipe) may be used.

- Other materials may be used if approved by the Project Engineer.

1102.21 Joint Sealing of Epoxy Coated Reinforced Concrete Pipe

Epoxy coated reinforced concrete pipe (*CMS 706.03*) is required to be sealed with fibrated coal tar joint compound placed in accordance with the manufacturers recommendation. After the joint filler is placed, the material is troweled or smoothed in place. The outside of the pipe is completely sealed.

1102.3 Sealing the Outside of Surfaces of Precast Reinforced Concrete Box Sections

The exterior joint gap on the top and sides between the exterior gap of the Precast Reinforced Concrete Boxes is filled with portland cement grout before placing the membrane waterproofing or joint wrap.

Membrane waterproofing is placed in accordance with the plans. The box shall be clean prior to the placement of the membrane. *CMS* Item 512 Type 2 Membrane Water Proofing is required for all areas in contact with the backfill material. When asphalt is in direct contact with the top of the box sections, the Membrane Water Proofing should be Type 3. No joint wrap is required under the membrane.

1102.31 Areas Outside the Membrane Waterproofing

An epoxy sealer, (*CMS 603.08*) and joint wrap, (ASTM C 877 and *CMS 603.06*) are placed in areas of the box sections outside the limits of the granular backfill. The epoxy sealer is applied to the top surface and 0.3 m (one foot) down the legs of the structure. This area includes the joint. The joint wrap is at least 230 mm (9") wide and is one continuous roll per joint. The joint shall be clean prior to the installation of the joint wrap.

1103.0 Precast Reinforced Concrete Arch Sections and Three-Sided Flat Topped Structures.

1103.1 Placement of Precast Reinforced Concrete Arch Sections and Three-Sided Flat Topped Structures.

The arch and the flat top structures require an approved shop drawing prior to installation. These details should be thoroughly examined prior to the installation of the sections.

The placement and jointing of these structures are approximately the same as concrete boxes, with the differences noted below.

The arch and flat top sections are placed on a footing designated in the plans. See Figure 900-6 or Figure 900-7; the newer designs will have the footings at zero grade. If needed, the sections can be placed on masonite or steel shims to properly align the sections.

The sections are placed by cranes from the outlet end to the inlet end (Upgrade). The crane holds the sections in place while winches and/or spud bars are used to make the final placement.

When the sections do not completely come together, a gap tolerance of 30 mm (1") per joint is desirable. The most important dimension is the top gap of the joint. The top elevation of the sections of the arch or flat top sections should be at approximately the same elevation. This maximizes the strength of the joint. If the jointing cannot be done successfully, then the use of winches should be considered.

1103.2 Joint Sealing and Sealing of Outside Surfaces of Three-Sided Flat Top Sections

The top joints of the Three-Sided Flat Top sections are designed with a keyway detailed in the shop drawings. The keyway is filled with a non-shrinking, non-metallic mortar (*CMS 705.22*) cement, in accordance with 706.051(joints). The leg and top joints are smoothed with a cement grout. Other joint sealers may be allowed by plan or shop drawing.

The sealing of the outside surfaces is the same as sections 1102.3 and 1102.31, except the joint wrap shall be 300 mm (12") wide.

1103.3Joint Sealing and Sealing of Outside Surfaces of the Three-sided Arch Sections

The joints of the arch sections have a 45 degree chamfer (*CMS 706.052*). The external side of the joint shall be cleaned prior to the installation of any sealing material.

One continuous section of flexible plastic gasket, (*CMS 706.14*) is placed from the bottom of the leg on one side to the bottom of the leg of the other. The chamfer section shall be primed at the project site prior to the installation of the plastic gasket.

1103.3 Joint Sealing and Sealing of Outside Surfaces of the Three-sided Arch Sections (Continued)

Each joint, sealed with the plastic gasket, shall be covered with a 225 mm (9") wide strip of Type 3 Membrane Waterproofing (*CMS 711.29*). The prime is placed on the external side of the joint under the area of the Type 3 Membrane Waterproofing. The prime is used as recommended by the manufacturer and is usually placed by the manufacturer. Other joint sealers may be allowed by plan or shop drawing.

The sealing of the outside surfaces is the same as sections 1102.3 and 1102.31

1104.0 Corrugated Metal and Thermoplastic Pipe

1104.1 General

Corrugated metal pipe joints shall be sealed with coupling bands with bolts. Thermoplastic joints may be sealed with coupling band or by gasketed bell and spigot joints. The seal shall not allow any infiltration by the backfill.

1104.2 Band Placement

The bands are placed around the first placed pipe and then the second pipe is brought into position. The two pipe sections should be within 25 mm (1").

1104.3 Thermoplastic Joints

When cable ties are used with thermoplastic split couplers, they shall be tightened sufficiently to securely close the band. When bells with looking lugs are used they shall be placed so that all the detents or lugs lock into the corrugation valleys.

1104.4 Corrugated Metal Joints

The joint is checked to ensure the ribs or dimples line up, then the sections are joined. The bolts are tightened sufficiently to securely close the band.

1104.5 Large Diameter Corrugated Metal Joints

For large diameter corrugated metal pipe, the band should be hammered in place by the use of a mallet to ensure the seating of the band. The permissible differences between adjacent section is 15 mm (½") for conduits greater than 1350 mm (54") and 2.77 mm (0.190") in wall thickness. Strutting may be required.

It is the intent of this section to recommend minimum documentation and inspection requirements for pipe construction. All pipe installation operations should have an Project Inspector present at all times to ensure the work is proceeding in accordance with the specifications. All of the following are required to be documented on **C-170 Daily Pipe Inspection Form or CMS-1 Inspector's Daily Report**. References to appropriate specification sections and/or plan documentation or details for all the inspector reports are required. Specifications waived by the Project Engineer or other authorized personnel shall be noted on the Daily Logs. Compaction Forms shall be fully filled out in accordance with the *Earthwork Manual of Procedures.*

Operation	**Required Documentation**
1. Pipe Materials	Check TE-24 or TE-215 with the Contract Shop Drawings as Required for all Precast Reinforced Concrete Three-sided Flat Topped and Arch Structures Check Material for Defects See Chapter 200, Pipe Delivery and Inspection or Section 603.02 of *CMS* Use C-170 Daily Pipe Construction Inspection Form or CMS-1 Inspector's Daily Report.
2. Check the Construction Layout	See Chapter 300 or Section 603.05 of *CMS* Use C-170 Daily Pipe Construction Inspection Form or CMS-1 Inspector's Daily Report.
3. Check the Trench Width	Record the Pipe Outside Diameter Record the Trench Width Used See Chapter 400, Trench Widths in a Cut or Section 603.03 of *CMS* Use C-170 Daily Pipe Construction Inspection Form or CMS-1 Inspector's Daily Report.
4. Check the Foundation of *CMS*	See Chapter 500, Foundations or Section 603.03 Type of Foundation Use C-170 Daily Pipe Construction Inspection Form or CMS-1 Inspector's Daily Report.
5. Dewatering	Required? Equipment or Procedures Used See Chapter 600, Dewatering or Section 603.03 and 603.081 of *CMS* Use C-170 Daily Pipe Construction Inspection Form or CMS-1 Inspector's Daily Report.

Operation	**Required Documentation** (Continued)
6. Bedding and Backfill Materials	Approved Materials Type of Materials Used Moisture Density Curve if Required See Chapter 700, Bedding and Backfill Material Use C-170 Daily Pipe Construction Inspection Form or CMS-1 Inspector's Daily Report.
7. Bedding Requirements	Type of Bedding Used for the Specified Pipe See Chapter 800, Bedding Requirements or Section 603.04 of *CMS* Use C-170 Daily Pipe Construction Inspection Form or CMS-1 Inspector's Daily Report.
8. Compaction Requirements	Check Compaction of the Bedding Insure All Haunch Material Is Well Compacted Use Compaction Forms in the *Manual of Procedures for Earthwork Construction* Equipment, Number of Passes and Lift Thickness See Chapter 1000, Compaction Requirements or Use C-170 Daily Pipe Construction Inspection Form or CMS-1 Inspector's Daily Report.
9. Setting the Pipe	Pipe Placed from the Outlet to the Inlet End Equipment and Procedures Used Field Measurement for Payment, "Daily" Measurement from Center to Center of Catch Basin, Inlet or Manhole for Payment See Chapter 1100, Placing and Jointing the Pipe or Sections 603.05, 603.06, 603.07, & 603.13 of *CMS* Use C-170 Daily Pipe Construction Inspection Form or CMS-1 Inspector's Daily Report.
10. Proper Jointing	See Chapter 1100, Placing and Jointing the Pipe or Section 603.05 and 603.06 of *CMS* Type of Materials and Procedures Used Use C-170 Daily Pipe Construction Inspection Form or CMS-1 Inspector's Daily Report.

