INDIANA DEPARTMENT OF TRANSPORTATION

Driving Indiana's Economic Growth

Design Memorandum No. 07-04
Technical Advisory

February 6, 2007

TO: **All Design, Operations, and District Personnel, and Consultants**

FROM: ***/s/ Anthony L. Uremovich***
Anthony L. Uremovich
Design Resources Engineer
Production Management Division

SUBJECT: **Backfilling and Video Inspection for Drainage Structures**

REVISES: ***Indiana Design Manual*** **Section 17-2.9**

EFFECTIVE: **March 7, 2007, Letting**

I. BACKFILL MATERIALS

A. Structure Backfill

Structure backfill is a separate pay item. When estimating the quantity of structure backfill, the following should be considered.

1. Drainage Structure. Section II herein discusses the procedure for estimating structure-backfill quantities for a drainage structure.

2. Abutment. The amount of structure backfill should be determined and shown similarly to that for a concrete retaining wall, i.e., 1:1 backslope to a point 1.5 ft (5 m) outside the neat lines of the abutment footing. See *Indiana Design Manual* Section 17-4.05(01).

3. Retaining Wall. The amount of structure backfill should be determined and shown on the cross sections at each retaining wall location. *Indiana Design Manual* Section 17-4.05(02) provides additional information regarding retaining-wall structure backfill.

B. Flowable Backfill

Flowable backfill is a separate pay item. It is required for backfilling behind the end bents of a reinforced-concrete slab bridge, or behind the wingwalls of a precast-concrete three- or four-sided structure. It is also required for backfilling a new cross-culvert placed under an existing roadway.

II. DETERMINING PIPE-BACKFILL QUANTITIES

The determination of pipe-backfill quantities is based on the pipe shape, pipe-interior designation, backfill method, and backfill material.

For additional guidance on determining pipe-backfill quantities, see the INDOT *Standard Specifications* or the INDOT *Standard Drawings*, or contact the Production Management Division's Design Resources Team.

A. Background Information

1. Pipe Shape. The pipe shape is either circular or deformed.

2. Pipe-Interior Designation. The interior of a pipe is either smooth or corrugated. For most pipe structures and pipe types, the contractor will have a choice of pipe materials, of either interior designation. For the purpose of determining backfill quantities, a smooth interior should be assumed.

3. Backfill Method. The standard backfill methods are described below, and also shown on the INDOT *Standard Drawings*.

    a. Method 1. This method should be used for a structure to be placed under a new- or replacement-roadway mainline or public road approach, for a structure to be placed under a median embankment, or for a new structure to be placed under an existing roadway mainline or public road approach.

    b. Method 2. This method should be used for a structure to be placed under a drive in new or replacement work, or under an existing drive.

c. Method 3. This method should be used for a structure to be placed under a new- or replacement-roadway's median trench.

4. Backfill Material. Unless instructed otherwise, structure backfill is required for each culvert or storm-drain structure, except a field-entrance culvert which is to be backfilled with suitable excavated material.

The contractor may substitute coarse aggregate as an option for structure backfill for backfilling a concrete culvert, pipe, structural plate pipe, pipe-arch, or arch. However, the backfill material should always be identified as structure backfill. If coarse aggregate is used, the ends and top of the trench are to be capped with geotextile as shown on the INDOT *Standard Drawings*. The geotextile is not a separate pay item.

A specific backfill type should only be specified if, for example, a pipe is to be placed in the vicinity of utilities. Then, flowable backfill should be specified. If structure backfill or flowable backfill are both acceptable alternates, the material should be identified and quantified as structure backfill.

See the INDOT *Standard Drawings* to determine the appropriate backfill materials for the structure based on the backfill method required.

B. Hand-Calculation of Backfill Quantities

Figure 07-__A identifies the values described below which are required for determining backfill quantities in english measurement units.

1. Circular Pipe, Earth Foundation.

C_t = corrrugations thickness = 0.5 in.

$$B_c = H_c = \frac{Inside\,Dia. + 2C_t}{12}$$

T_c = trench cover depth over pipe

V_c = 1 ft for $B_c \leq 1.5$ ft, or 1.5 ft for $B_c > 1.5$ ft

For backfill method 1 or 2, $L_B = 2(5) + Pvmt.\ Width + 2\left[2(T_c + H_c)\right]$,
where $T_c = V_c$. The pavement width is that of the travel lanes plus shoulders.

For backfill method 3, or method 1 in a median embankmemt, $L_B = Median\ Width - 2[2(T_c + H_c)] - 2(5)$. The median width excludes the shoulder widths.

$$A_c = \frac{\pi(B_c)^2}{4}$$

$W = 0.3B_c$ or 0.75 ft, whichever is greater

$W_b = 2W + B_c$

$$K = 2W + B_c + \frac{2H_c}{12}$$

For backfill method 3, $K_3 = 2W + B_c + \frac{2(H_c + V_c)}{12}$

$$W_t = K + \frac{2T_c}{12}$$

All methods, backfill quantity, B_{BC}, per linear foot from trench bottom to pipe crown:

$$B_{BC} = \frac{[0.5H_c(W_b + K)] - A_c}{27}$$

Method 1 or 2 backfill quantity, B_{CT}, per linear foot from pipe crown to top of trench:

$$B_{CT} = \frac{T_c(K + W_t)}{54}$$

Method 3 backfill quantity, B_{CV}, per linear foot from pipe crown to top of V_c dimension:

$$B_{CV} = \frac{V_c(K + K_3)}{54}$$

Method 3 backfill quantity, B_{VT}, per linear foot from top of V_c dimension to top of trench:

$$B_{VT} = \frac{(T_c - V_c)(K_3 + W_t)}{54}$$

Method 1 backfill per linear foot = $B_{BC} + B_{CT}$.
Method 1 total backfill quantity = $L_B(B_{BC} + B_{CT})$.

For backfill method 2, B_{BC} and B_{CT} each represent different materials, so the quantities should not be added. The total quantity for method 2's B_{BC} material is $(L_B)(B_{BC})$. The total quantity for method 2's B_{CT} material is $(L_B)(B_{CT})$.

For backfill method 3, B_{BC} and B_{CV} are the same material, so the total method 3 quantity of this material is $L_B(B_{BC}+ B_{CV})$. B_{VT} represents a different material, so it should not be added to $B_{BC}+ B_{CV}$. The total quantity for method 3's B_{VT} material is $(L_B)(B_{VT})$.

2. Circular Pipe, Rock Foundation. The total backfill quantity is that required for an earth foundation plus the foundation backfill required below the pipe. The additional volume is determined as follows:

A = 8 in. or 2/3 ft. The entry in the formula below for W_F must be made in feet.

$$W_F = 2W + B_c - \frac{2A}{12}$$

Backfill quantity, B_F, per linear foot of foundation area:

$$B_F = A\left(\frac{W_b + W_F}{2}\right)$$

Total foundation-backfill quantity = $(L_B)(B_F)$

3. Deformed Pipe, Earth Foundation.

C_t = corrrugations thickness = 0.5 in.

$$B_c = \frac{Span + 2C_t}{12}$$

$$H_c = \frac{Rise + 2C_t}{12}$$

For backfill method 1 or 2, $L_B = 2(5) + Pvmt.\ Width + 2\left[2\left(T_c + H_c\right)\right]$,
where $T_c = V_c$. The pavement width is that of the travel lanes plus shoulders.

For backfill method 3, or method 1 in a median embankmemt,
$L_B = Median\ Width - 2\left[2\left(T_c + H_c\right)\right] - 2(5)$. The median width excludes the shoulder widths.

$$A_c = \frac{(Pipe\ Opening)(C_t)(P)}{12}$$

$W = 0.3B_c$ or 0.75 ft, whichever is greater

$W_b = 2W + B_c$

$$K = 2W + B_c + \frac{2H_c}{12}$$

All methods, backfill quantity, B_{BC}, per linear foot from trench bottom to pipe crown:

$$B_{BC} = \frac{[0.5H_c(W_b + K)] - A_c}{27}$$

Method 1 or 2 backfill quantity, B_{CT}, per linear foot from pipe crown to top of trench:

$$B_{CT} = \frac{T_c(K + W_t)}{54}$$

Method 3 backfill quantity, B_{CV}, per linear foot from pipe crown to top of V_c dimension:

$$B_{CV} = \frac{V_c(K + K_3)}{54}$$

Method 3 backfill quantity, B_{VT}, per linear foot from top of V_c dimension to top of trench:

$$B_{VT} = \frac{(T_c - V_c)(K_3 + W_t)}{54}$$

Method 1 total backfill per linear foot = $B_{BC} + B_{CT}$.
Method 1 total backfill quantity = $L_B(B_{BC} + B_{CT})$.

For backfill method 2, B_{BC} and B_{CT} each represent different materials, so the quantities should not be added. The total quantity for method 2's B_{BC} material is $(L_B)(B_{BC})$. The total quantity for method 2's B_{CT} material is $(L_B)(B_{CT})$.

For backfill method 3, B_{BC} and B_{CV} are the same material, so the total method 3 quantity of this material is $L_B(B_{BC} + B_{CV})$. B_{VT} represents a different material, so it should not be added to $B_{BC} + B_{CV}$. The total quantity for method 3's B_{VT} material is $(L_B)(B_{VT})$.

4. Deformed Pipe, Rock Foundation. The total backfill quantity is that required for an earth foundation plus the foundation backfill required below the pipe. The additional volume is determined in the same manner as for a circular pipe.

For a metric-units project, the english-units procedure described above should be used, with english-units pipe sizes. The final cubic-yards backfill quantities should be converted to cubic meters.

C. Computer Program for Determining Backfill Quantities

The computer program, Backfill Calculation Software, is now available on the Department's website at www.in.gov/dot/div/contracts/standards/07Bkfl-qt.xls, and will be included on the Department's Design and Construction Reference Guide CD dated September 2007. The program, along with its related reference sheets and examples, is currently available in english measurement units only. Use of the program precludes the need for hand-calculations. For a metric-units project, the final cubic-yards backfill quantities determined from use of the program should be converted to cubic meters.

For a circular pipe, the input data include pipe diameter, pavement or median width as required, and T_c.

For a deformed pipe, the input data include pipe size, pavement or median width as required, T_c, span, rise, and perimeter P. Span, rise, and P can be determined from the reference sheets included with the program.

The following backfill-quantities calculation examples are included with the program.

1. Method 1, Circular Corrugated Pipe, Rock Foundation
2. Method 1, Deformed Smooth-Interior Pipe, Earth Foundation
3. Method 1, Circular Smooth-Interior Pipe, Earth Foundation
4. Method 2, Circular Corrugated Pipe, Earth Foundation
5. Method 2, Circular Corrugated Pipe, Structural-Plate Metal, Rock Foundation
6. Method 2, Deformed Corrugated Pipe, Earth Foundation
7. Method 3, Circular Corrugated Pipe, Earth Foundation
8. Method 3, Deformed Corrug. Pipe, Structural-Plate Aluminum Alloy, Earth Foundation
9. Method 3, Deformed Corrugated Pipe, Structural-Plate Steel, Rock Foundation

IV. VIDEO INSPECTION

Video inspection will be required for each pipe that cannot be visually inspected. A structure which will require video inspection is 100% of the length of any pipe deemed by the designer to be difficult or impossible to visually inspect or is inaccessible for visual inspection. This would include locations considered to be in confined spaces. Commercial- and private-drive pipes will not be video inspected. This is a pay item, and should be applied as necessary to all non-underdrain pipe pay items, without regard to INDOT *Standard Specifications* reference number.

V. INFORMATION TO BE SHOWN ON PLANS

The backfill method, material, and quantity; geotextile quantity if applicable; and video-inspection quantity if applicable, should be shown in the Structure Data table for each pipe structure. For a metric-units project, the metric pipe sizes should be shown on the plans, even though english pipe sizes were used to determine the backfill quantities.

VI. RECURRING SPECIAL PROVISIONS AND RECURRING PLAN DETAIL

The Recurring Special Provisions and Recurring Plan Detail, all listed below and attached hereto, should be called for beginning with the March, 2007, letting, and through the August 22, 2007, letting. The bases for use are also listed below.

Document No. and Title	Basis for Use
211-R-534, B Borrow and Structure Backfill	Pay item for B borrow or structure backfill
714-R-535, Concrete Culverts and Retaining Walls	Pay item with *Standard Specifications* Section 714 reference number
715-R-536, Pipe Culverts and Storm and Sanitary Sewers	Pay item with *Standard Specifications* Section 715 reference number
715-R-536d, Recurring plan details for pipe-backfill methods	Pay item with *Standard Specifications* Section 211, 714, 715, 717, or723 reference number
717-R-537, Structural Plate Pipe, Pipe-Arches, and Arches	Pay item with *Standard Specifications* Section 717 reference number
904-R-538, Structure Backfill	Pay item with *Standard Specifications* Section 211, 714, 715, 717, or723 reference number

Beginning with the September 6, 2007, letting, the recurring special provisions will be incorporated into the INDOT *Standard Specifications* and the recurring plan detail will become the new INDOT *Standard Drawings* 715-BKFL- series. The provisions and detail will then no longer be required to be called for in specific contracts.

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Attachments

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B BORROW AND STRUCTURE BACKFILL

The Standard Specifications are revised as follows:

SECTION 211, BEGIN LINE 1, DELETE AND INSERT AS FOLLOWS:

SECTION 211 – B BORROW ~~FILL~~ AND *STRUCTURE* BACKFILL

SECTION 211, AFTER LINE 23, INSERT AS FOLLOWS:

Aggregate for end bent backfill shall be No. 8 or No. 9 crushed stone or ACBF, class D or higher.

SECTION 211, BEGIN LINE 48, DELETE AND INSERT AS FOLLOWS:

~~When~~ *Where* structure backfill is specified, the Contractor may substitute flowable backfill in accordance with 213. However, flowable backfill shall not be placed into or through standing water, unless approved in writing.

SECTION 211, AFTER LINE 83, DELETE AND INSERT AS FOLLOWS:

Where specified, aggregate for end bent backfill shall be placed behind end bents and compacted in accordance with 211.04. Prior to placing the aggregate, a geotextile shall be installed in accordance with 616.11.

211.04 ~~Mechanical~~ Compaction

~~Where~~ B borrow ~~or~~ *and* structure backfill ~~is to~~ *shall* be compacted ~~by mechanical compaction, it shall, unless otherwise specified, be placed~~ *with mechanical tamps or vibrators* in accordance with the applicable provisions of 203.23 ~~except, if mechanical tamps or vibrators are used, the material shall be deposited in approximately 6 in. (150 mm) lifts, loose measurements, and each lift compacted to density requirements~~ *except as otherwise set out herein.*

Aggregate for end bent backfill and coarse aggregate No. 8, No. 9, or No. 11 used for structure backfill shall be deposited in layers not to exceed 12 in. (300 mm) loose measurement. Each layer shall be mechanically compacted with a compactor having a plate width of 17 in. (425 mm) or larger that delivers 3000 to 9000 lb (13.3 to 40 kN) per blow. Each lift shall be compacted with two passes of the compactor.

SECTION 211, BEGIN LINE 117, DELETE AND INSERT AS FOLLOWS:

211.07 ~~Aggregate For End Bent Backfill~~ *Blank*

~~When specified, coarse aggregate shall be placed behind end bents as shown on the plans. The material shall be deposited in lifts not to exceed 12 in. (300 mm) loose measurement, and each lift shall be mechanically compacted using a hand held vibratory plate compactor having a plate width of 17 in. (425 mm) or larger that delivers 3000 to 9000 lb (13.3 to 40 kN) per blow. Each lift shall be compacted with two passes of the compactor.~~

~~Prior to placing the aggregate, a geotextile shall be installed in accordance with 616.11.~~

CONCRETE CULVERTS AND RETAINING WALLS

The Standard Specifications are revised as follows:

SECTION 714, AFTER LINE 37, INSERT AS FOLLOWS:

714.03.1 Backfill

Structure backfill or flowable backfill shall be used as backfill around concrete culverts. Backfill shall be placed in accordance with 211 or 213 as applicable.

SECTION 714, BEGIN LINE 86, INSERT AS FOLLOWS:

714.07 Method of Measurement

Concrete used in retaining walls, culverts, and culvert extensions will be measured in accordance with 702.27. Reinforcing steel will be measured in accordance with 703.07. Precast reinforced concrete box sections and precast reinforced concrete box section extensions will be measured by the linear foot (meter), complete in place. *Common excavation for retaining walls will be measured by the cubic yard (cubic meter) to the neat lines shown on the plans.* Structure backfill *and B borrow for retaining walls* will be measured in accordance with 211.09 *to the neat lines shown on the plans. Structure backfill for drainage structures will be measured in accordance with 211.09. Flowable backfill will be measured in accordance with 213.08.* Field drilled holes will be measured in accordance with 702.27.