Operation	**Required Documentation** (Continued)
11. Backfill Requirements	Type of Material Used Record the Outside Pipe Diameter Trench widths used See Chapter 900 for Backfill Requirements Equipment, number of passes and lift thickness Section (*CMS 603.08*)

Figure Index

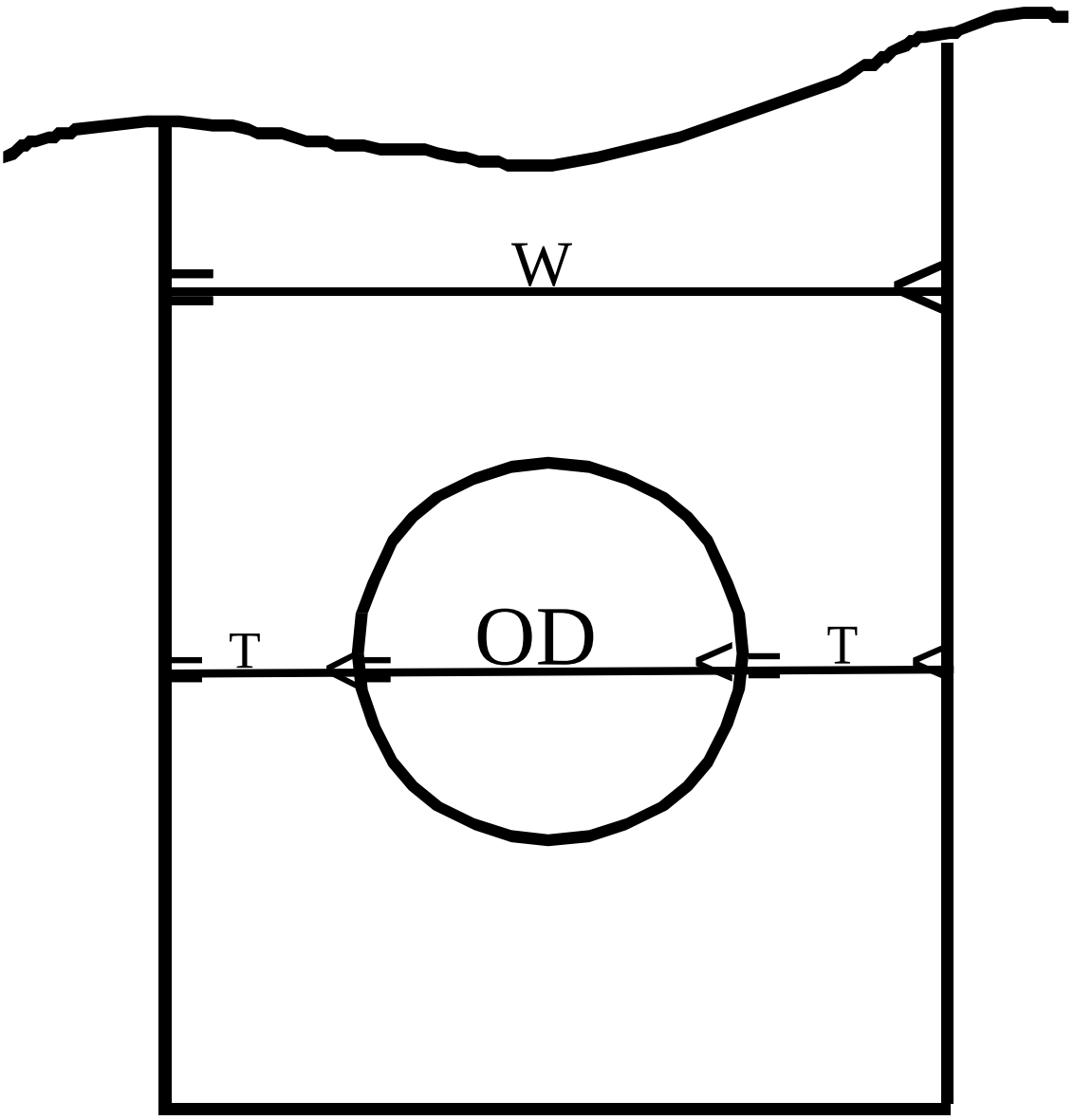


Figure 400-1 Trench Widths

Inside Diameter mm (inches)	Outside Diameter mm (inches)	Minimum Trench Widths Meters (in)
300 (12)	356 (14)	0.8 (30)
375 (15)	450 (17.7)	0.9 (34)
450 (18)	536 (21.1)	1.0 (38)
525 (21)	622 (24.5)	1.1 (43)
600 (24)	699 (28.4)	1.2 (48)
750 (30)	866 (36.0)	1.4 (57)
900 (36)	1041 (41.0)	1.6 (63)
1050 (42)	1219 (48.0)	1.8 (72)
1200 (48)	1372 (54.0)	2.0 (80)
1350 (54)	1557 (61.3)	2.3 (89)
1500 (60)	1707 (67.2)	2.4 (96)

Figure 400-2 Minimum Trench Widths for Thermoplastic Pipe in a Cut

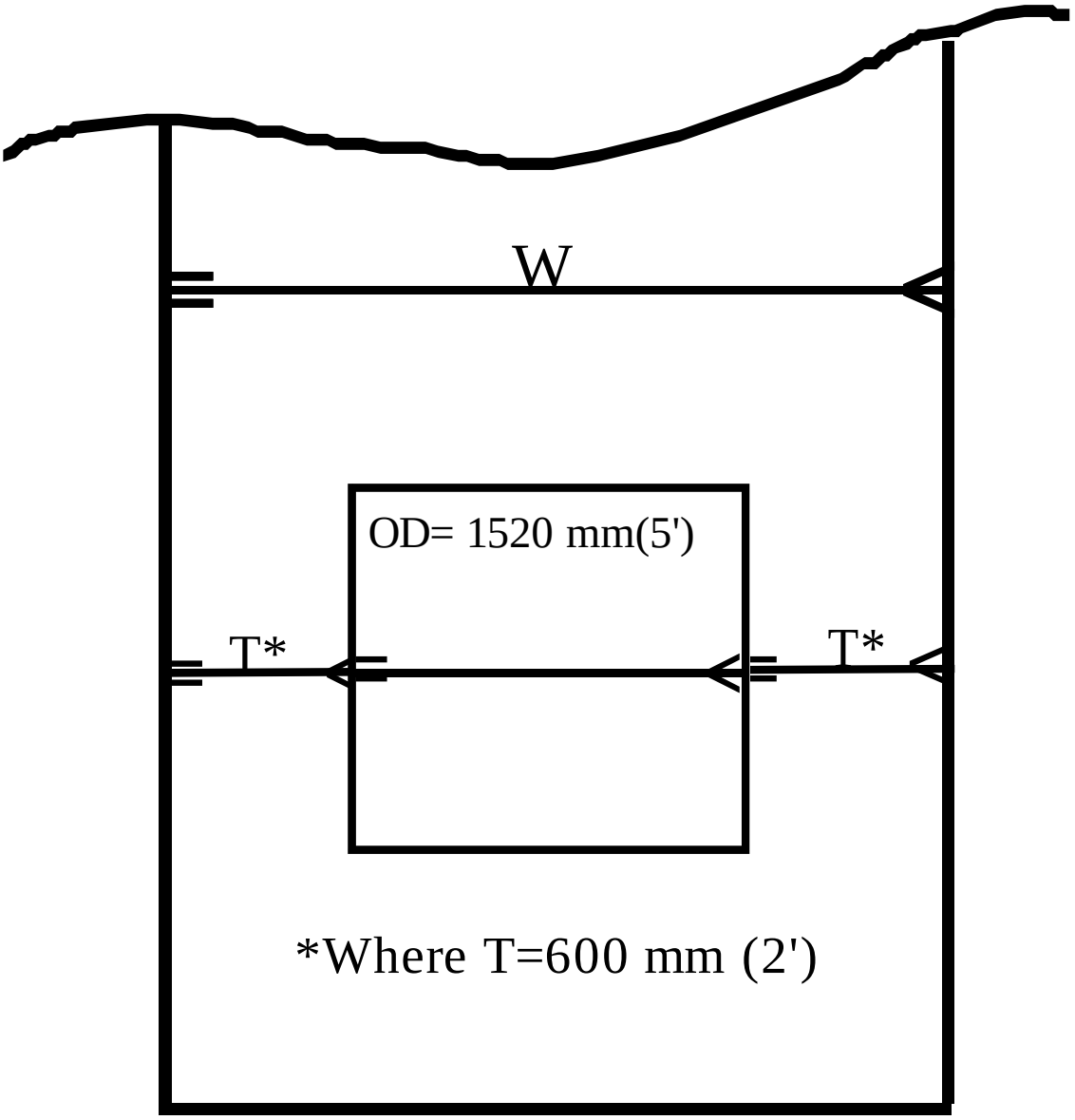


Figure 400-3 Minimum Trench Width for a Large Pipe Structure in a Cut

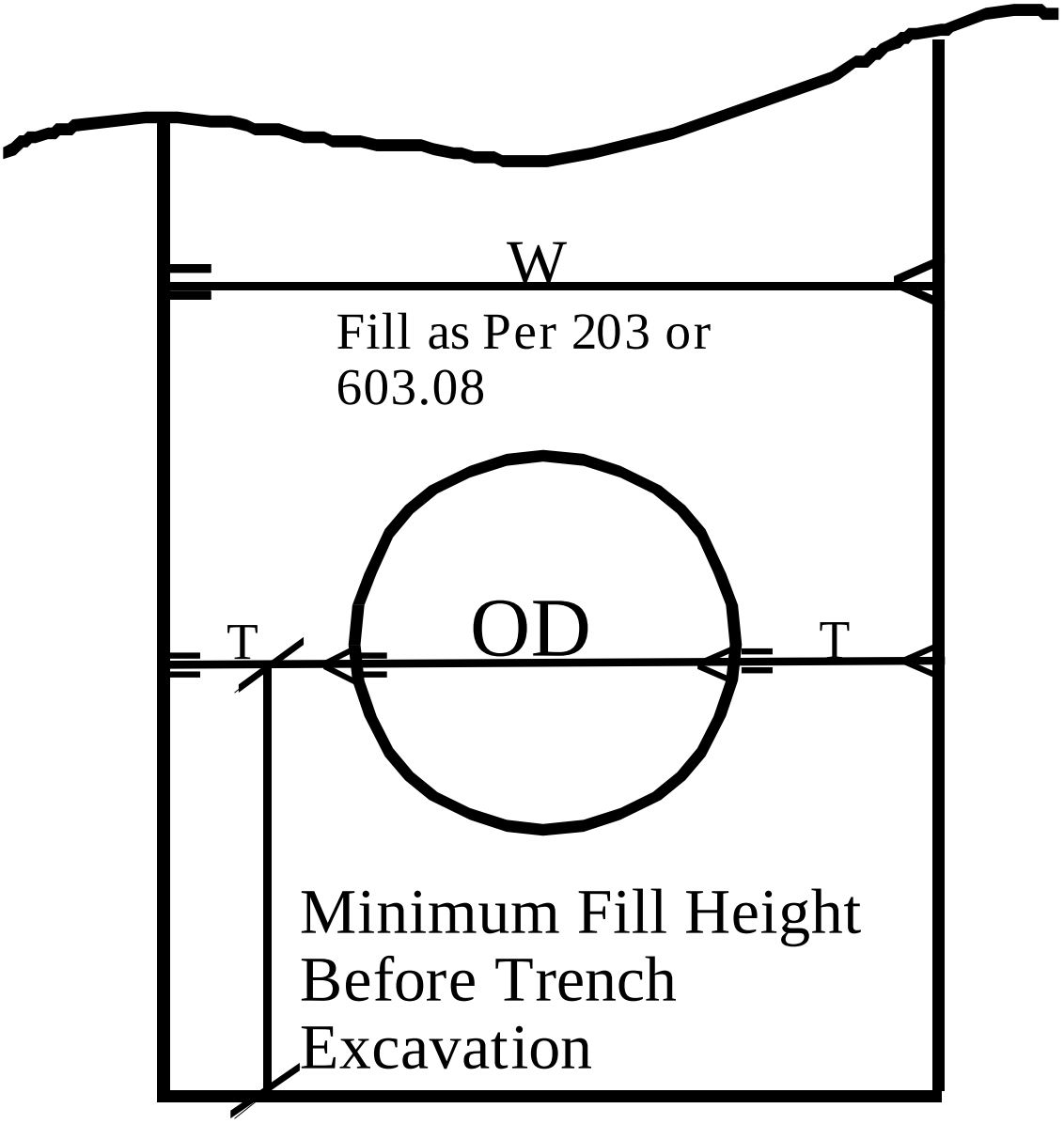


Figure 400-4 Minimum Fill Height Before Excavation

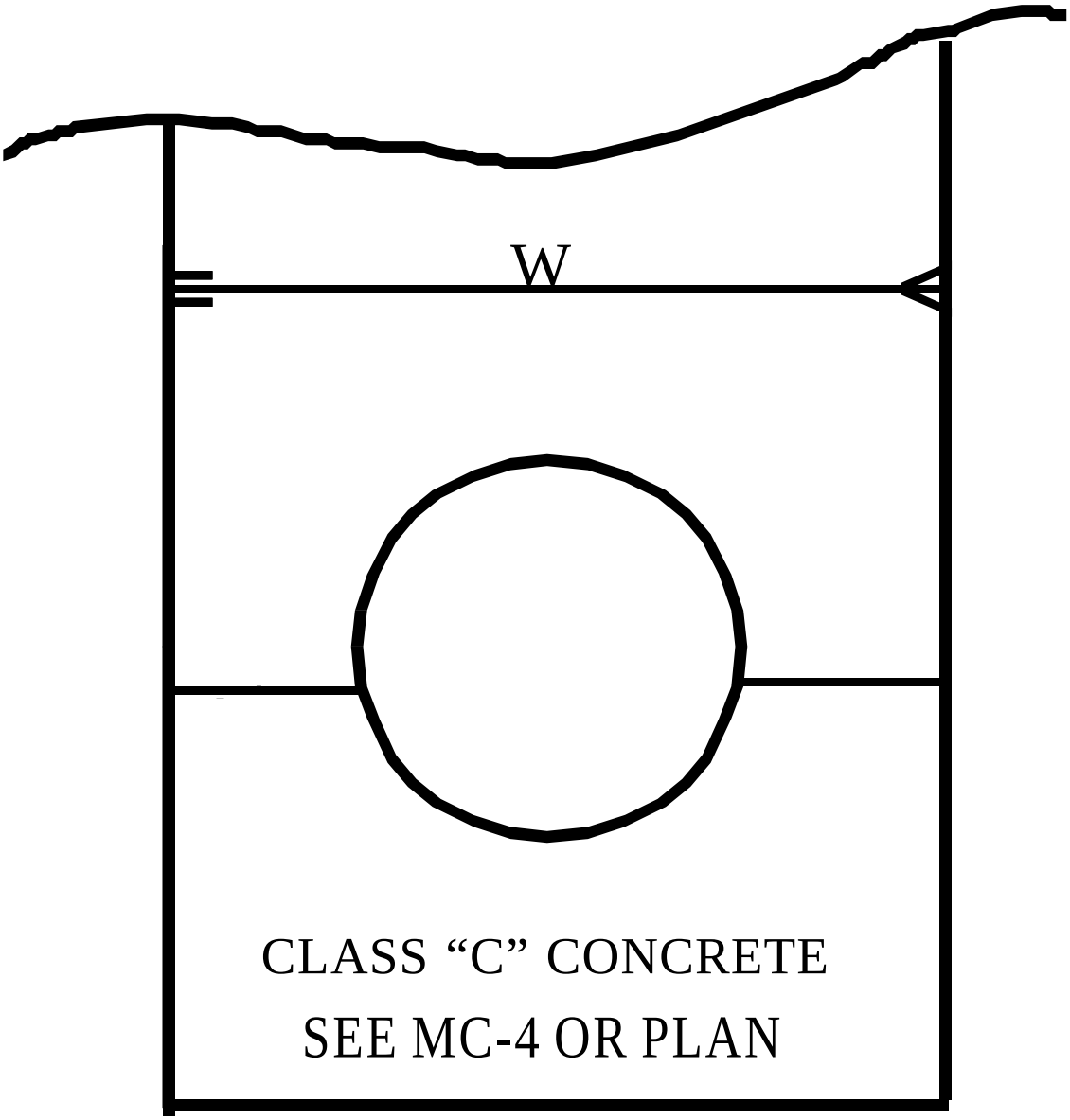