714.08 Basis of Payment

The accepted quantities of concrete used in retaining walls, culverts, and culvert extensions will be paid for at the contract unit price per cubic yard (cubic meter) for concrete, of the class specified, structures. Reinforcing steel will be paid for in accordance with 703.08. Precast reinforced concrete box sections will be paid for at the contract unit price per linear foot (meter) for culvert, precast reinforced concrete box sections, of the size specified, complete in place. Precast reinforced concrete box section extensions will be paid for at the contract unit price per linear foot (meter) for culvert extension, precast reinforced concrete box sections, of the size specified, complete in place. *Common excavation for retaining walls will be paid for at the contract unit price per cubic yard (cubic meter) to the neat lines in accordance with 203.28.* Structure backfill *and B borrow for retaining walls* will be paid for in accordance with 211.10. *Structure backfill for drainage structures will be paid for in accordance with 211.10. Where used as a substitute for structure backfill, flowable backfill will be paid for as structure backfill. Where specified for backfill, flowable backfill will be paid for in accordance with 213.09.* Field drilled holes will be paid for in accordance with 702.28.

PIPE CULVERTS AND STORM AND SANITARY SEWERS

The Standard Specifications are revised as follows:

SECTION 715, AFTER LINE 27, INSERT AS FOLLOWS:

Concrete	702
Flowable Backfill	213
Geotextiles	*918.02*
Reinforcing Steel	910.01
Rubber Type Gaskets	906.04
Straps, Hook Bolts, and Nuts	908.12
Structure Backfill	904

The maximum particle size of backfill material for corrugated pipe shall be less than one-half the corrugation depth.

SECTION 715, BEGIN LINE 287, DELETE AND INSERT AS FOLLOWS:

715.09 Backfilling

All ~~plastic~~ pipes, ~~except longitudinal underdrains, which are not fabricated with hydrostatic design basis rated resins and are installed within 5 ft (1.5 m) of mainline or public road approach pavement, paved shoulders, or sidewalks~~ shall be backfilled with *structure backfill or* flowable backfill. *Structure backfill shall be placed in accordance with 211.* Flowable backfill shall be placed in accordance with 213.07. ~~All other pipe installations shall be backfilled~~ as shown on the plans or as directed. ~~Structure backfill shall be placed in accordance with 211.04.~~

Prior to placing flowable backfill, all standing water shall be removed from the trench. If the water cannot be removed from the trench, structure backfill shall be used in lieu of flowable backfill to an elevation 2 ft (0.6 m) above the groundwater. The remainder of the trench shall be backfilled as shown on the plans.

~~Except where prohibited due to groundwater, flowable backfill may be used as a substitute for structure backfill.~~

~~After the completion of the backfill operation and prior to beginning the paving operation, all plastic pipes, except longitudinal underdrains, not fabricated with hydrostatic design basis rated resins installed within 5 ft (1.5 m) of mainline or public road approach pavement, paved shoulders, or sidewalks~~ *All pipes, except underdrains,* ~~shall~~ *will* be ~~mandrel tested~~ *visually inspected for acceptance a minimum of 30 days after the completion of backfill operations. Pipes that cannot be visually inspected shall be video inspected for acceptance in accordance with 718.07. The Engineer will determine the sections of pipe to be video inspected.*

After the visual or video inspection, all polyethylene and smooth wall polyvinyl chloride pipes 36 in. (900 mm) or less in pipe pay item diameter shall be mandrel tested. The mandrel shall be a go/no go mandrel with a minimum of nine arms or prongs and a diameter of 5% less than the pipe pay item diameter. If the mandrel does not pass through the pipe when pulled by hand or the mandrel damages the pipe, the deficient pipe shall be removed, replaced, and mandrel tested *a minimum of 30 days* after the ~~flowable~~ backfill has been replaced.

Commercial and private drive pipes are excluded from the mandrel testing and video inspection requirements.

Where material other than structure backfill or flowable backfill is permitted and used for backfilling, it shall be of such nature that compacts readily. That portion around and for 6 in. (150 mm) above the top of the pipe shall be free from large stones. This material shall be placed in layers not to exceed 6 in. (150 mm), loose measurement, and each layer compacted thoroughly by means of mechanical tamps. *Where coarse aggregate No. 8, No. 9, or No. 11 is used for structure backfill, geotextile shall be installed.*

An adequate earth cover, as shown on the plans, shall be placed over the structure before heavy equipment is ~~driven~~ *operated* over it.

Backfill for slotted drain pipe and slotted vane drain pipe shall consist of class A concrete on both sides of the pipe. During the backfilling and paving operations, the slot shall be covered to prevent infiltration of material into the pipe.

SECTION 715, BEGIN LINE 408, INSERT AS FOLLOWS:

Structure backfill will be measured in accordance with 211.09. Flowable backfill will be measured in accordance with 213.08.

Pavement replacement and subbase necessary due to structure replacement under an existing pavement will be measured to the neat lines shown on the plans.

For structures for which the plans permit pipes of differing sizes for either smooth or corrugated interiors, and the corrugated interior alternate is installed, measurement of ~~B borrow for~~ structure backfill or flowable ~~mortar~~ *backfill* will be based on the neat line dimensions shown on the plans for the smooth interior alternate.

Grated box end sections will be measured per each for the specified type, surface slope, and pipe size.

Video inspection for pipe will be measured by the linear foot (meter) as determined by the electronic equipment.

Mandrel testing of polyethylene and smooth wall polyvinyl chloride pipes 36 in. (900 mm) or less in pipe pay item diameter will not be measured for payment.

Geotextile used to wrap backfill material will not be measured for payment.

SECTION 715, AFTER LINE 439, INSERT AS FOLLOWS:

Structure backfill will be paid for in accordance with 211.10. Where used as a substitute for structure backfill, flowable backfill will be paid for as structure backfill. When specified for pipe backfill, flowable backfill will be paid for in accordance with 213.09.

SECTION 715, AFTER LINE 461, INSERT AS FOLLOWS:

Video inspections for pipe will be paid for at the contract unit price per linear foot (meter) completed.

SECTION 715, AFTER LINE 562, INSERT AS FOLLOWS:

Video Inspection for Pipe.....LFT (m)

SECTION 715, AFTER LINE 592, INSERT AS FOLLOWS:

Geotextile required for coarse aggregate No. 8, No. 9, or No. 11 structure backfill material will not be paid for separately. The cost of the geotextile shall be included in the cost of structure backfill.

The cost of providing the video inspection equipment, technician, videotapes, or computer disks shall be included in the cost of the video inspection for pipe. No additional payment will be made for repair or removal of pipes, backfill, the video re-inspection of the repairs or replaced pipe, and all other work associated with the repair or removal of unaccepted pipes.

STRUCTURAL PLATE PIPE, PIPE-ARCHES, AND ARCHES

The Standard Specifications are revised as follows:

SECTION 717, BEGIN LINE 3, DELETE AND INSERT AS FOLLOWS:

717.01 Description

This work shall consist of furnishing and placing structural plate pipe, pipe-arches, or arches in accordance with ~~these specifications and in reasonably close conformance with the lines, grades, and details shown on the plans or as directed~~ *105.03*.

SECTION 717, BEGIN LINE 81, DELETE AND INSERT AS FOLLOWS:

717.04 Backfill

~~Where shown on the plans or when directed,~~ *All structural plate pipe and pipe arches shall be backfilled with* structure backfill or flowable backfill ~~shall be used in backfilling around pipe and pipe-arch structures~~. Arch ~~structure~~ backfill shall be structure backfill. The amount of camber on the invert of the pipe or pipe-arch shall be varied to suit the height of fill and supporting soil, except the camber grade shall not be above level. ~~The finished backfill grade shall be as shown on the plans.~~ *Structure backfill shall be placed in accordance with 211. Flowable backfill shall be placed in accordance with 213.*

~~After the pipe or pipe-arch has been assembled and is in place, backfill material shall be placed in accordance with 211.04 or 213.07.~~

An adequate earth cover shall be provided over the structure, as shown on the plans, before heavy construction equipment is ~~driven~~ *operated* over it. This earth cover shall be free of stones.

~~When~~ *Where* backfilling at arches before headwalls are placed, the material shall first be placed midway between the ends of the arch, forming as narrow a ramp as possible, until the top of the arch is reached. The ramp shall be built up evenly on both sides and the backfilling material compacted as it is placed. After both ramps have been built to the top of the arch, the remainder of the backfill shall be deposited in both directions from the center to the ends and evenly on both sides of the arch.

SECTION 717, BEGIN LINE 160, DELETE AND INSERT AS FOLLOWS:

~~Flowable~~ *Where used as a substitute for structure backfill, flowable backfill will be paid for as structure backfill. Where specified for backfill, flowable* backfill will be paid for in accordance with 213.09.

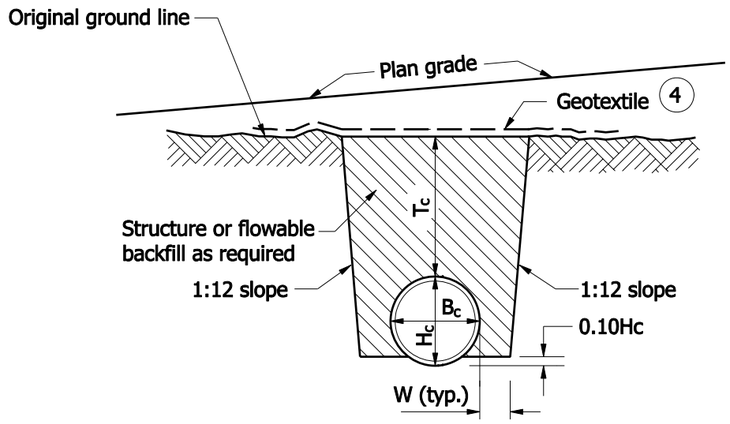
STRUCTURE BACKFILL

The Standard Specifications are revised as follows:

SECTION 904, BEGIN LINE 360, DELETE AND INSERT AS FOLLOWS:

904.05 Structure Backfill

The material shall be of acceptable quality, free from large or frozen lumps, wood, or other extraneous matter. It shall consist of suitable sand, gravel, crushed stone, ACBF, or GBF. ~~Coarse aggregate used for backfilling end bents on beam structures shall be No. 8 or No. 9 crushed stone or BF slag, class D or higher, in accordance with 904.~~ Structure backfill shall be in accordance with one of the following gradations *or No. 8, No. 9, No. 11, No. 53, or No. 73 coarse aggregate in accordance with the gradation requirements of 904.03(e). Coarse aggregate No. 8, No. 9, No. 11, No. 53, or No. 73 shall be crushed stone or ACBF, class D or higher.*



SECTION A-A

LEGEND

H_c = Overall diameter or rise (typ.)

B_c = Overall diameter or span

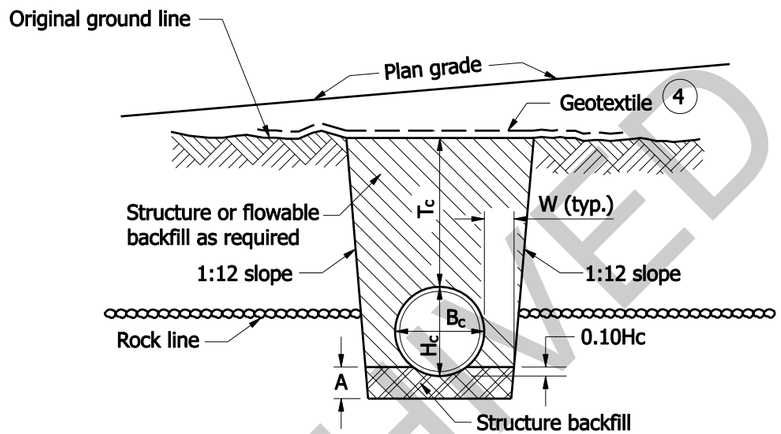
A = 8" min. for fill height less than 16'
= 12" min. for fill height of 16' or more

T_c = Trench cover depth over pipe

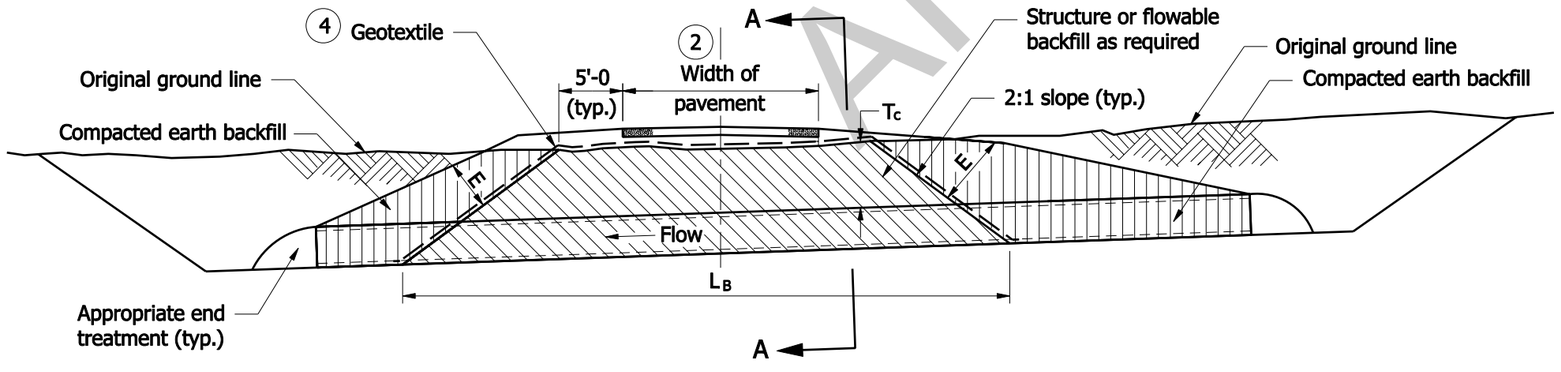
W = 0.3 B_c or 9", whichever is greater

E = Encasement

L_B = Backfill length measured from toe to toe of the 2:1 slopes.



SECTION A-A
ROCK FOUNDATION



ELEVATION

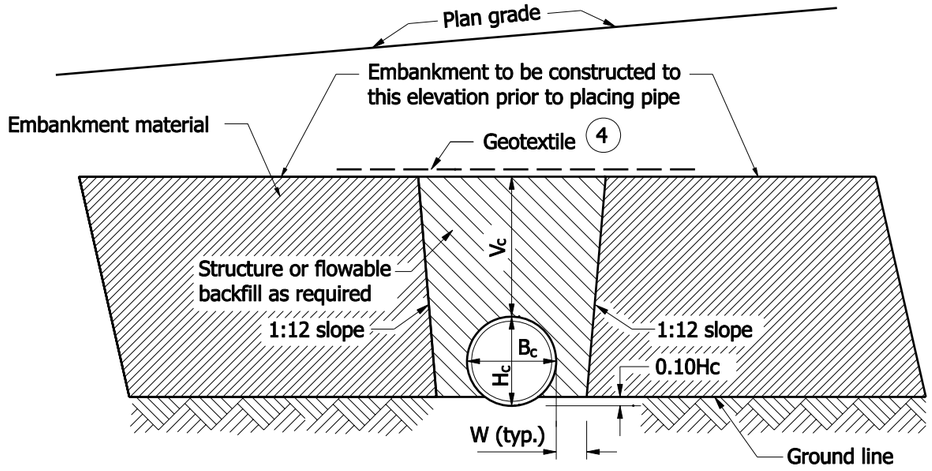
NOTES :

1. Protective cover shall be constructed prior to running heavy equipment over installed pipes. The minimum covers are listed below:
   a.) 1.5' for $B_c \leq 18"$
   b.) 3' for $18" < B_c \leq 54"$
   c.) 4' for $B_c > 54"$
2. For backfill purposes, paved shoulders, curbs, and sidewalks are considered pavement. See Standard Drawing E 715-BKFL-10 for pavement limits when curbs, paved shoulders, or sidewalks are present.
3. Flowable or structure backfill shall be encased by compacted earth backfill. The minimum encasement shall be 2 ft. If necessary, the 2:1 slope between the flowable or structure backfill and the encasement shall be modified to maintain the minimum 2 ft encasement.
4. Geotextile required if coarse aggregate is used. Geotextile should extend 1 foot beyond each edge of the excavated trench or toe of slope.