Figure 800-1 Class A Bedding
For Applicable Conduits

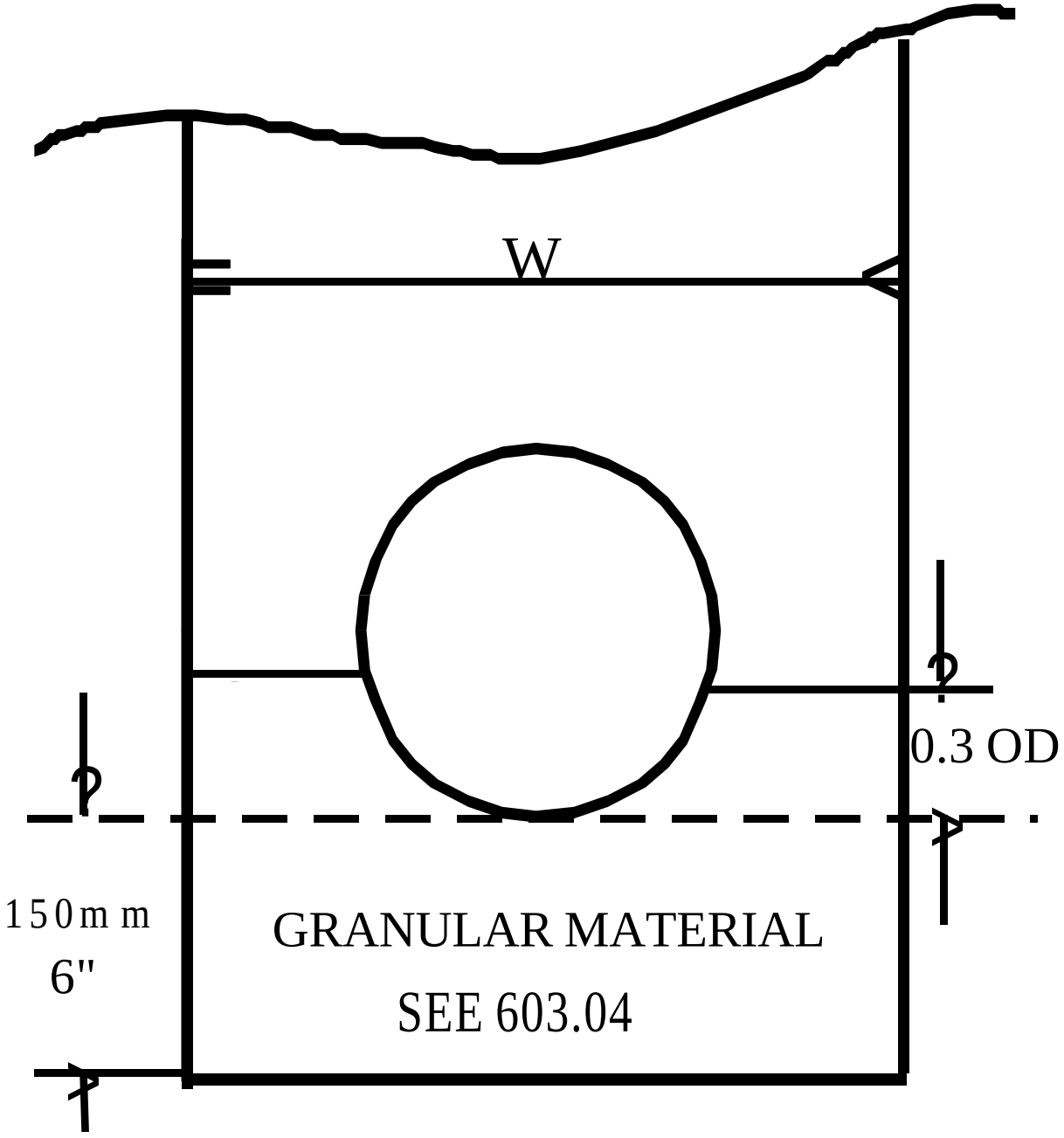


Figure 800-2 Class B Bedding
For all Type A, B, & C Conduits and all Type B, C, & D Thermoplastic Conduits

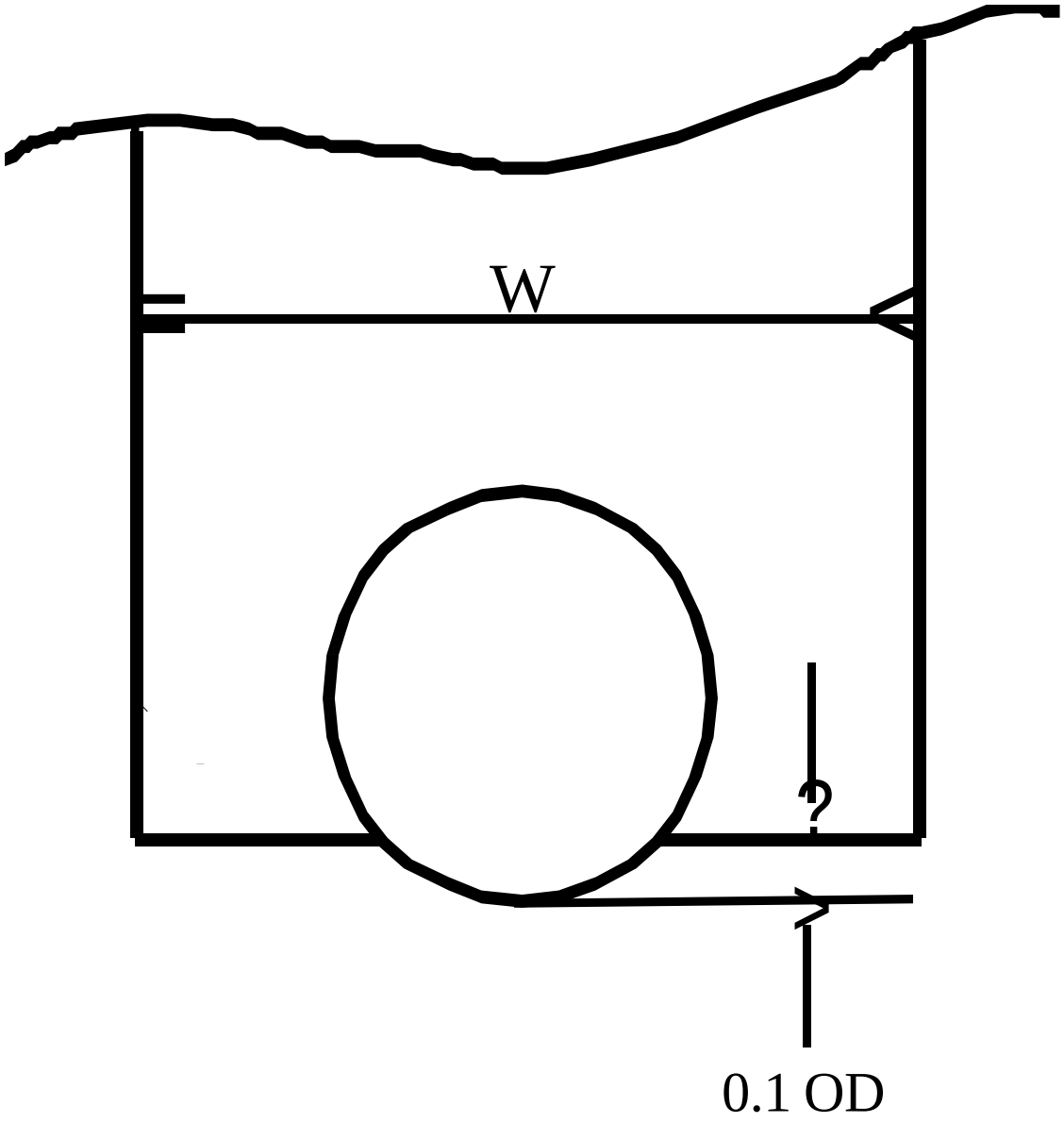


Figure 800-3 Class C Bedding
For Type D, E, & F Conduits
Except for Type D Thermoplastic Pipe

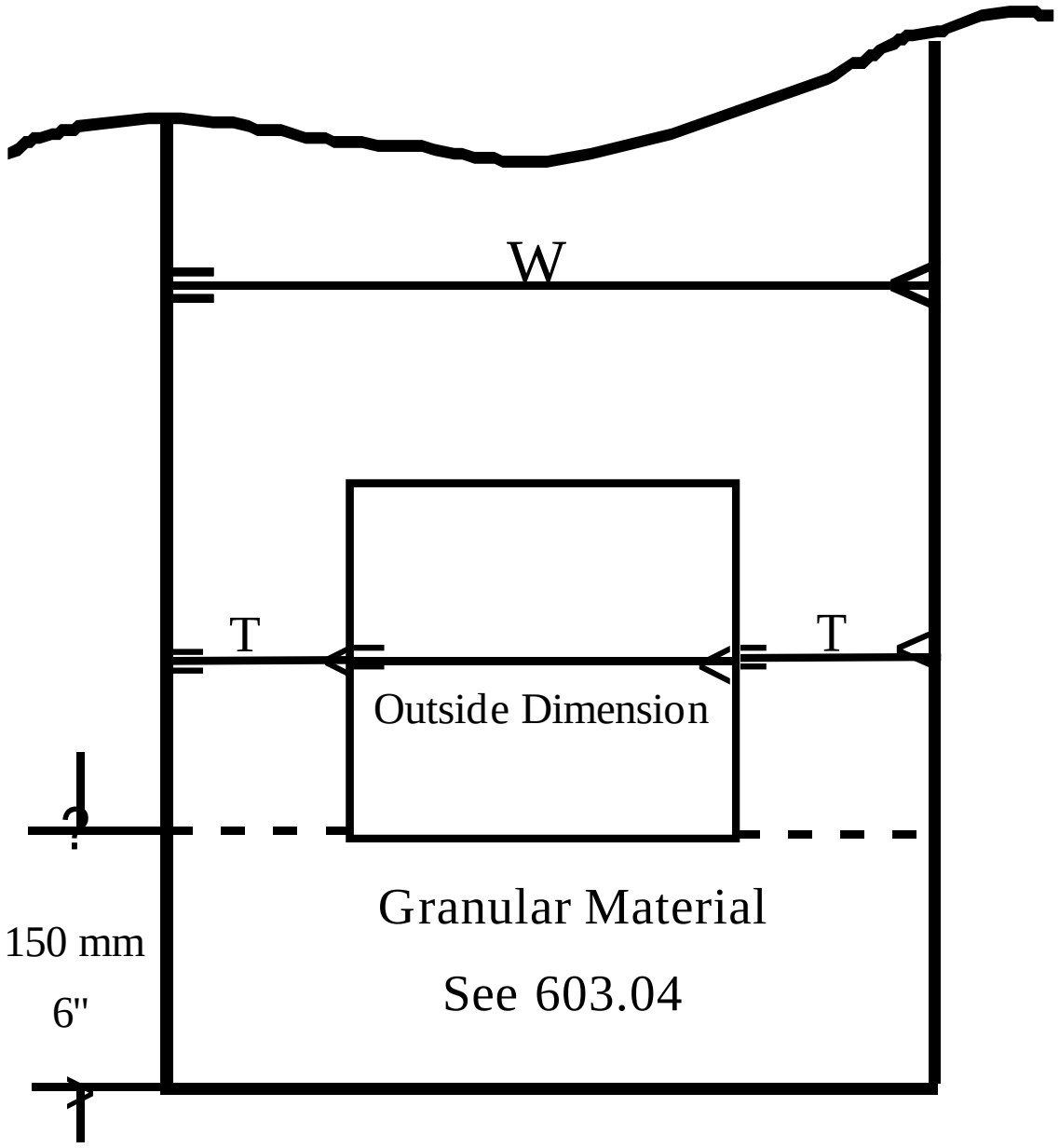
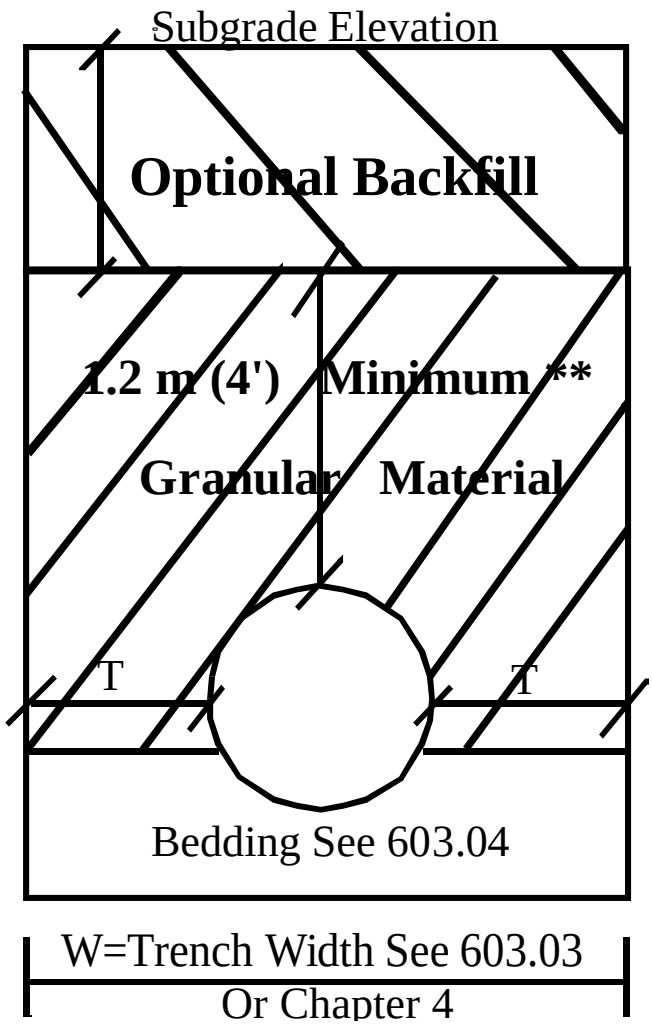
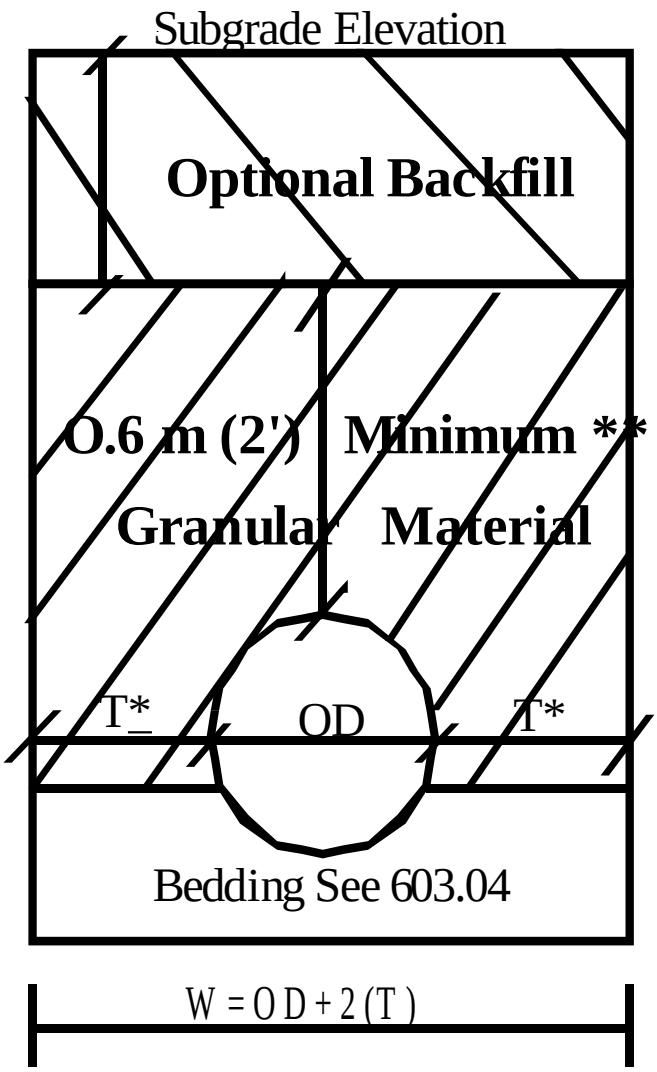


Figure 800-4 Bedding for Large Pipe Structures
For Type A, B, & C



** This minimum height may be less; see note in Chapter 900 text

Figure 900-1 Backfill for Type A & B Conduits in a Cut
Includes Type B Thermoplastic Pipe



*Where T=1.2 m (4') or 1 OD whichever is less
** This minimum height may be less; see note in Chapter 900 text.