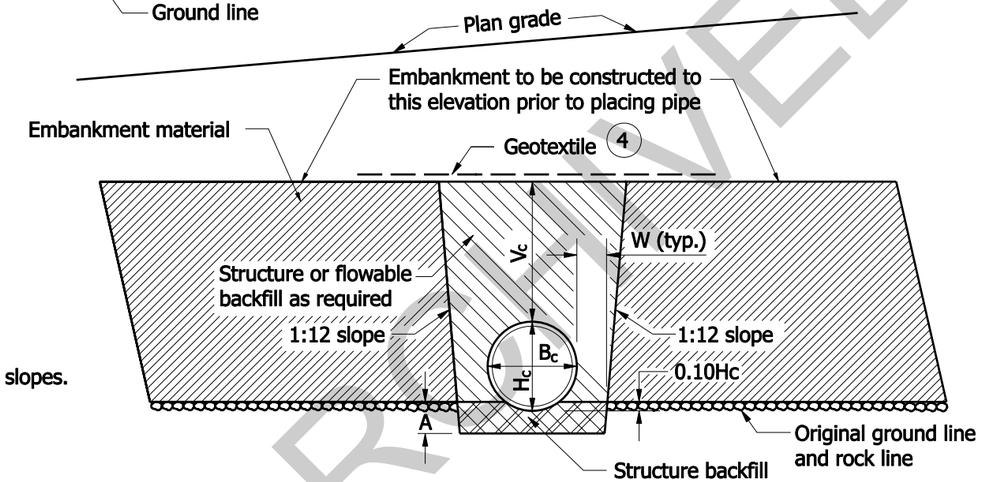
INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL METHOD 1
NEW ROADWAY, TRENCH

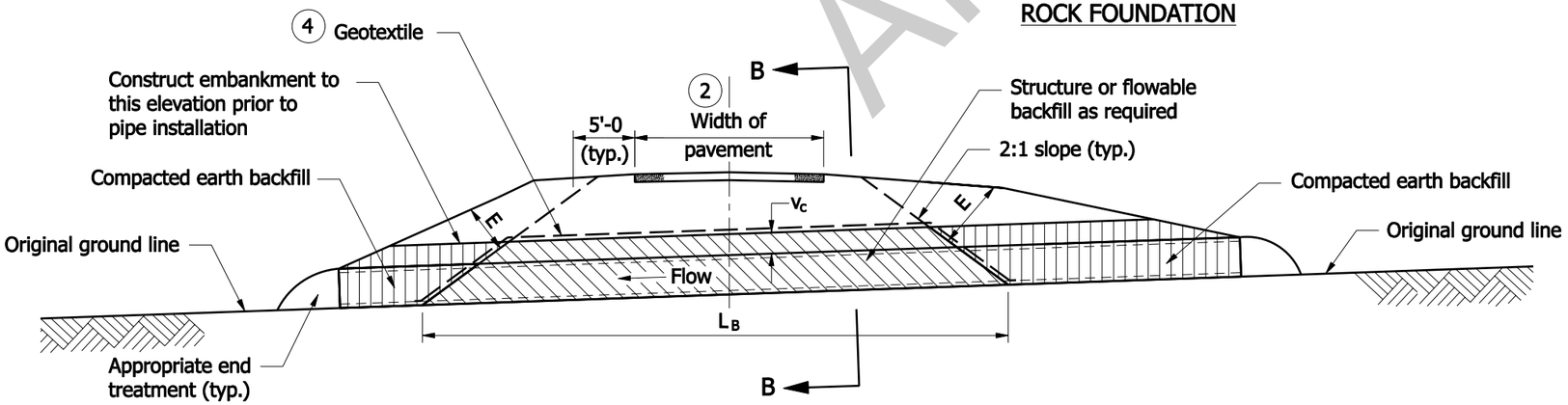
11-16-06



SECTION B-B



SECTION B-B
ROCK FOUNDATION



ELEVATION

LEGEND

H_c = Overall diameter or rise (typ.)

B_c = Overall diameter or span

A = 8" min. for fill height less than 16'
= 12" min. for fill height of 16' or more

V_c = 12" for $B_c \leq 18$"
18" for $B_c > 18$"

W = 0.3 B_c or 9", whichever is greater

L_B = Backfill length measured from toe to toe of the 2:1 slopes.

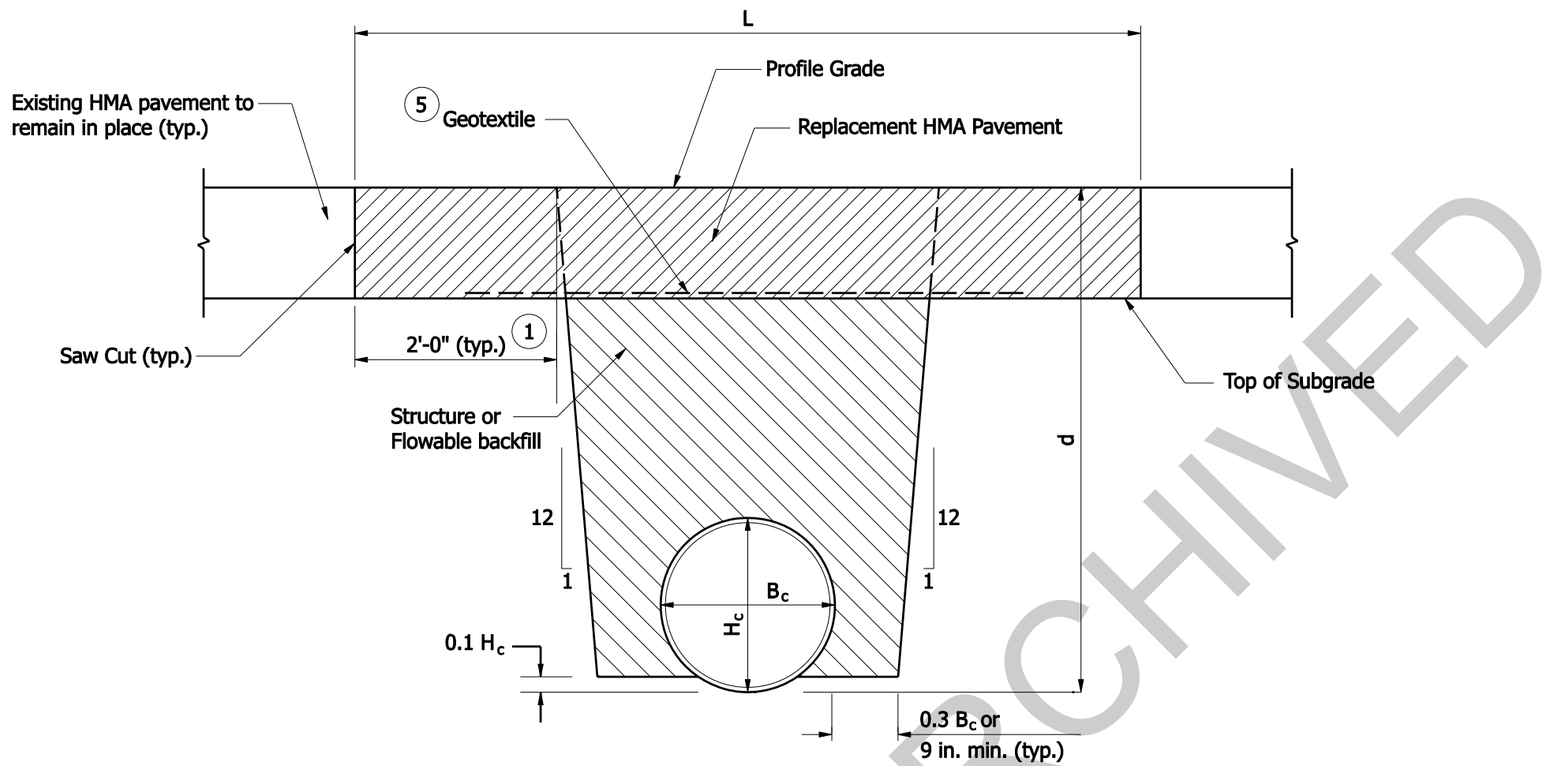
NOTES :

1. Protective cover shall be constructed prior to running heavy equipment over installed pipes. The minimum covers are listed below:
   a.) 1.5' for $B_c \leq 18$"
   b.) 3' for 18" < $B_c \leq 54$"
   c.) 4' for $B_c > 54$"
2. For backfill purposes, paved shoulders, curbs, and sidewalks are considered pavement. See Standard Drawing E 715-BKFL-10 for pavement limits when curbs, paved shoulders, or sidewalks are present.
3. Flowable or structure backfill shall be encased by compacted earth backfill. The minimum encasement shall be 2 ft. If necessary, the 2:1 slope between the flowable or structure backfill and the encasement shall be modified to maintain the minimum 2 ft encasement.
4. Geotextile required if coarse aggregate is used. Geotextile should extend 1 foot beyond each edge of the excavated trench or toe of slope.

INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL METHOD 1
NEW ROADWAY, EMBANKMENT

11-16-06



L = Pay limits of pavement removal and pavement replacement (ft); for cross pipe, measured along roadway centerline; for pipe parallel to roadway centerline, measured prependicular to pipe centerline.

B_C = Overall diameter or span (in.)

H_C = Overall diameter or rise (in.)

d = Vertical distance from flowline to profile grade (ft)

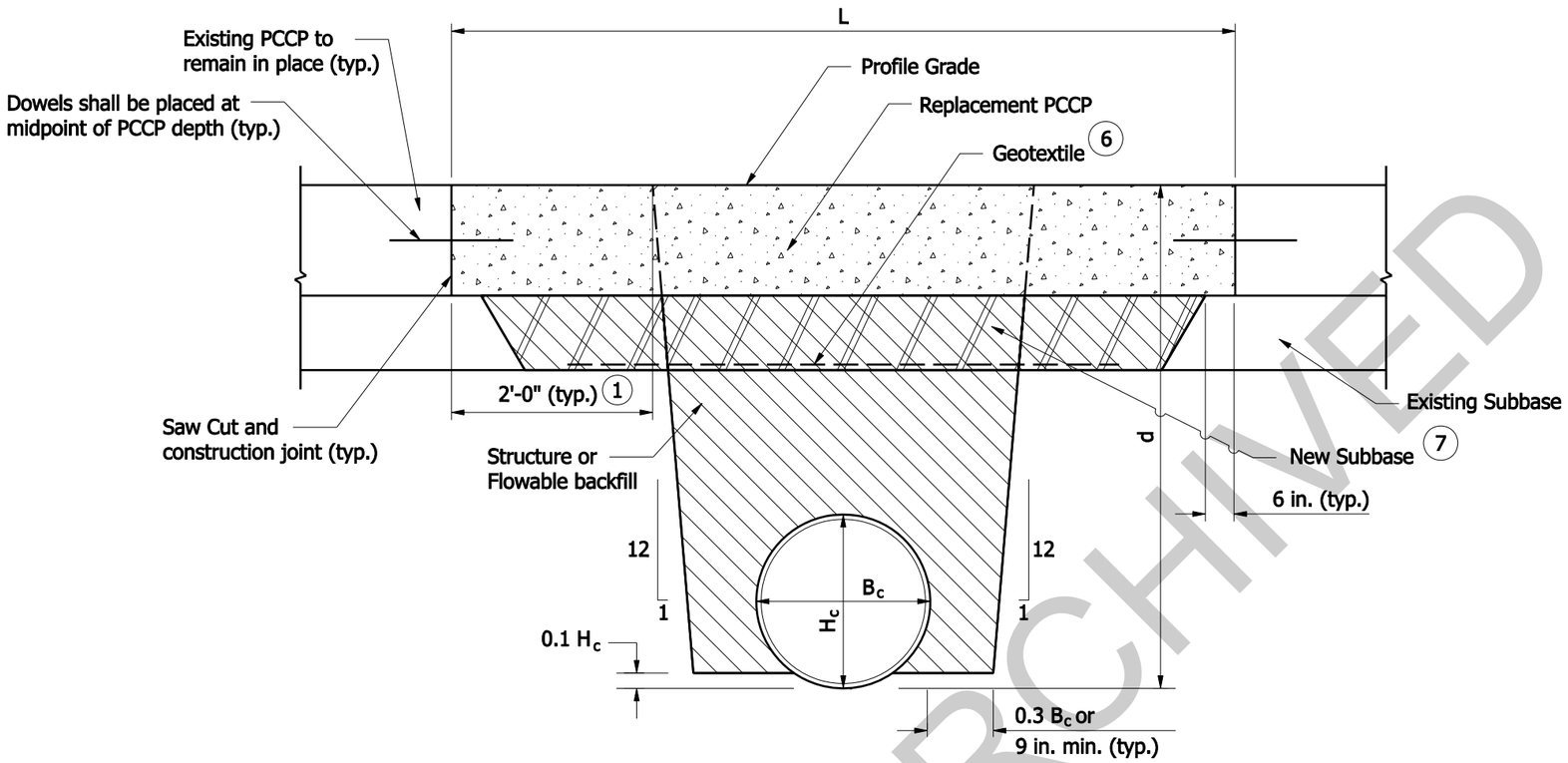
HMA REPLACEMENT PAVEMENT

NOTES :

1. Existing subgrade over this distance shall remain in place.
2. The minimum pavement sections shall be as follows:
   HMA: 165 #/syd HMA Surface, Type A,B,C or D on
   variable HMA Intermediate, Type A, B, C or D
3. If underdrains are present, they shall be perpetuated in accordance with the details shown on Standared Drawing E 718-UNDR-01.
4. See Standard Drawing E 715-BKFL-01 for pipe backfill trench elevation view.
5. Geotextile required if coarse aggregate is used. Geotextile should extend 1 foot beyond each edge of the excavated trench.

INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL METHOD 1
EXISTING ROADWAY, TRENCH



L = Pay limits of pavement removal and pavement replacement (ft); for cross pipe, measured along roadway centerline; for pipe parallel to roadway centerline, measured prependicular to pipe centerline.

B_C = Overall diameter or span (in.)

H_C = Overall diameter or rise (in.)

d = Vertical distance from flowline to profile grade (ft)

PCCP REPLACEMENT PAVEMENT

NOTES :

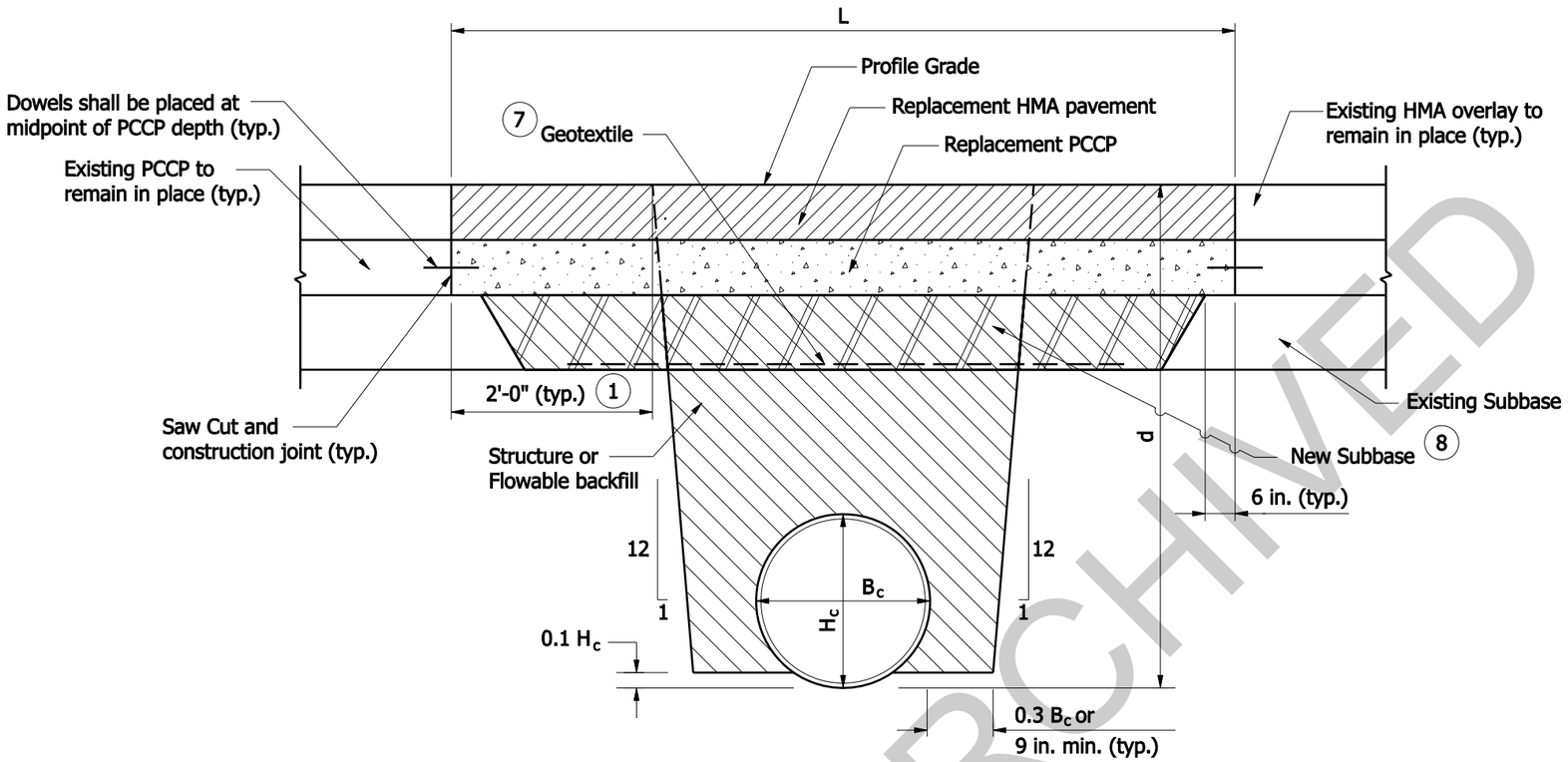
1. Existing subgrade over this longitudinal distance shall remain in place.
2. The thickness of the replacement PCCP shall match that of the existing concrete pavement.
3. See Standard Drawing E 506-CCPP-01 for subbase, dowels, and construction joint details.
4. If underdrains are present, they shall be perpetuated in accordance with the details shown on Standard Drawing E 718-UNDR-01.
5. See Standard Drawing E 715-BKFL-01 for pipe backfill trench elevation view.
6. Geotextile required if coarse aggregate is used. Geotextile should extend 1 foot beyond each edge of the excavated trench.
7. New subbase type shall match the existing subbase type and thickness.

INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL, METHOD 1
EXISTING ROADWAY, TRENCH

11-16-06

E 715-R-536d 4 of 10



L = Pay limits of pavement removal and pavement replacement (ft); for cross pipe, measured along roadway centerline; for pipe parallel to roadway centerline, measured prependicular to pipe centerline.

B_C = Overall diameter or span (in.)

H_C = Overall diameter or rise (in.)

d = Vertical distance from flowline to profile grade (ft)

COMPOSITE REPLACEMENT PAVEMENT

NOTES :

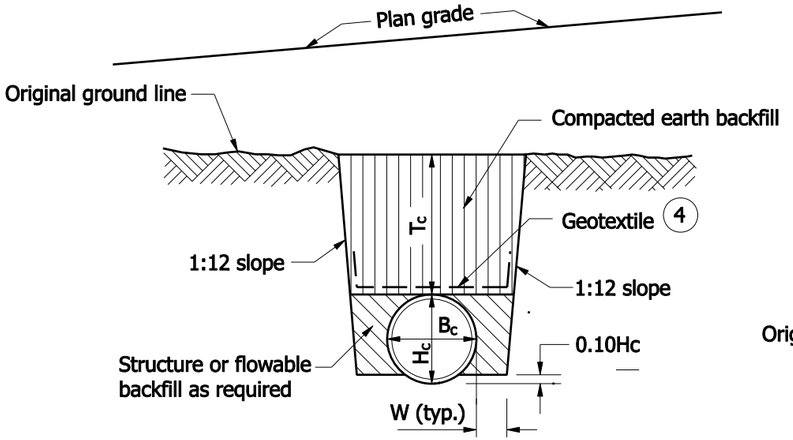
1. Existing subgrade over this distance shall remain in place.
2. The thickness of the replacement PCCP shall match that of the existing concrete pavement.
3. The minimum pavement sections shall be as follows:
   HMA: 165 #/syd HMA Surface, Type A,B,C or D on
   variable HMA Intermediate, Type A, B, C or D
4. See Standard Drawing E 506-CCPP-01 for subbase, dowels, and construction joint details.
5. If underdrains are present, they shall be perpetuated in accordance with the details shown on Standard Drawing E 718-UNDR-01.
6. See Standard Drawing E 715-BKFL-01 for pipe backfill trench elevation view.
7. Geotextile required if coarse aggregate is used. Geotextile should extend 1 foot beyond each edge of the excavated trench.
8. New subbase type shall match the existing subbase type and thickness.

INDIANA DEPARTMENT OF TRANSPORTATION

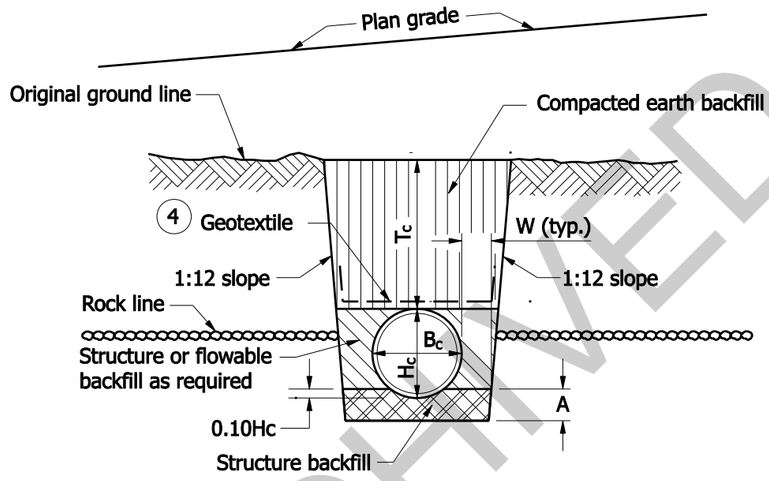
PIPE BACKFILL METHOD 1
EXISTING ROADWAY, TRENCH

11-16-06

E 715-R-536d 5 of 10



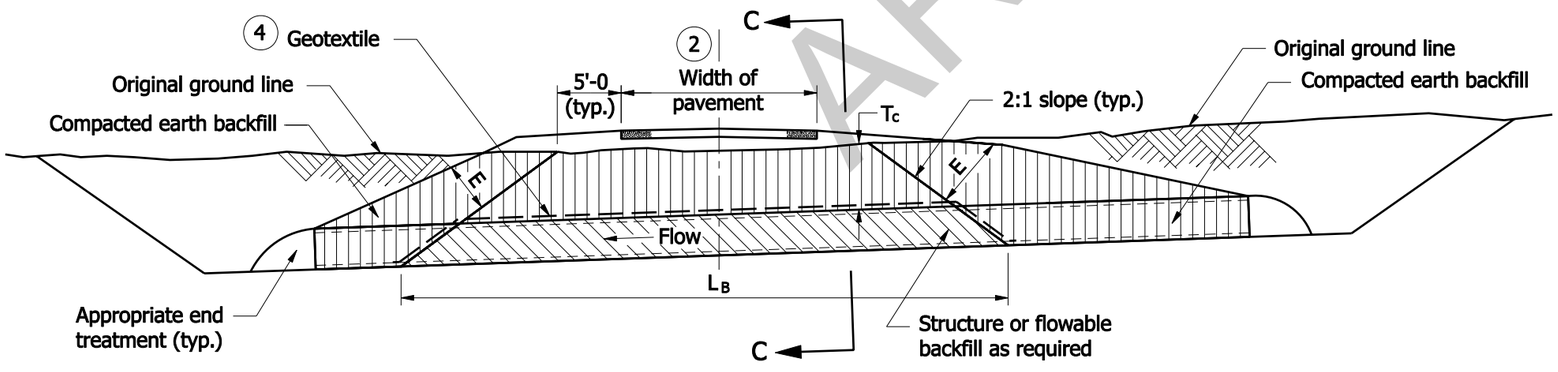
SECTION C-C



SECTION C-C
ROCK FOUNDATION

LEGEND

H_c = Overall diameter or rise (typ.)
B_c = Overall diameter or span
A = 8" min. for fill height less than 16'
= 12" min. for fill height of 16' or more
T_c = Trench cover depth over pipe
W = 0.3 B_c or 9", whichever is greater
E = Encasement
L_B = Backfill length measured from toe to toe of the 2:1 slopes.



ELEVATION

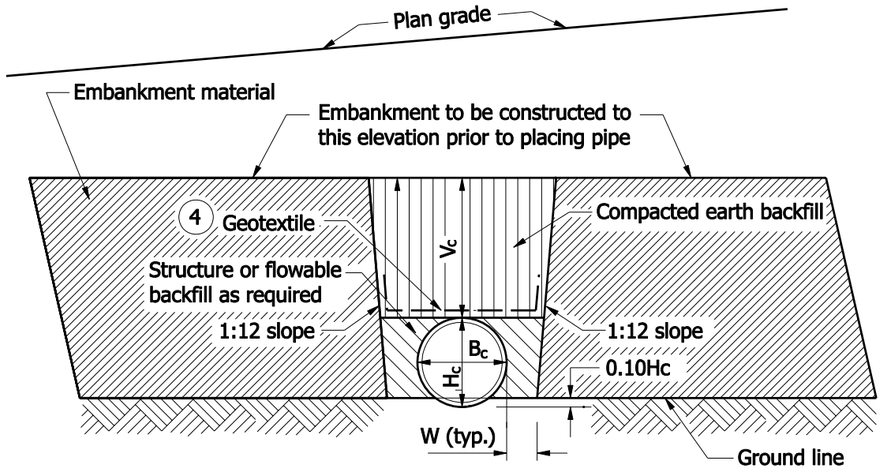
NOTES :

1. Protective cover shall be constructed prior to running heavy equipment over installed pipes. The minimum covers are listed below:
   a.) 1.5' for $B_c \leq 18"$
   b.) 3' for $18" < B_c \leq 54"$
   c.) 4' for $B_c > 54"$
2. For backfill purposes, paved shoulders, curbs, and sidewalks are considered pavement. See Standard Drawing E 715-BKFL-10 for pavement limits when curbs, paved shoulders, or sidewalks are present.
3. Flowable or structure backfill shall be encased by compacted earth backfill. The minimum encasement shall be 2 ft. If necessary, the 2:1 slope between the flowable or structure backfill and the encasement shall be modified to maintain the minimum 2 ft encasement.
4. Geotextile required if coarse aggregate is used. Geotextile should extend 1 foot beyond each edge of the excavated trench or toe of slope.

INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL METHOD 2
CLASS II, IV, V AND VI DRIVES, TRENCH

11-16-06



SECTION D-D

LEGEND

H_c = Overall diameter or rise (typ.)

B_c = Overall diameter or span

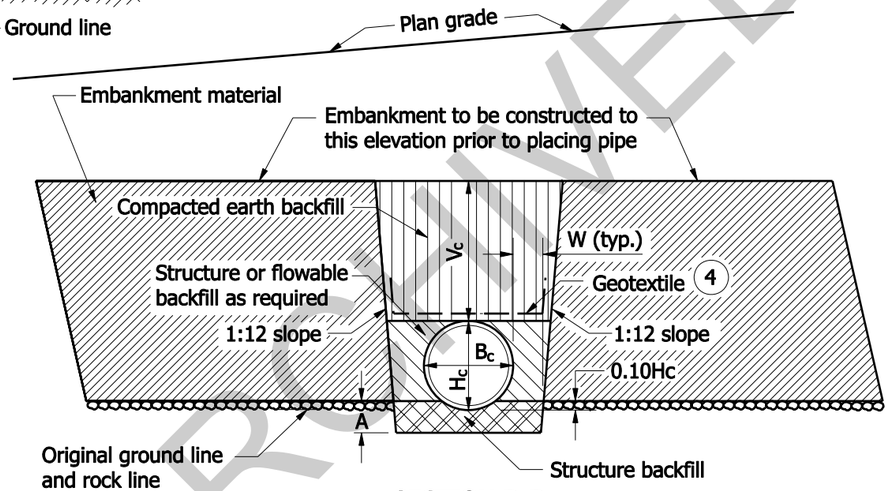
A = 8" min. for fill height less than 16'
= 12" min. for fill height of 16' or more

V_c = 12" for $B_c \leq 18$"
18" for $B_c > 18$"

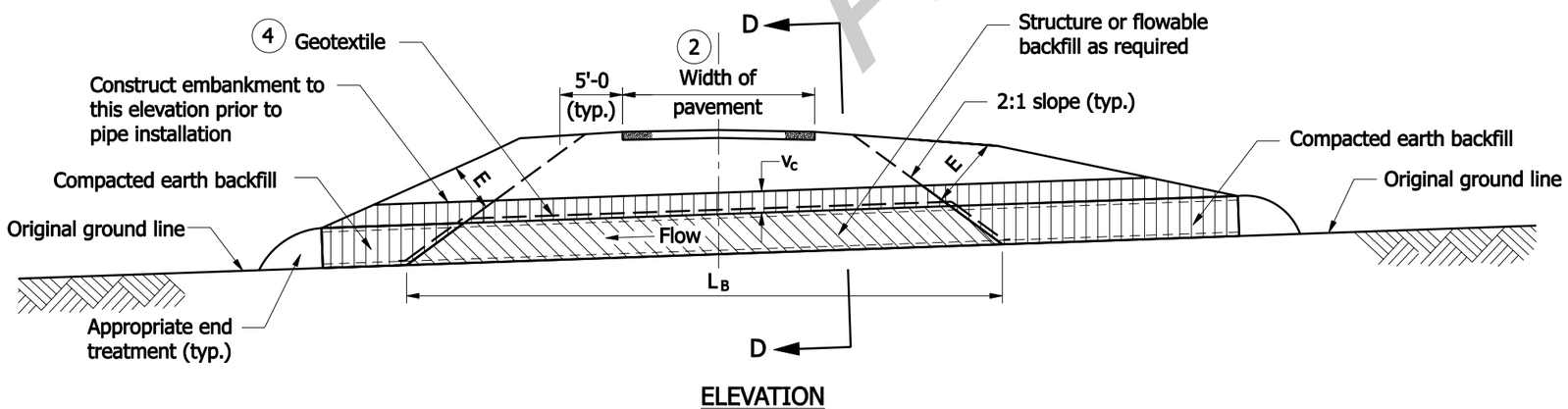
W = 0.3 B_c or 9", whichever is greater

E = Encasement

L_B = Backfill length measured from toe to toe of the 2:1 slopes.



SECTION D-D
ROCK FOUNDATION



ELEVATION

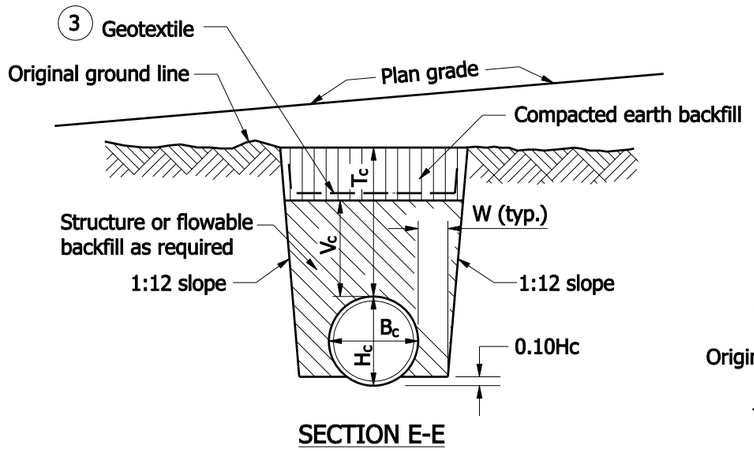
NOTES :

1. Protective cover shall be constructed prior to running heavy equipment over installed pipes. The minimum covers are listed below:
   a.) 1.5' for $B_c \leq 18$"
   b.) 3' for 18" < $B_c \leq 54$"
   c.) 4' for $B_c > 54$"
2. For backfill purposes, paved shoulders, curbs, and sidewalks are considered pavement. See Standard Drawing E 715-BKFL-10 for pavement limits when curbs, paved shoulders, or sidewalks are present.
3. Flowable or structure backfill shall be encased by compacted earth backfill. The minimum encasement shall be 2 ft. If necessary, the 2:1 slope between the flowable or structure backfill and the encasement shall be modified to maintain the minimum 2 ft encasement.
4. Geotextile required if coarse aggregate is used. Geotextile should extend 1 foot beyond each edge of the excavated trench or toe of slope.

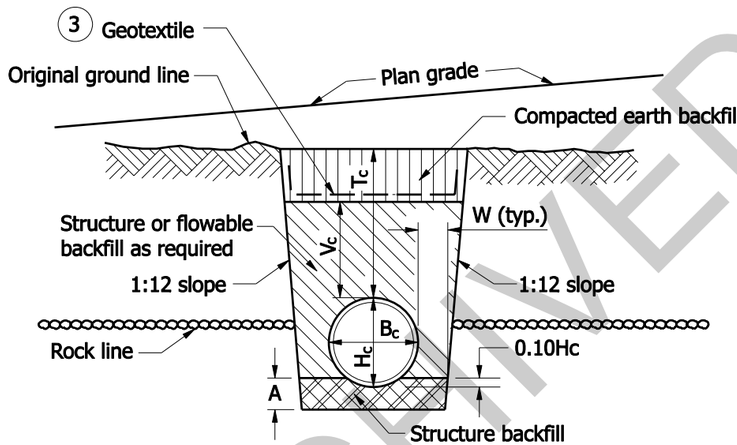
INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL METHOD 2
CLASS II, IV, V AND VI DRIVES, EMBANKMENT

11-16-06



SECTION E-E



SECTION E-E
ROCK FOUNDATION

LEGEND

H_c = Overall diameter or rise (typ.)