Figure 900-2 Backfill for Type A & B Conduit in a Fill
Includes Type B Thermoplastic Pipe

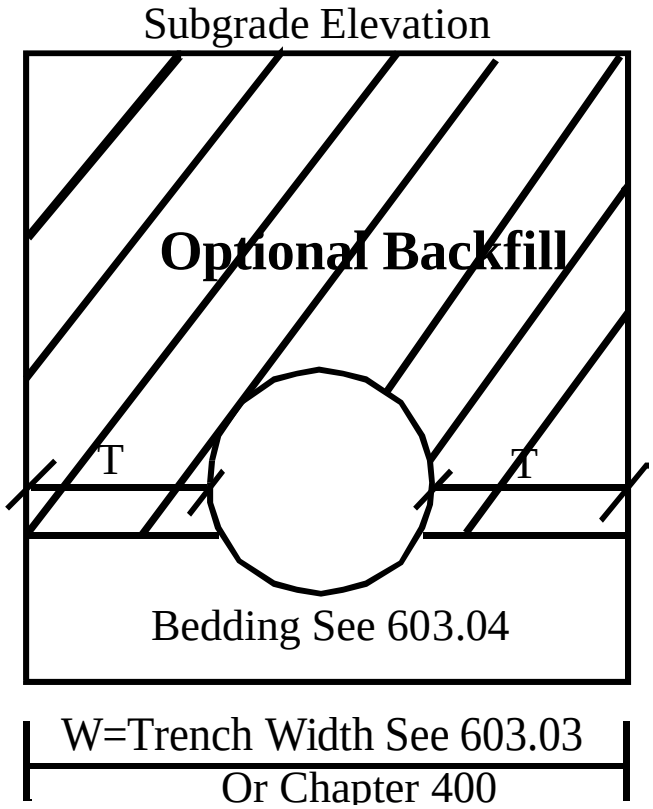


Figure 900-3 Backfill for Type C Conduits in a Cut or Fill
Except for Thermoplastic Conduit

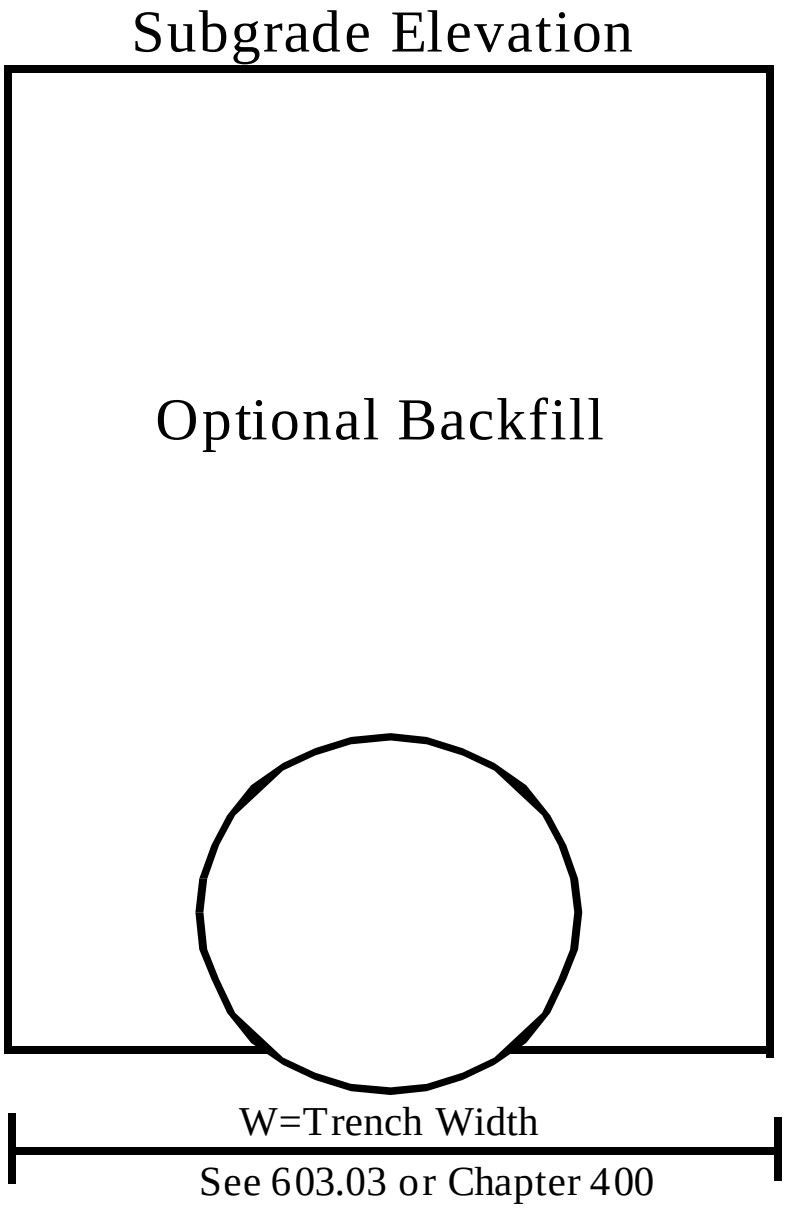


Figure 900-4 Backfill for Type D & F Conduits in a Cut or Fill
Except for Thermoplastic Conduit