B_c = Overall diameter or span

A = 8" min. for fill height less than 16'
= 12" min. for fill height of 16' or more

V_c = 12" for $B_c \leq 18"$
18" for $B_c > 18"$

T_c = Trench cover depth over pipe

W = 0.3 B_c or 9", whichever is greater

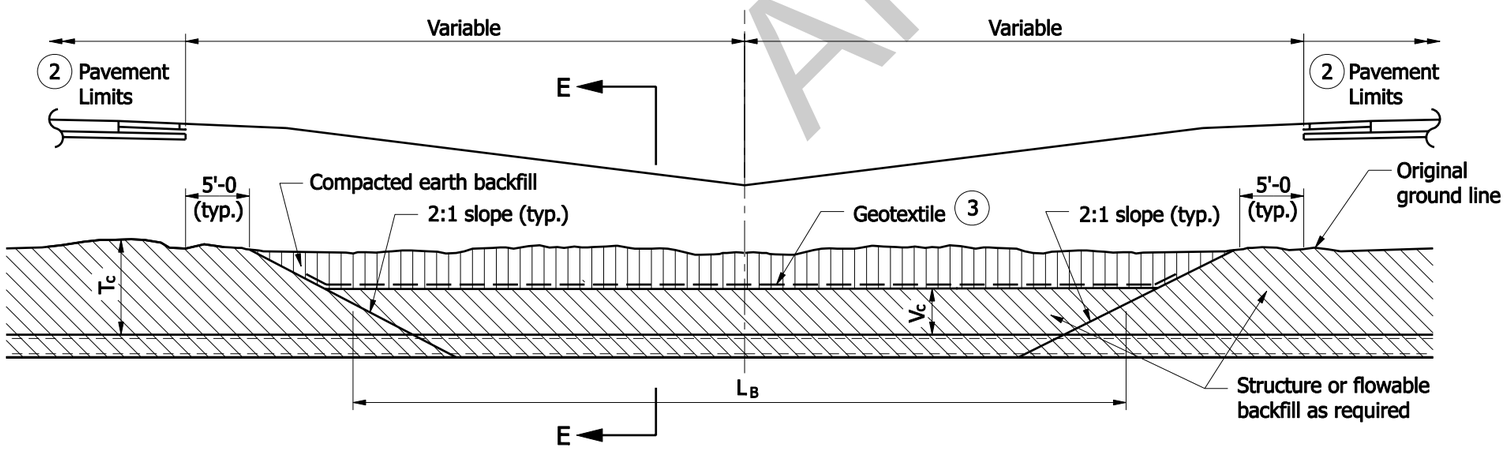
L_B = Backfill length measured from toe to toe of the 2:1 slopes.

NOTES :

1. Protective cover shall be constructed prior to running heavy equipment over installed pipes. The minimum covers are listed below:
   a.) 1.5' for $B_c \leq 18"$
   b.) 3' for $18" < B_c \leq 54"$
   c.) 4' for $B_c > 54"$

(2) For backfill purposes, paved shoulders, curbs, and sidewalks are considered pavement. See Standard Drawing E 715-BKFL-10 for pavement limits when curbs, paved shoulders, or sidewalks are present.

(3) Geotextile required if coarse aggregate is used. Geotextile should extend 1 foot beyond each edge of the excavated trench or toe of slope.



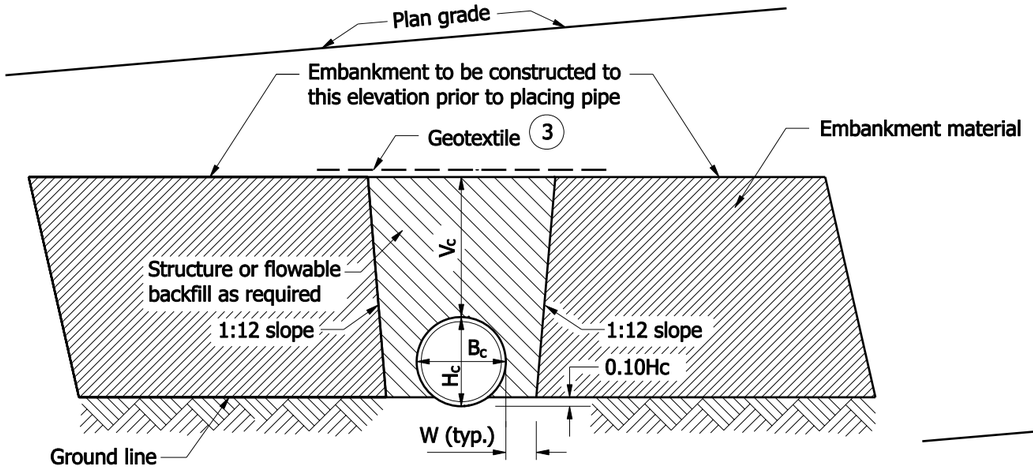
ELEVATION THRU MEDIAN STRIP

INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL METHOD 3
MEDIAN INSTALLATION, TRENCH

11-16-06

E 715-R-536d 8 of 10



SECTION F-F

LEGEND

H_c = Overall diameter or rise (typ.)

B_c = Overall diameter or span

A = 8" min. for fill height less than 16'
= 12" min. for fill height of 16' or more

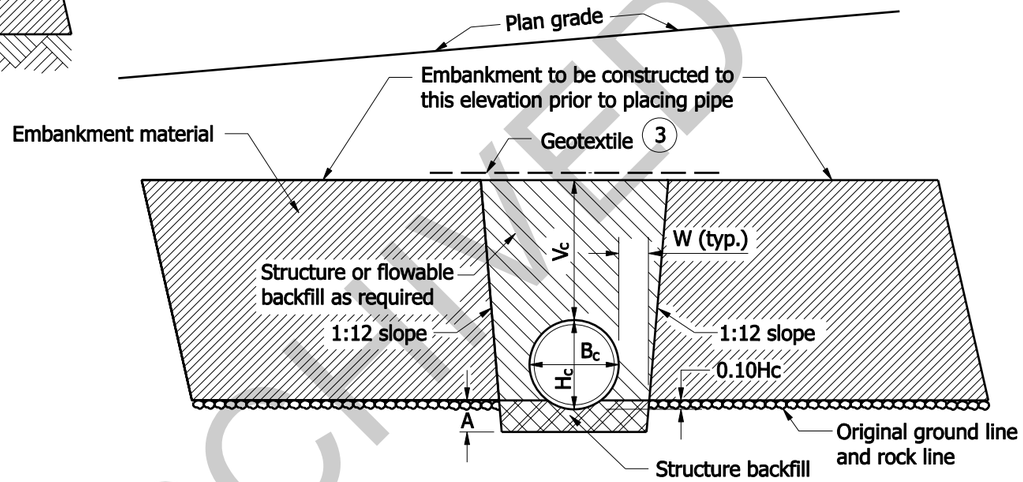
V_c = 12" for $B_c \leq 18$"
18" for $B_c > 18$"

W = 0.3 B_c or 9", whichever is greater

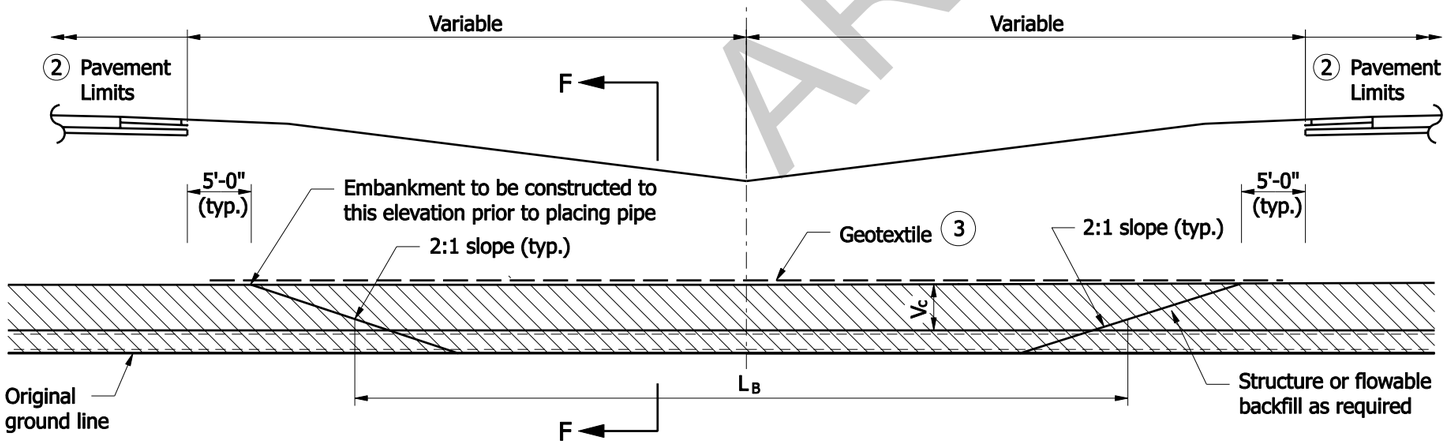
L_B = Backfill length measured from toe to toe of the 2:1 slopes.

NOTES :

1. Protective cover shall be constructed prior to running heavy equipment over installed pipes. The minimum covers are listed below:
   a.) 1.5' for $B_c \leq 18$"
   b.) 3' for 18" < $B_c \leq 54$"
   c.) 4' for $B_c > 54$"
2. For backfill purposes, paved shoulders, curbs, and sidewalks are considered pavement. See Standard Drawing E 715-BKFL-10 for pavement limits when curbs, paved shoulders, or sidewalks are present.
3. Geotextile required if coarse aggregate is used. Geotextile should extend 1 foot beyond each edge of the excavated trench or toe of slope.



SECTION F-F
ROCK FOUNDATION



ELEVATION THRU MEDIAN STRIP

INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL METHOD 1
MEDIAN INSTALLATION, EMBANKMENT

11-16-06

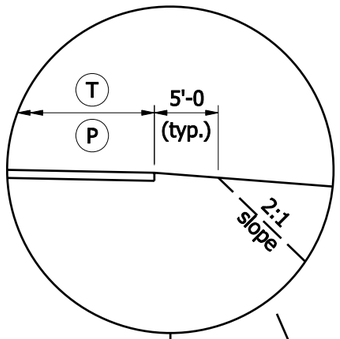
E 715-R-536d 10 of 10

LEGEND

- (C) Curb
- (P) Pavement Limits *
- (S) Sidewalk
- (T) Travel Lane
- (U) Utility Strip
- (V) Paved Shoulder

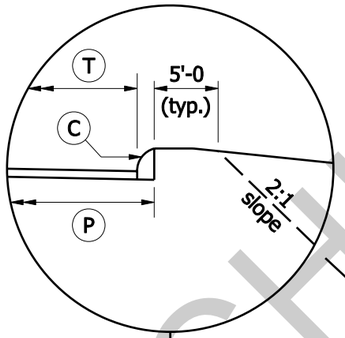
* For backfill placement and computation

EDGE OF TRAVELWAY



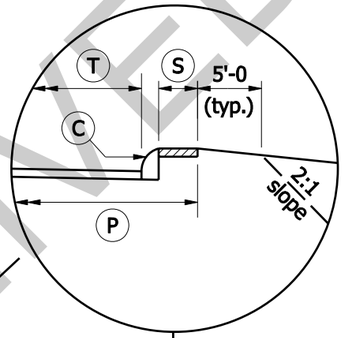
or

BACK OF CURB



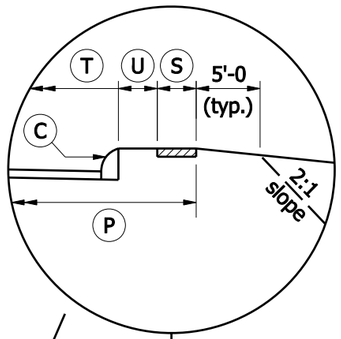
or

EDGE OF SIDWEWALK
ADJACENT TO CURB



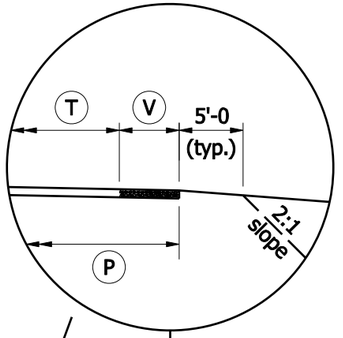
or

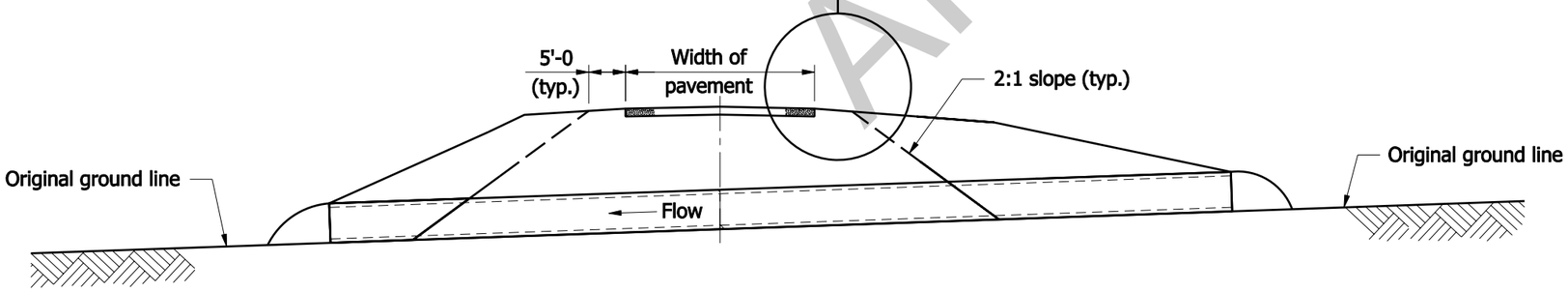
EDGE OF SIDEWALK
ADJACENT TO UTILITY
STRIP



or

EDGE OF PAVED
SHOULDER



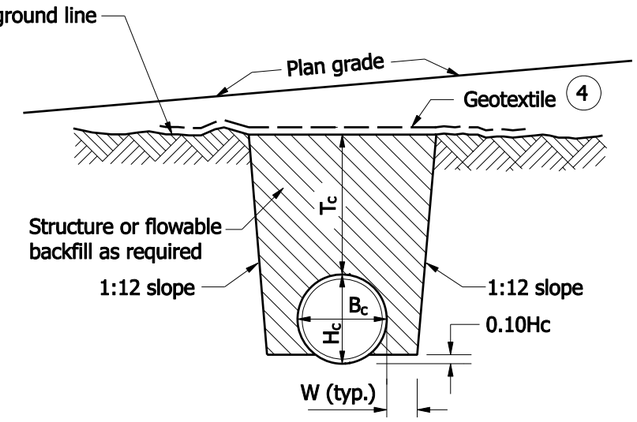


ELEVATION

INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL
LIMIT DETERMINATION

11-16-06



SECTION A-A

LEGEND

H_c = Overall diameter or rise (typ.)

B_c = Overall diameter or span

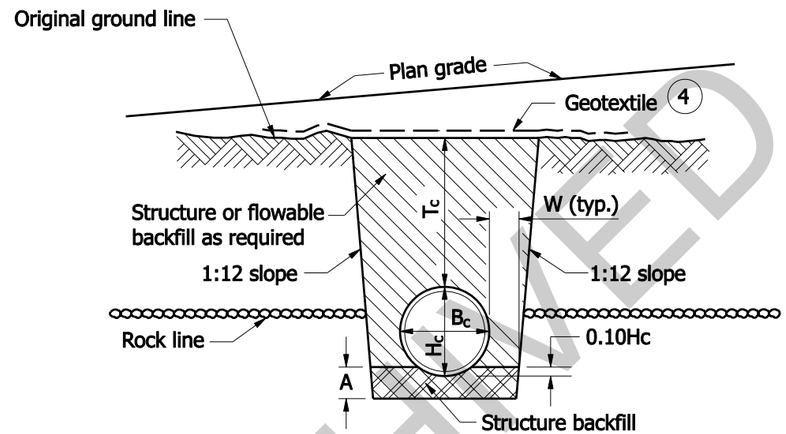
A = 200 min. for fill height less than 5.0 m
= 300 min. for fill height of 5.0 m or more

T_c = Trench cover depth over pipe

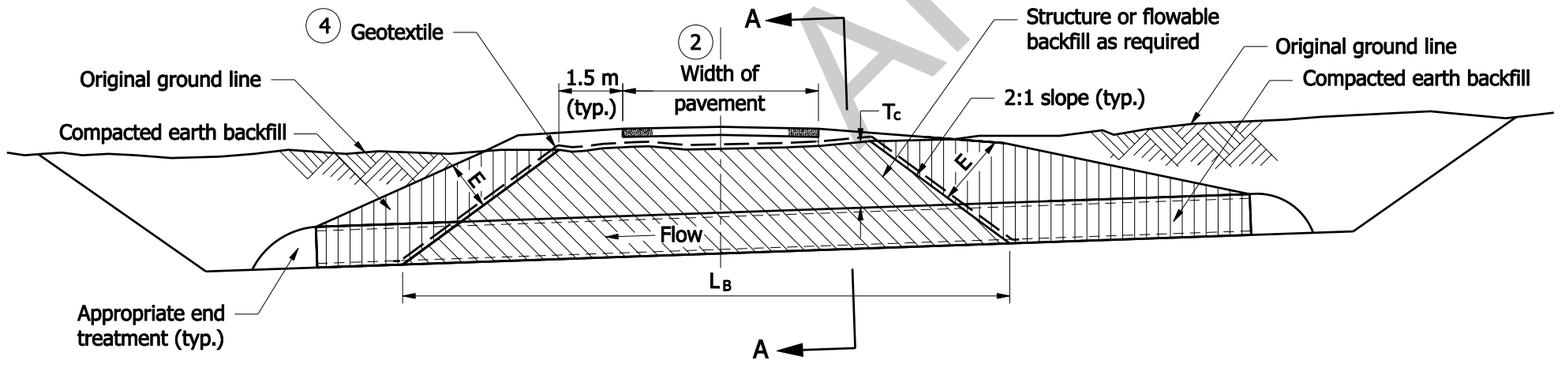
W = 0.3 B_c or 230, whichever is greater

E = Encasement

L_B = Backfill length measured from toe to toe of the 2:1 slopes.



SECTION A-A
ROCK FOUNDATION



ELEVATION

NOTES :

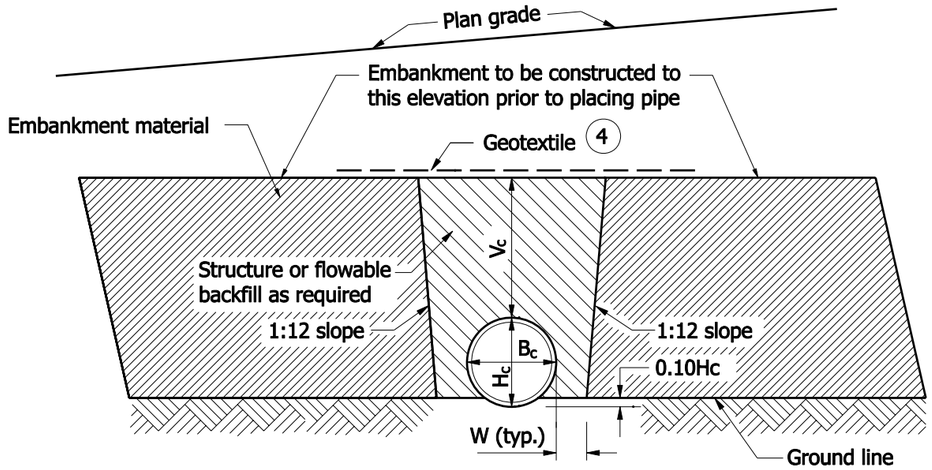
1. Protective cover shall be constructed prior to running heavy equipment over installed pipes. The minimum covers are listed below:
   a.) 0.5 m for $B_c \leq 450$
   b.) 0.9 m for 18" < $B_c \leq 1350$
   c.) 1.2 m for $B_c > 1350$
2. For backfill purposes, paved shoulders, curbs, and sidewalks are considered pavement. See Standard Drawing 715-BKFL-10 for pavement limits when curbs, paved shoulders, or sidewalks are present.
3. Flowable or structure backfill shall be encased by compacted earth backfill. The minimum encasement shall be 0.6 m. If necessary, the 2:1 slope between the flowable or structure backfill and the encasement shall be modified to maintain the minimum 0.6 m encasement.
4. Geotextile required if coarse aggregate is used. Geotextile should extend 300 beyond each edge of the excavated trench or toe of slope.

All Dimensions are in mm unless otherwise specified.

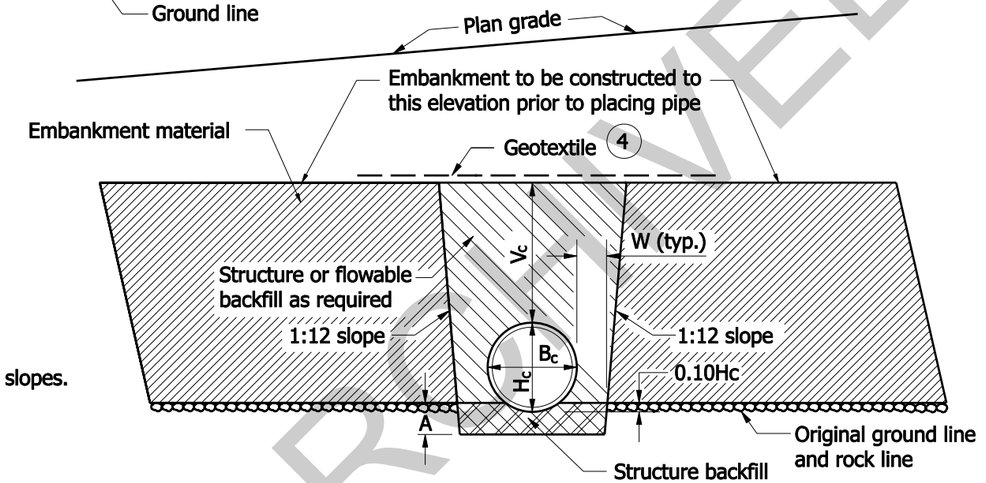
INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL METHOD 1
NEW ROADWAY, TRENCH

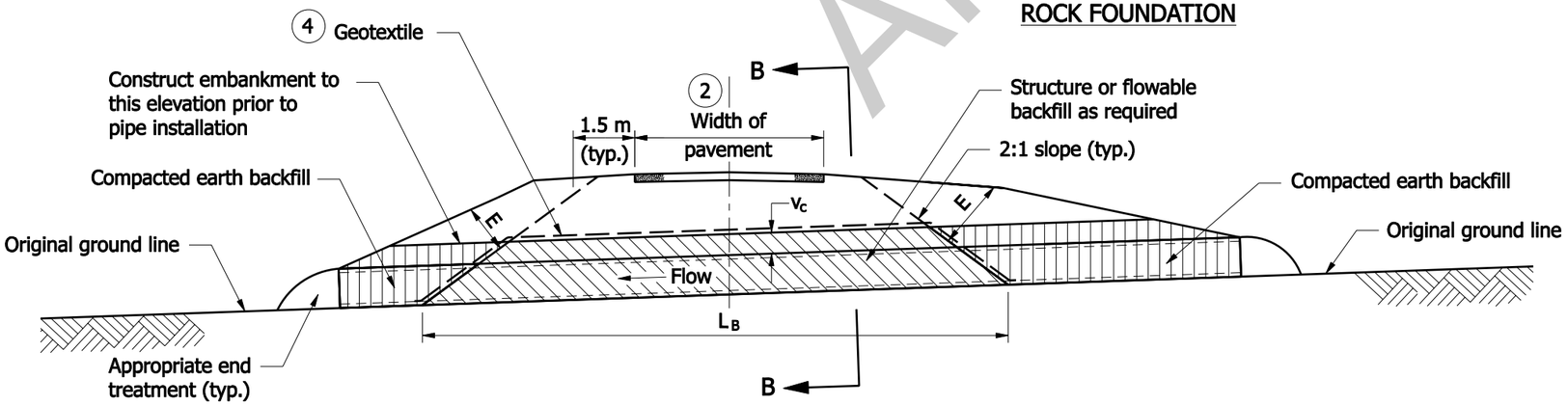
11-16-06



SECTION B-B



SECTION B-B
ROCK FOUNDATION



ELEVATION

LEGEND

H_c = Overall diameter or rise (typ.)

B_c = Overall diameter or span

A = 200 min. for fill height less than 5.0 m
= 300 min. for fill height of 5.0 m or more

V_c = 300 for $B_c \leq 450$
450 for $B_c > 450$

W = 0.3 B_c or 230, whichever is greater

L_B = Backfill length measured from toe to toe of the 2:1 slopes.

NOTES :

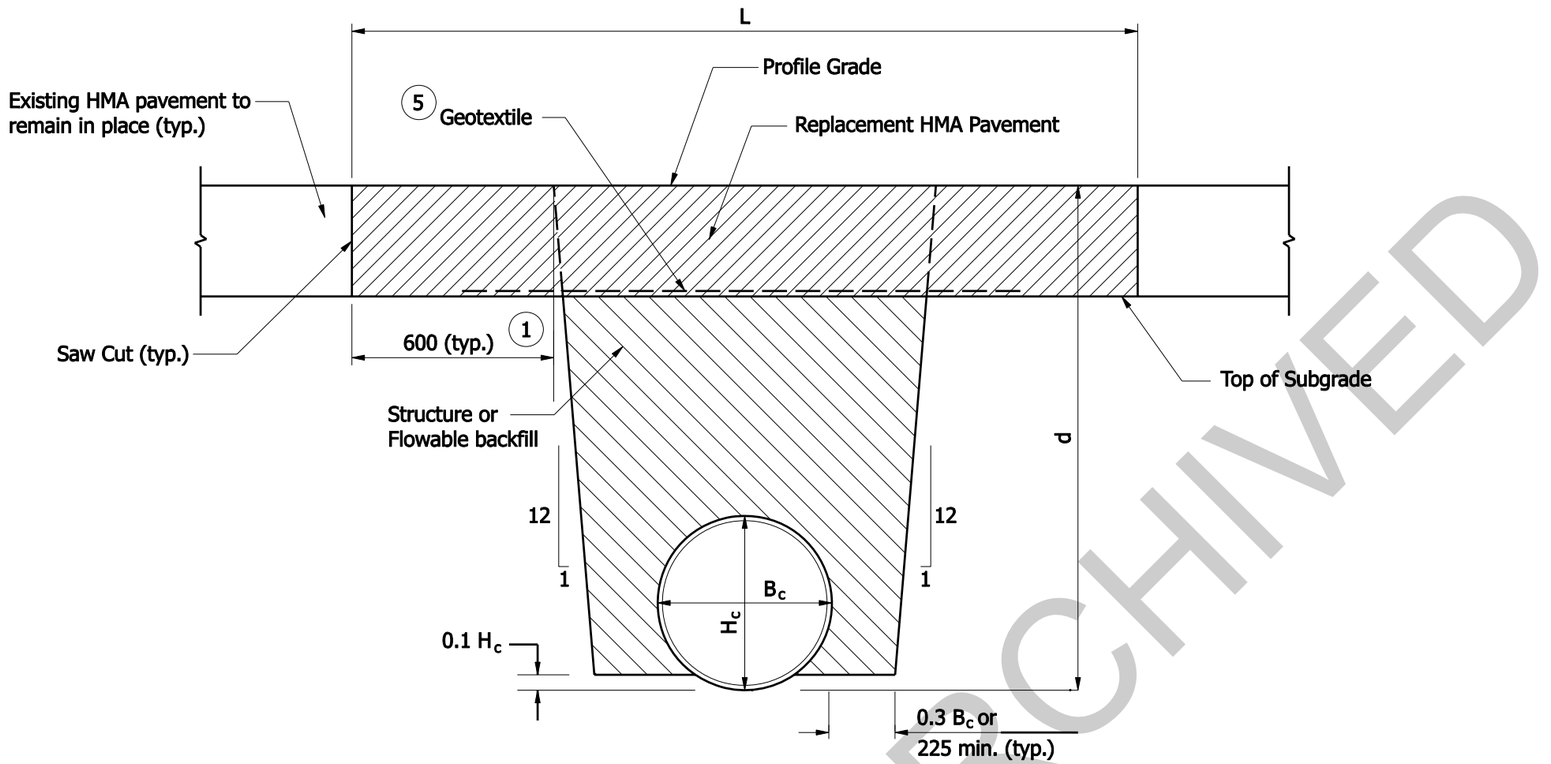
1. Protective cover shall be constructed prior to running heavy equipment over installed pipes. The minimum covers are listed below:
   a.) 0.5 m for $B_c \leq 450$
   b.) 0.9 m for 18" < $B_c \leq 1350$
   c.) 1.2 m for $B_c > 1350$
2. For backfill purposes, paved shoulders, curbs, and sidewalks are considered pavement. See Standard Drawing 715-BKFL-10 for pavement limits when curbs, paved shoulders, or sidewalks are present.
3. Flowable or structure backfill shall be encased by compacted earth backfill. The minimum encasement shall be 0.6 m. If necessary, the 2:1 slope between the flowable or structure backfill and the encasement shall be modified to maintain the minimum 0.6 m encasement.
4. Geotextile required if coarse aggregate is used. Geotextile should extend 300 beyond each edge of the excavated trench or toe of slope.

All Dimensions are in mm unless otherwise specified.

INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL METHOD 1
NEW ROADWAY, EMBANKMENT

11-16-06



L = Pay limits of pavement removal and pavement replacement (m); for cross pipe, measured along roadway centerline; for pipe parallel to roadway centerline, measured prependicular to pipe centerline.

B_C = Overall diameter or span (mm)

H_C = Overall diameter or rise (mm)

d = Vertical distance from flowline to profile grade (m)

HMA REPLACEMENT PAVEMENT

NOTES :

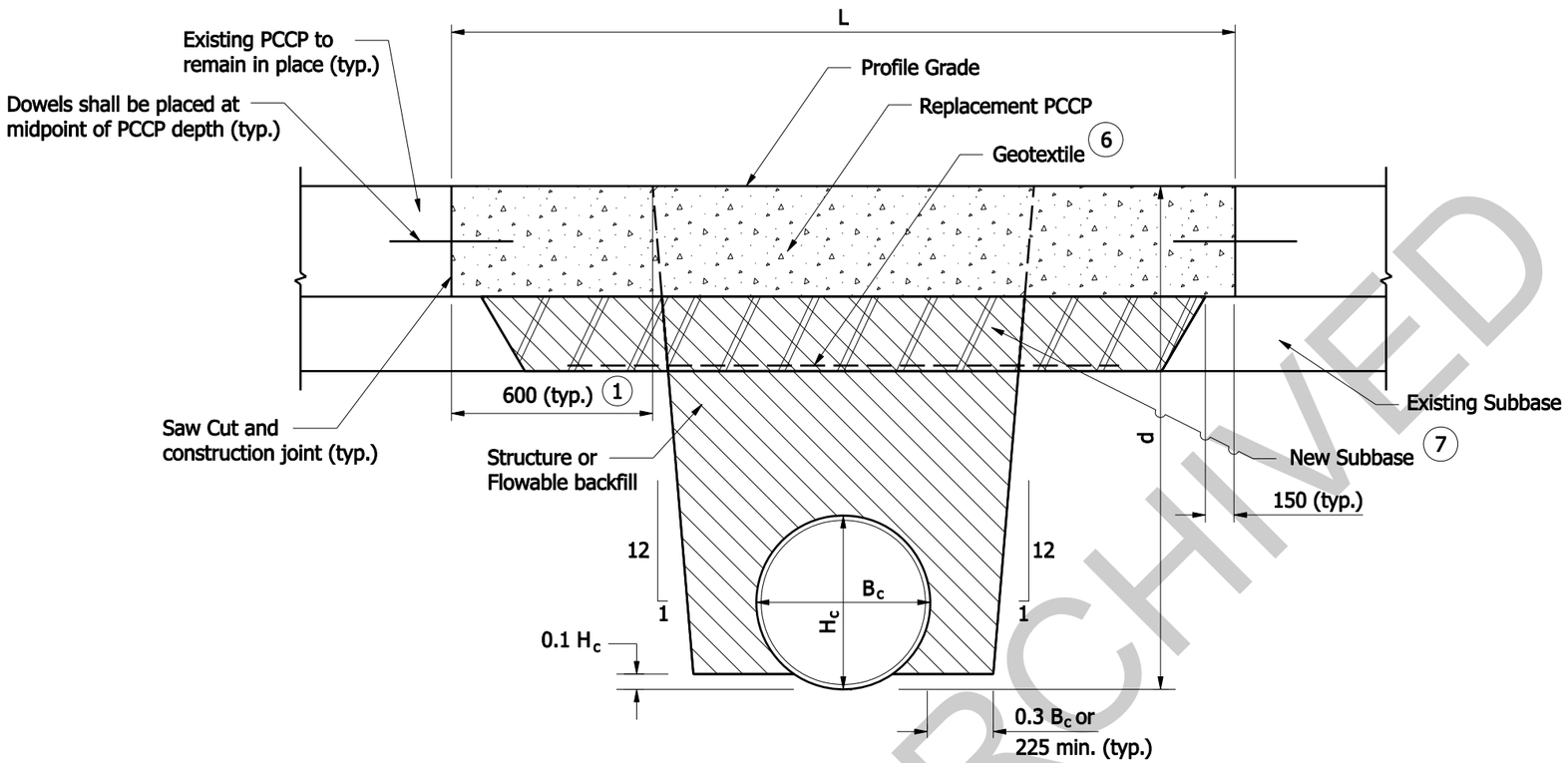
1. Existing subgrade over this distance shall remain in place.
2. The minimum pavement sections shall be as follows:
   HMA: 90 kg/m^2 HMA Surface, Type A,B,C or D on
   variable HMA Intermediate, Type A, B, C or D
3. If underdrains are present, they shall be perpetuated in accordance with the details shown on Standared Drawing 718-UNDR-01.
4. See Standard Drawing 715-BKFL-01 for pipe backfill trench elevation view.
5. Geotextile required if coarse aggregate is used. Geotextile should extend 300 beyond each edge of the excavated trench.