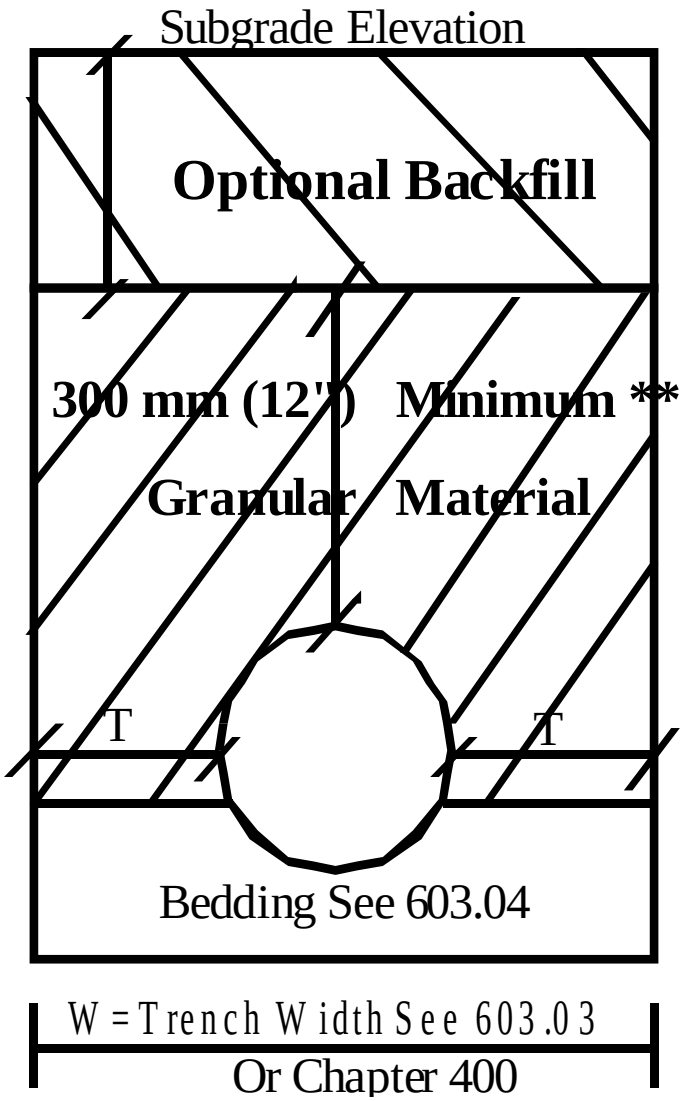


Figure 900-5 Backfill for Type C & D Thermoplastic Conduits in a Cut or Fill

** This minimum height may be less; see note in Chapter 900 text.

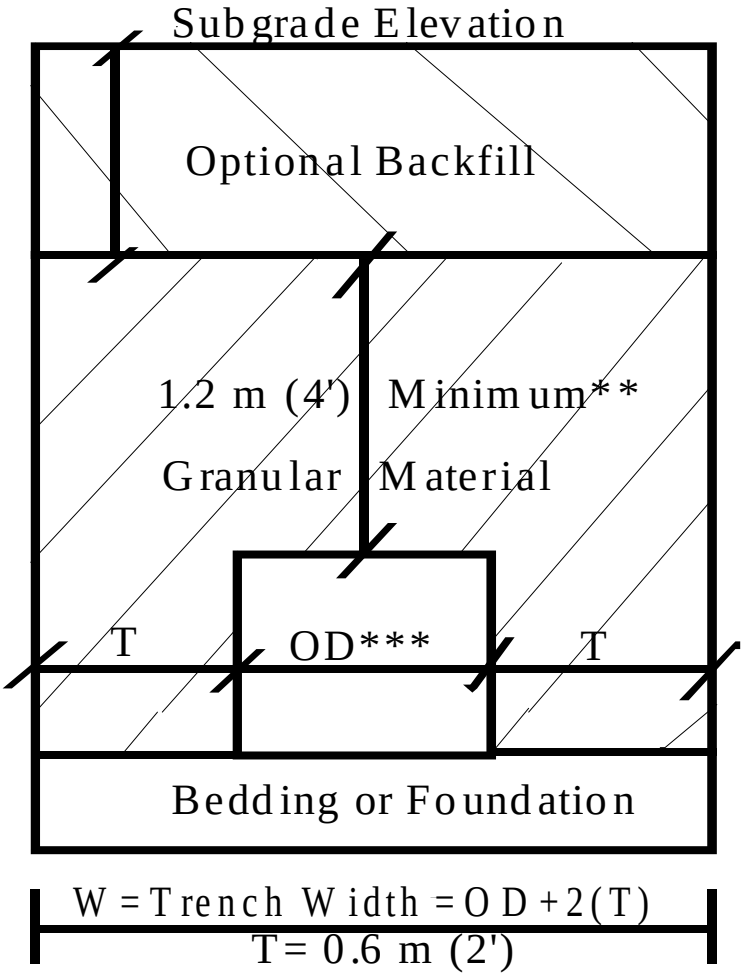


Figure 900-6 Backfill for Large Conduit Structure in a Cut

** This minimum height may be less; see note in Chapter 900 text
***Where OD= Outside Dimension

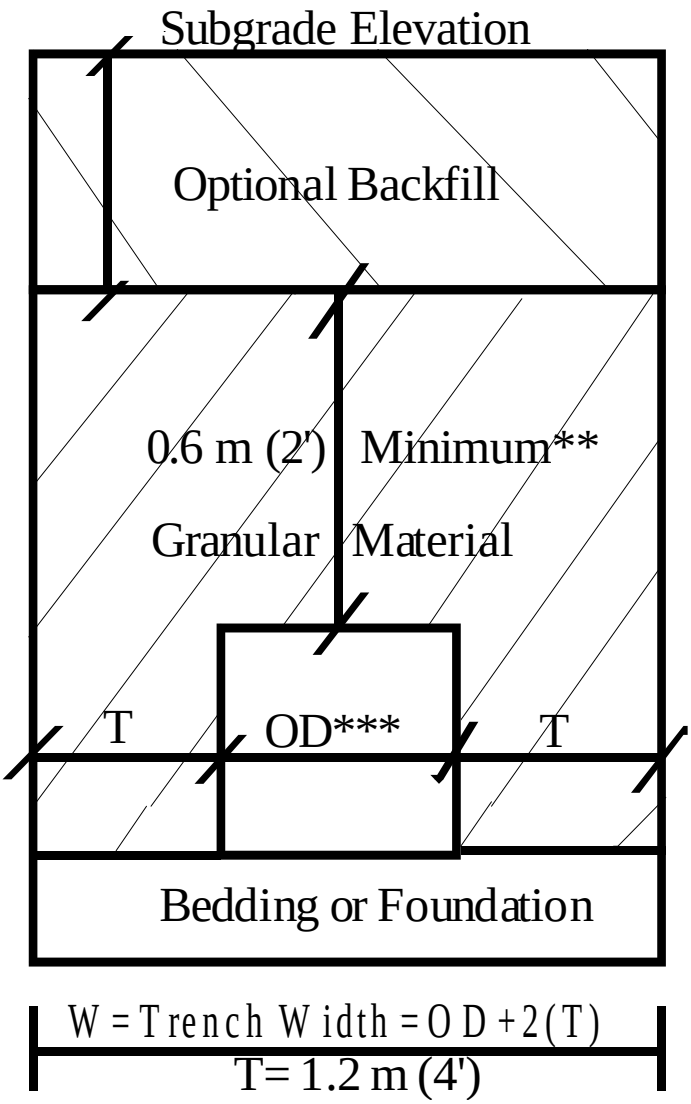
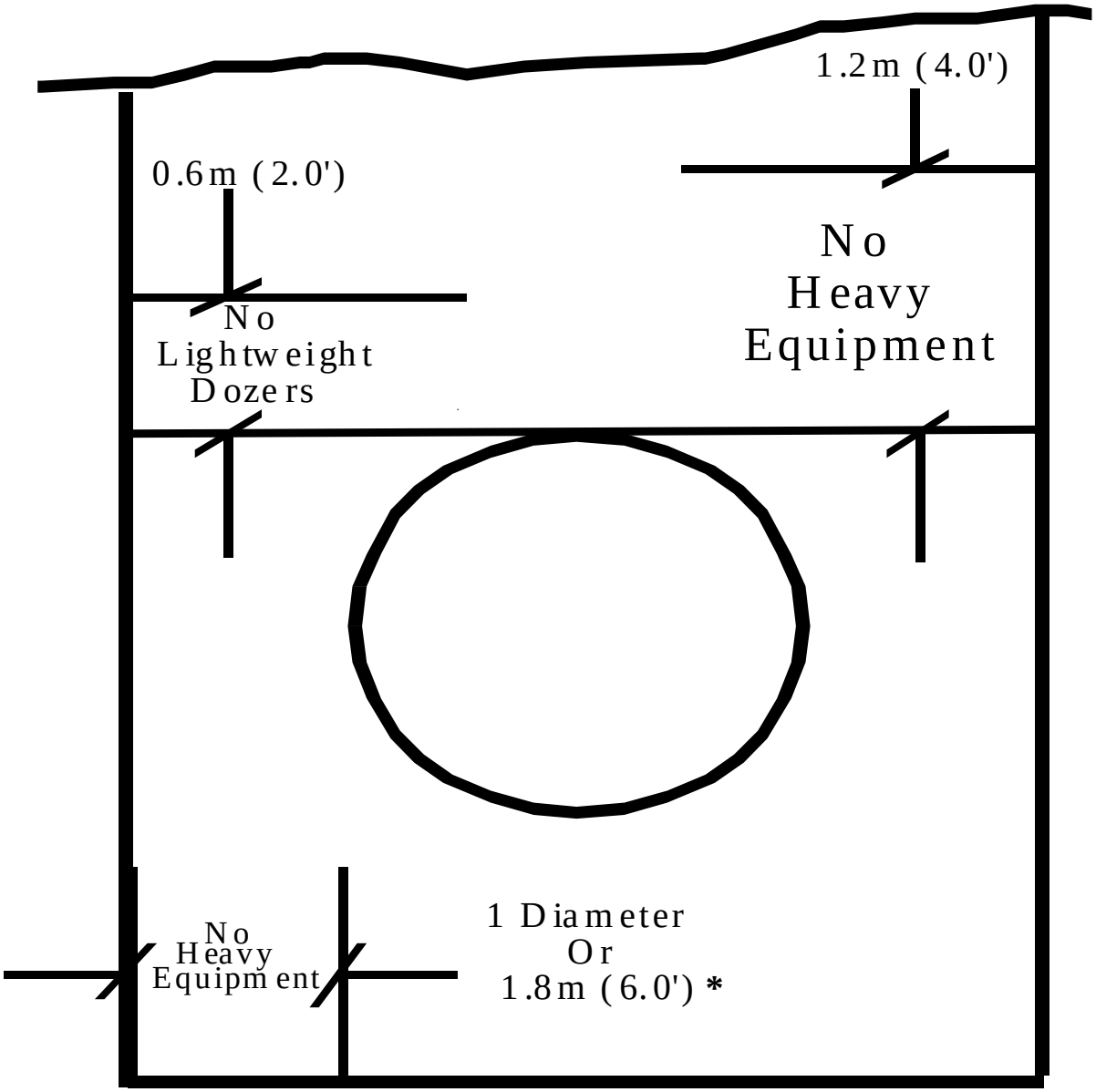


Figure 900-7 Backfill for Large Conduit Structure in a Fill

** This minimum height may be less; see note in Chapter 900 text.
***Where OD= Outside Dimension



* Use the lesser of the two values.