All Dimensions are in mm unless otherwise specified.

INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL METHOD 1
EXISTING ROADWAY, TRENCH

11-16-06



L = Pay limits of pavement removal and pavement replacement (m); for cross pipe, measured along roadway centerline; for pipe parallel to roadway centerline, measured prependicular to pipe centerline.

B_C = Overall diameter or span (mm)

H_C = Overall diameter or rise (mm)

d = Vertical distance from flowline to profile grade (m)

PCCP REPLACEMENT PAVEMENT

NOTES :

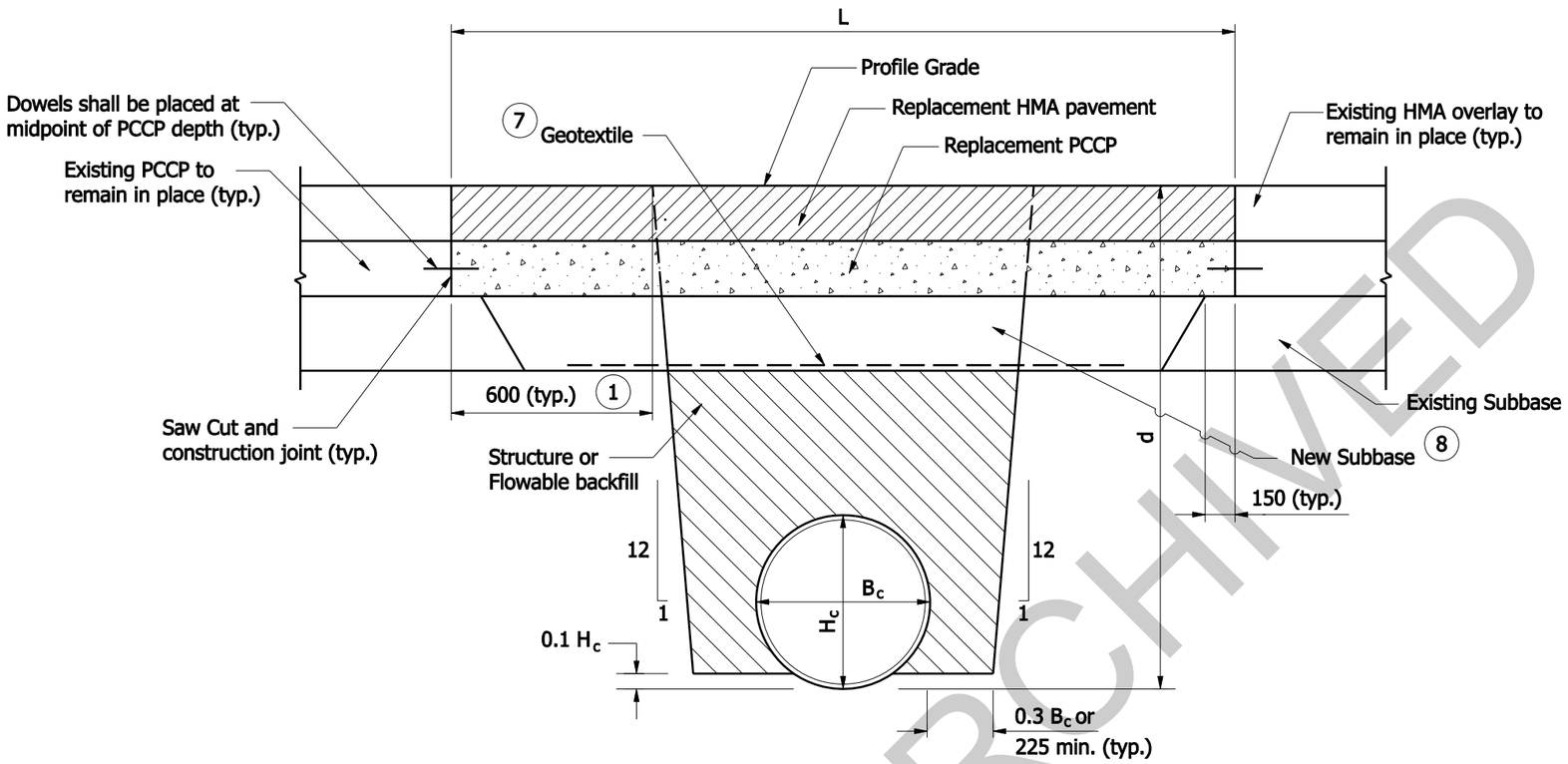
1. Existing subgrade over this longitudinal distance shall remain in place.
2. The thickness of the replacement PCCP shall match that of the existing concrete pavement.
3. See Standard Drawing 506-CCPP-01 for subbase, dowels, and construction joint details.
4. If underdrains are present, they shall be perpetuated in accordance with the details shown on Standard Drawing 718-UNDR-01.
5. See Standard Drawing 715-BKFL-01 for pipe backfill trench elevation view.
6. Geotextile required if coarse aggregate is used. Geotextile should extend 300 beyond each edge of the excavated trench.
7. New subbase type shall match the existing subbase type and thickness.

All Dimensions are in mm unless otherwise specified.

INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL, METHOD 1
EXISTING ROADWAY, TRENCH

11-16-06



NOTES :

1. Existing subgrade over this distance shall remain in place.
2. The thickness of the replacement PCCP shall match that of the existing concrete pavement.
3. The minimum pavement sections shall be as follows:
   HMA: 90 kg/m^2 #/syd HMA Surface, Type A,B,C or D on variable HMA Intermediate, Type A, B, C or D
4. See Standard Drawing 506-CCPP-01 for subbase, dowels, and construction joint details.
5. If underdrains are present, they shall be perpetuated in accordance with the details shown on Standard Drawing 718-UNDR-01.
6. See Standard Drawing 715-BKFL-01 for pipe backfill trench elevation view.
7. Geotextile required if coarse aggregate is used. Geotextile should extend 300 beyond each edge of the excavated trench.
8. New subbase type shall match the existing subbase type and thickness.

L = Pay limits of pavement removal and pavement replacement (m); for cross pipe, measured along roadway centerline; for pipe parallel to roadway centerline, measured prependicular to pipe centerline.

B_C = Overall diameter or span (mm)

H_C = Overall diameter or rise (mm)

d = Vertical distance from flowline to profile grade (m)

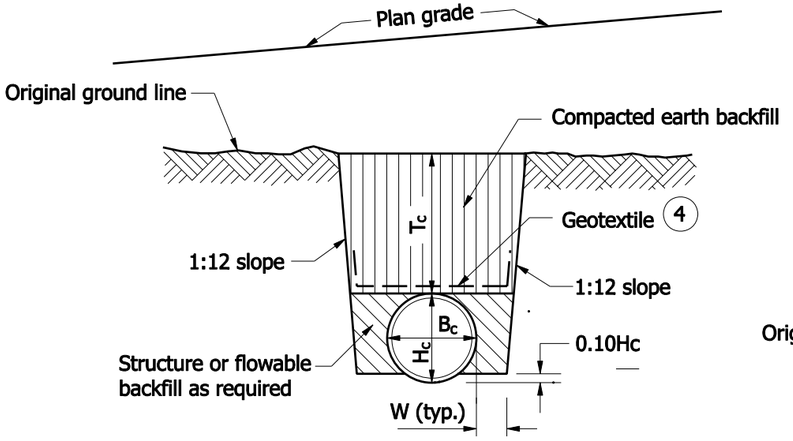
COMPOSITE REPLACEMENT PAVEMENT

All Dimensions are in mm unless otherwise specified.

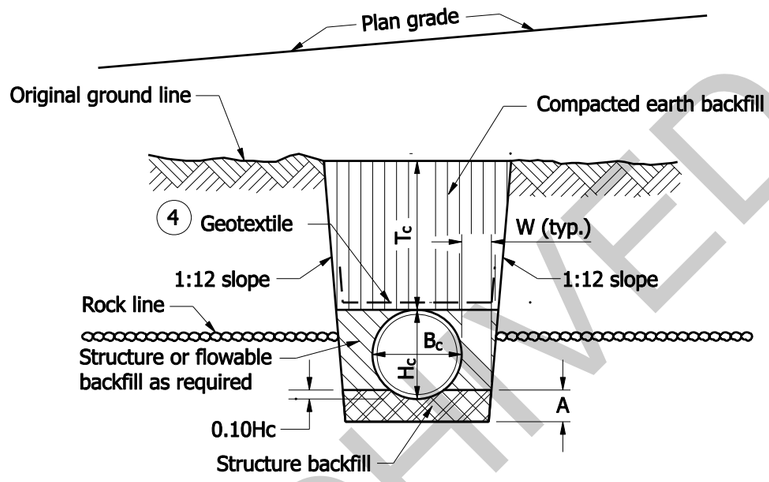
INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL METHOD 1
EXISTING ROADWAY, TRENCH

11-16-06



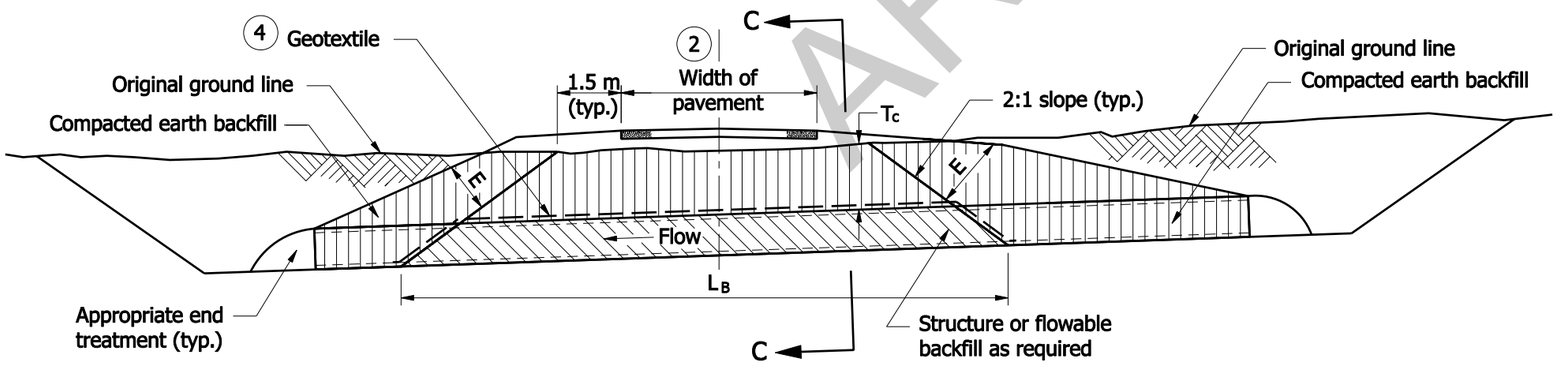
SECTION C-C



SECTION C-C
ROCK FOUNDATION

LEGEND

H_c = Overall diameter or rise (typ.)
B_c = Overall diameter or span
A = 200 min. for fill height less than 5.0 m
= 300 min. for fill height of 5.0 m or more
T_c = Trench cover depth over pipe
W = 0.3 B_c or 230, whichever is greater
E = Encasement
L_B = Backfill length measured from toe to toe of the 2:1 slopes.



ELEVATION

NOTES :

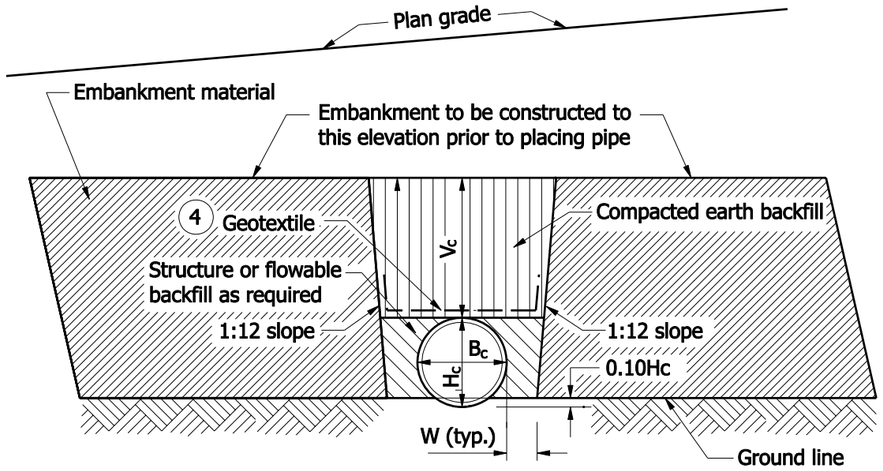
1. Protective cover shall be constructed prior to running heavy equipment over installed pipes. The minimum covers are listed below:
   a.) 0.5 m for $B_c \leq 450$
   b.) 0.9 m for 18" < $B_c \leq 1350$
   c.) 1.2 m for $B_c > 1350$
2. For backfill purposes, paved shoulders, curbs, and sidewalks are considered pavement. See Standard Drawing 715-BKFL-10 for pavement limits when curbs, paved shoulders, or sidewalks are present.
3. Flowable or structure backfill shall be encased by compacted earth backfill. The minimum encasement shall be 0.6 m. If necessary, the 2:1 slope between the flowable or structure backfill and the encasement shall be modified to maintain the minimum 0.6 m encasement.
4. Geotextile required if coarse aggregate is used. Geotextile should extend 300 beyond each edge of the excavated trench or toe of slope.

All Dimensions are in mm unless otherwise specified.

INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL METHOD 2
CLASS II, IV, V AND VI DRIVES, TRENCH

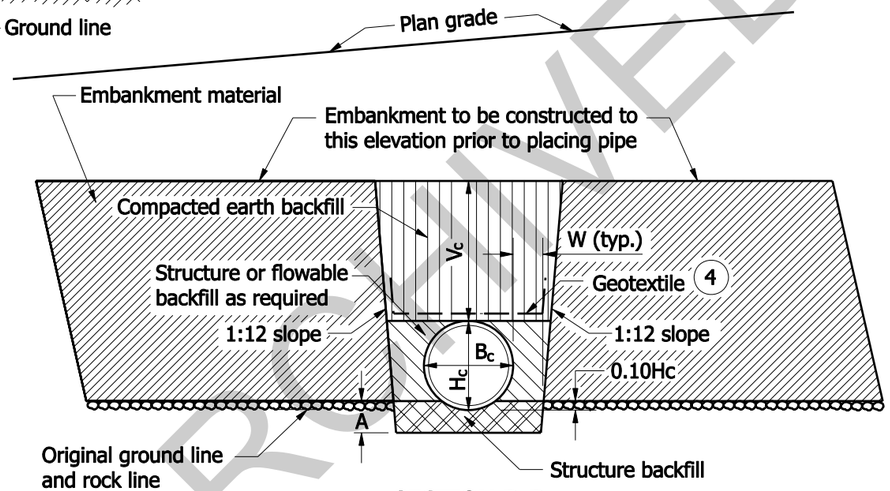
11-16-06



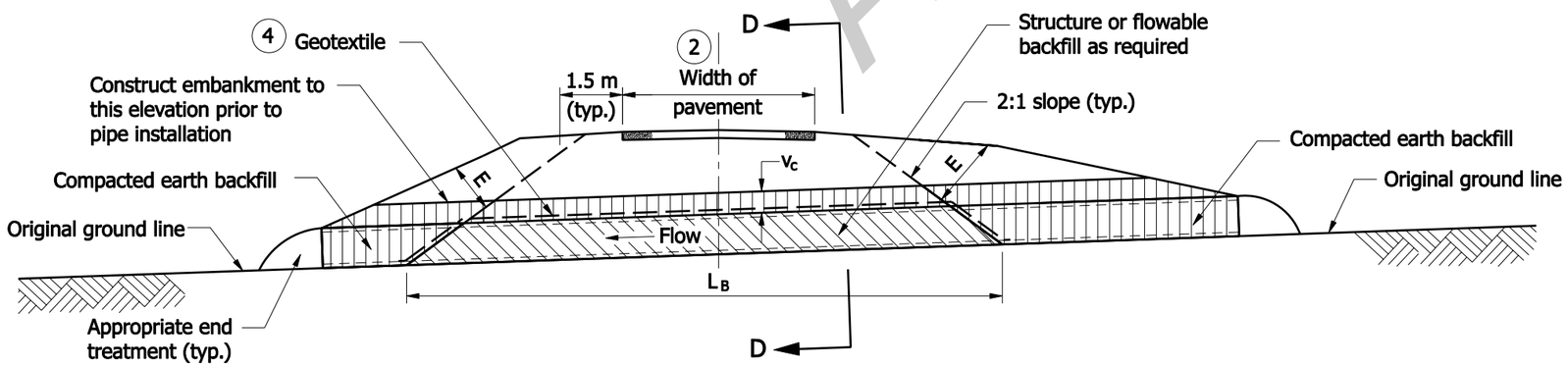
SECTION D-D

LEGEND

H_c = Overall diameter or rise (typ.)
B_c = Overall diameter or span
A = 200 min. for fill height less than 5.0 m
= 300 min. for fill height of 5.0 m or more
V_c = 300 for $B_c \leq 450$
450 for $B_c > 450$
W = 0.3 B_c or 230, whichever is greater
E = Encasement
L_B = Backfill length measured from toe to toe of the 2:1 slopes.