Figure 900-8 Protection of the Pipe

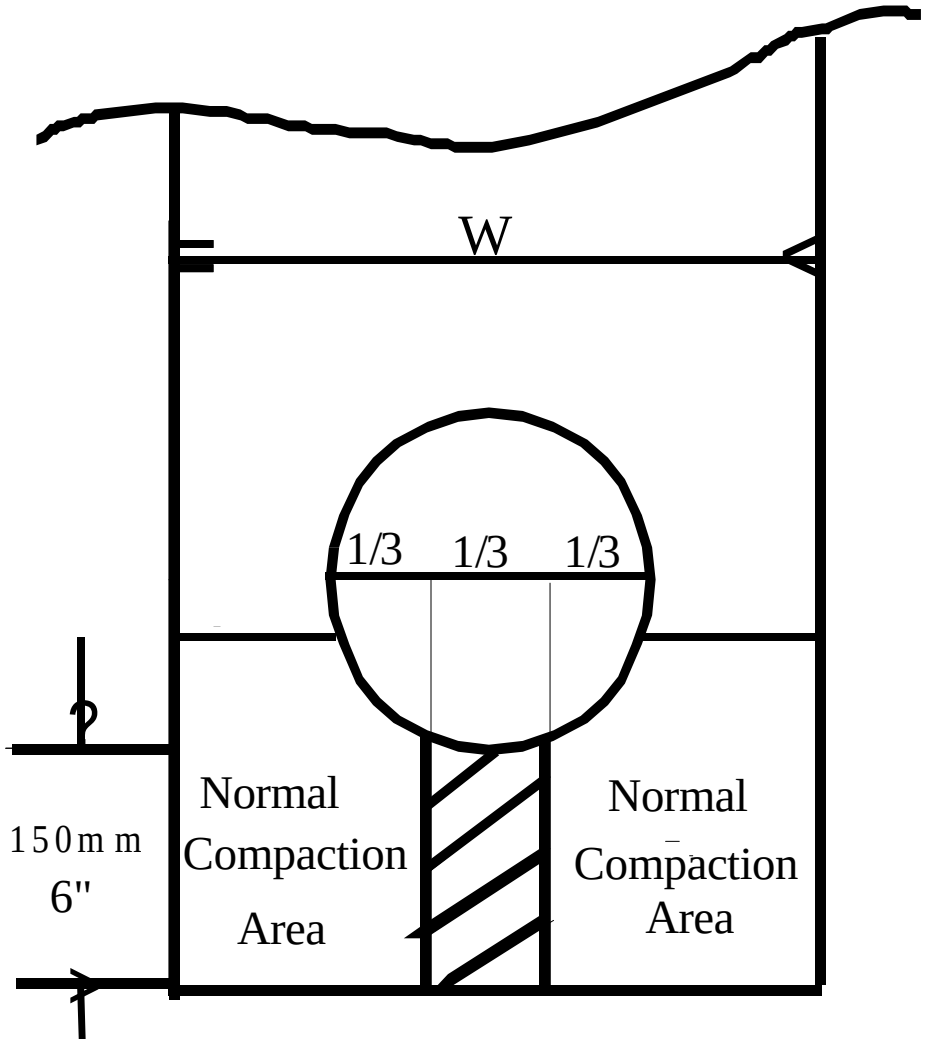


Figure 1000-1 Uncompacted or Lightly Compacted Bedding
Cross Hatched Area

State of Ohio
Department of Transportation

DAILY PIPE CONSTRUCTION INSPECTION FORM

Sample ID _____ Personnel ID _____ Date Sampled _____

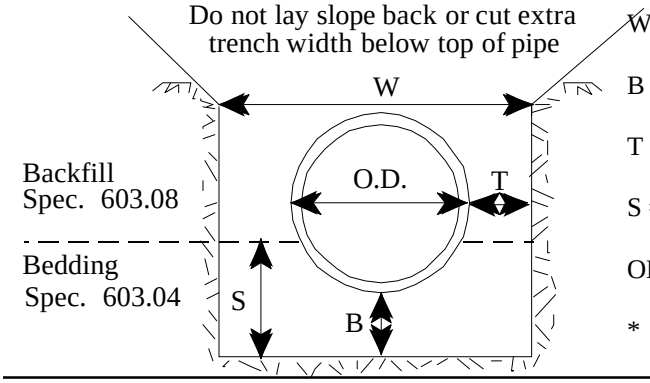
Item # _____ Ref. # Producer Code _____ Contractor # _____

Project # _____ County, Route & Section _____

Description _____

Location _____ Bubble # _____ Plan Page _____ Plan Ref. # _____

Type of Pipe *(circle one)* A B C D E F



W = Width of trench at top of pipe. Refer to Spec. 603.03 _____

B = Thickness of bedding under pipe. * _____

T = Outside diameter of pipe to trench wall. _____

S = Depth of bedding. _____

OD = Outside diameter of pipe. _____

* For Class B Bedding: B=150mm (6"), S=150mm (6") + 30% OD
For Class C Bedding: B=0, S=10% OD

TRENCH & BEDDING CHECKS (ACTUAL FIELD MEASUREMENTS)

Check Stations & Location *	T	W	B	S	Manual Fig.	Initial	Date

* Recommended checks every 50 feet, with a minimum of two checks per run. Check locations may be related to starting point such as outlet end, catch basin, C/L station, etc.

Indiv. Field Measurements lf (meter)	Actual Pay Length lf (meter)	Grade Check Method	Backfill			Compaction Form#	Initials & Date
			Compaction Method (603.081) tamp, flood, etc.	Type: Soil or Granular matl. 1,2 or 3	Lift Depth		

"Class"
Pipe Markings _____ Type of Joints (*603.06*) _____
Joints Installed Satisfactorily? ‘ Yes ‘ No

Materials: All tested and approved prior to incorporation into the project.

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TOTAL DAILY MEASUREMENT FOR PAY

Bubble # _____ Plan Page _____ Plan Ref# _____

Station _____

Plan Quantity _____ meters (lf) **

Remarks: _____

Daily Total Field Measured _____ meters (lf) (to 1/10)

Remarks: _____

Daily Total Authorized Pay _____ meter (lf) * _____

* To nearest 1/10 generally -- usual exception is an authorized lesser plan length. Round total of all items in reference to nearest 0.1 meter (foot).

** Explain field measurements and authorized pay. Is pay in accordance with 603.13 Method of Measurement?

a) Structure or pipe end location moved or least cost to State when accommodating full sections.

b) Measured to C/L of structure (except over 2 meters (6 linear feet) inside structure dimension in direction of flow)

c) You must account to "Lab" for pipe length due to creepage & measurements to C/L of structures.

Remarks: Record problems, soft foundations, under cuts, rock, instructions, utilities encountered, etc. Describe and note location of existing conduits encountered, whether connected, plugged and abandoned, reconnected, etc.

_____

_____

_____

Sketch

_____ _____

Inspector's Signature Date P.E./P.S. Signature Date

DOT-1640 **THIS FORM IS DOUBLE-SIDED** F-55

To Manual Holders:

For **initial registration**, the form below has been provided in order to ensure you will receive future revisions and updates to the Ohio Department of Transportation's Manual of Procedures for Pipe Construction. When initially receiving this manual, please complete the form and mail to:

Ohio Department of Transportation
Office of Highway Management
Construction Section
1980 West Broad Street
Post Office Box 899
Columbus, Ohio 43216-0899

MANUAL OF PROCEDURES FOR PIPE CONSTRUCTION

REGISTRATION FORM

Name:_____

Organization:_____

Address:_____

City:_____ State_____

Zip Code:_____ Phone: _____

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Office of Highway Management
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1980 West Broad Street
Post Office Box 899
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Name:
_____

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_____

Address:
_____

City:_____ State_____

Zip Code:_____ Phone:_____

Comment Information:

Section of Manual:_____

Page Number:_____

Comment:_____

_____

_____

Attach additional pages as necessary.

LOG OF REVISIONS AND UPDATES

DATE	SUBJECT/SECTION	COMMENTS