SECTION D-D
ROCK FOUNDATION



ELEVATION

NOTES :

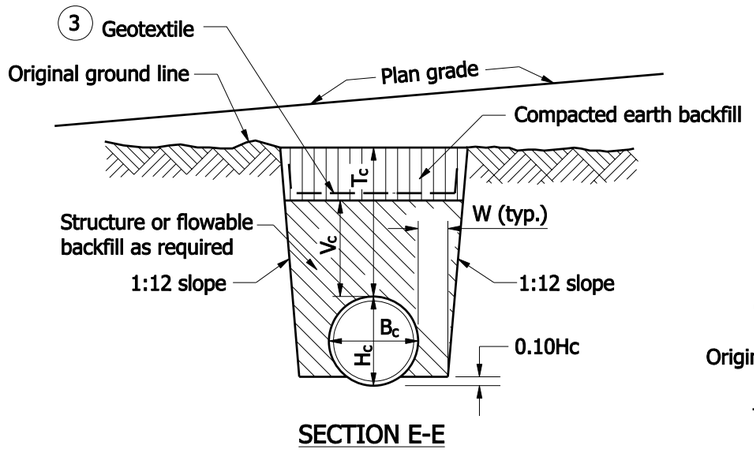
1. Protective cover shall be constructed prior to running heavy equipment over installed pipes. The minimum covers are listed below:
   a.) 0.5 m for $B_c \leq 450$
   b.) 0.9 m for 18" < $B_c \leq 1350$
   c.) 1.2 m for $B_c > 1350$
2. For backfill purposes, paved shoulders, curbs, and sidewalks are considered pavement. See Standard Drawing 715-BKFL-10 for pavement limits when curbs, paved shoulders, or sidewalks are present.
3. Flowable or structure backfill shall be encased by compacted earth backfill. The minimum encasement shall be 0.6 m. If necessary, the 2:1 slope between the flowable or structure backfill and the encasement shall be modified to maintain the minimum 0.6 m encasement.
4. Geotextile required if coarse aggregate is used. Geotextile should extend 300 beyond each edge of the excavated trench or toe of slope.

All Dimensions are in mm unless otherwise specified.

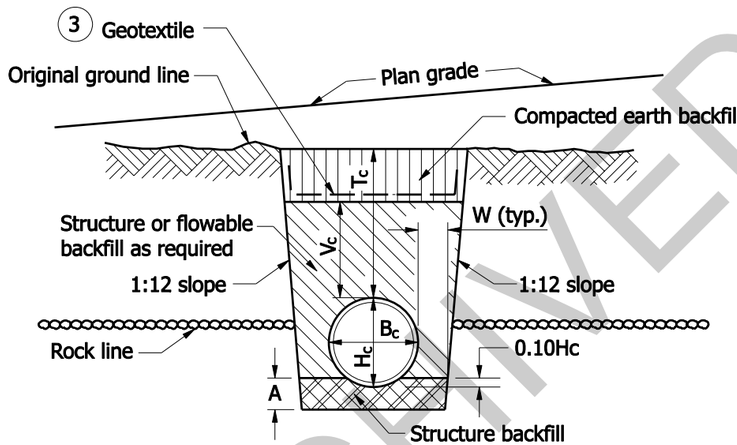
INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL METHOD 2
CLASS II, IV, V AND VI DRIVES, EMBANKMENT

11-16-06



SECTION E-E



SECTION E-E
ROCK FOUNDATION

LEGEND

H_c = Overall diameter or rise (typ.)

B_c = Overall diameter or span

A = 200 min. for fill height less than 5.0 m
= 300 min. for fill height of 5.0 m or more

V_c = 300 for $B_c \leq 450$
450 for $B_c > 450$

T_c = Trench cover depth over pipe

W = 0.3 B_c or 230, whichever is greater

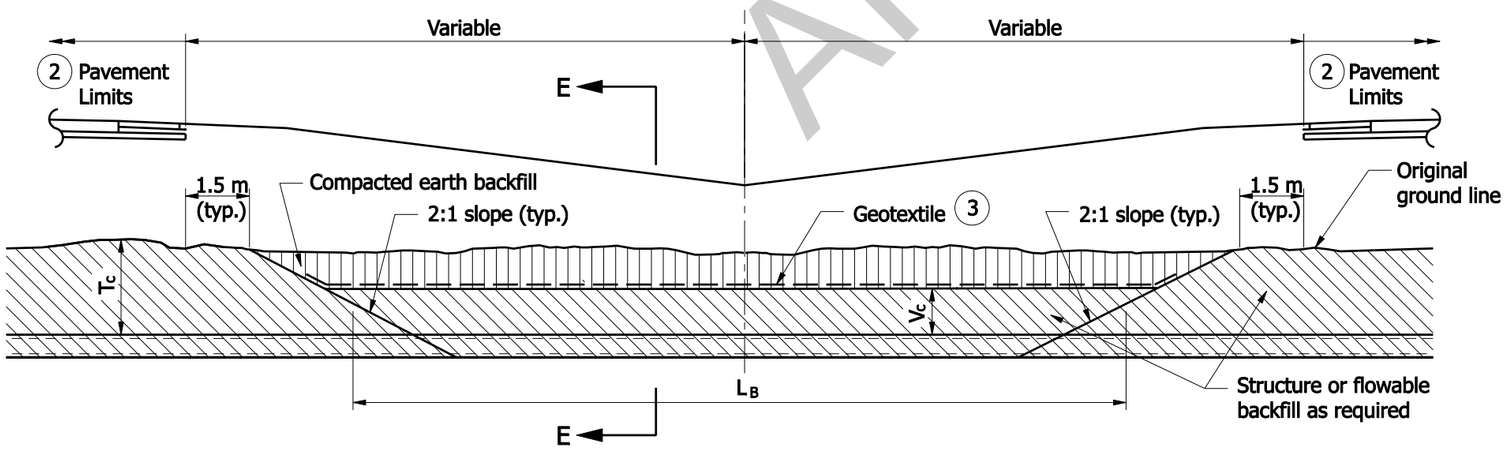
L_B = Backfill length measured from toe to toe of the 2:1 slopes.

NOTES :

1. Protective cover shall be constructed prior to running heavy equipment over installed pipes. The minimum covers are listed below:
   a.) 0.5 m for $B_c \leq 450$
   b.) 0.9 m for 18" < $B_c \leq 1350$
   c.) 1.2 m for $B_c > 1350$

(2) For backfill purposes, paved shoulders, curbs, and sidewalks are considered pavement. See Standard Drawing 715-BKFL-10 for pavement limits when curbs, paved shoulders, or sidewalks are present.

(3) Geotextile required if coarse aggregate is used. Geotextile should extend 300 beyond each edge of the excavated trench or toe of slope.



ELEVATION THRU MEDIAN STRIP

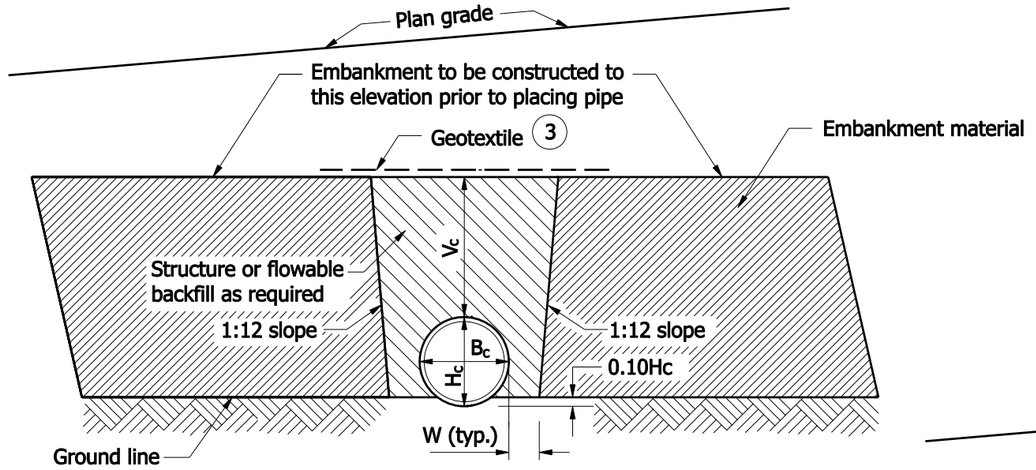
All Dimensions are in mm unless otherwise specified.

INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL METHOD 3
MEDIAN INSTALLATION, TRENCH

11-16-06

715-R-536d 8 of 10



SECTION F-F

LEGEND

H_c = Overall diameter or rise (typ.)

B_c = Overall diameter or span

A = 200 min. for fill height less than 5.0 m
= 300 min. for fill height of 5.0 m or more

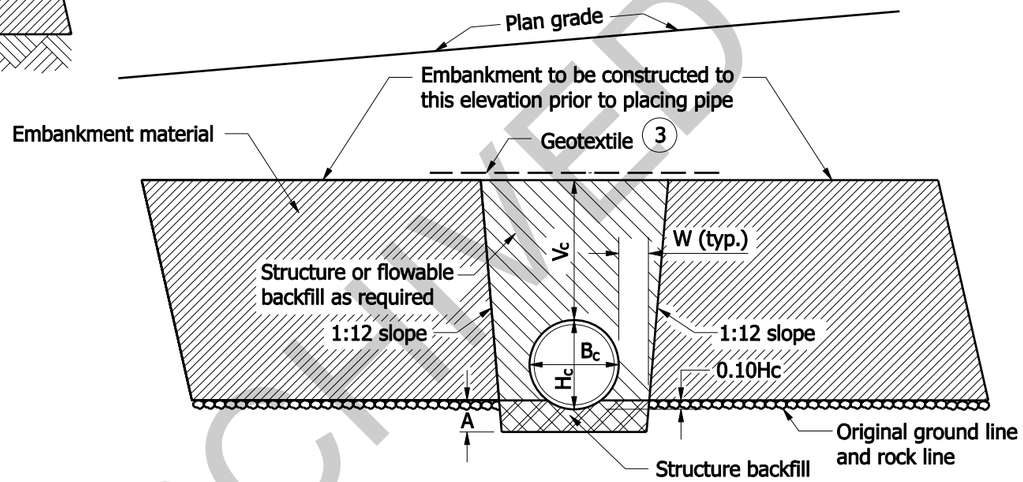
V_c = 300 for $B_c \leq 450$
450 for $B_c > 450$

W = 0.3 B_c or 230, whichever is greater

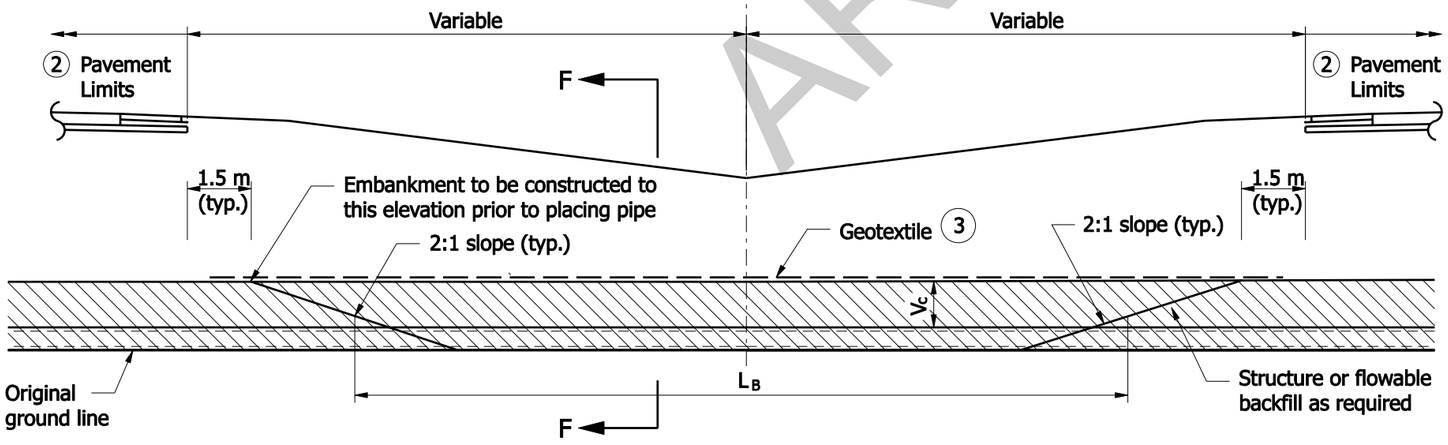
L_B = Backfill length measured from toe to toe of the 2:1 slopes.

NOTES :

1. Protective cover shall be constructed prior to running heavy equipment over installed pipes. The minimum covers are listed below:
   a.) 0.5 m for $B_c \leq 450$
   b.) 0.9 m for 18" < $B_c \leq 1350$
   c.) 1.2 m for $B_c > 1350$
2. For backfill purposes, paved shoulders, curbs, and sidewalks are considered pavement. See Standard Drawing 715-BKFL-10 for pavement limits when curbs, paved shoulders, or sidewalks are present.
3. Geotextile required if coarse aggregate is used. Geotextile should extend 300 beyond each edge of the excavated trench or toe of slope.



SECTION F-F
ROCK FOUNDATION



ELEVATION THRU MEDIAN STRIP

All Dimensions are in mm unless otherwise specified.

INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL METHOD 1
MEDIAN INSTALLATION, EMBANKMENT

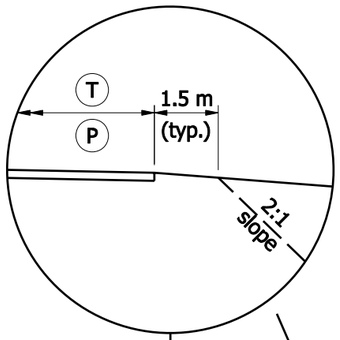
11-16-06

LEGEND

- (C) Curb
- (P) Pavement Limits *
- (S) Sidewalk
- (T) Travel Lane
- (U) Utility Strip
- (V) Paved Shoulder

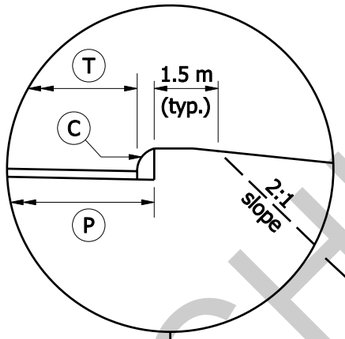
* For backfill placement and computation

EDGE OF TRAVELWAY



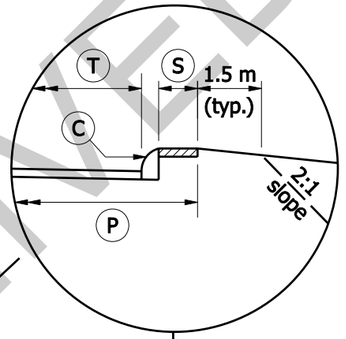
or

BACK OF CURB



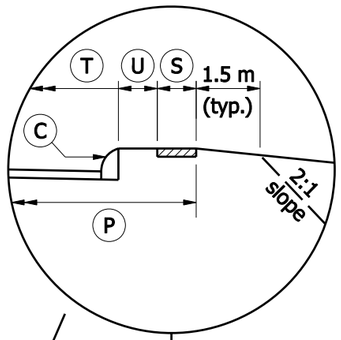
or

EDGE OF SIDWEWALK
ADJACENT TO CURB



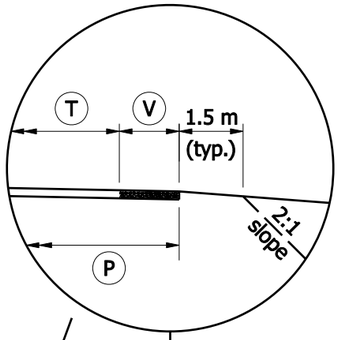
or

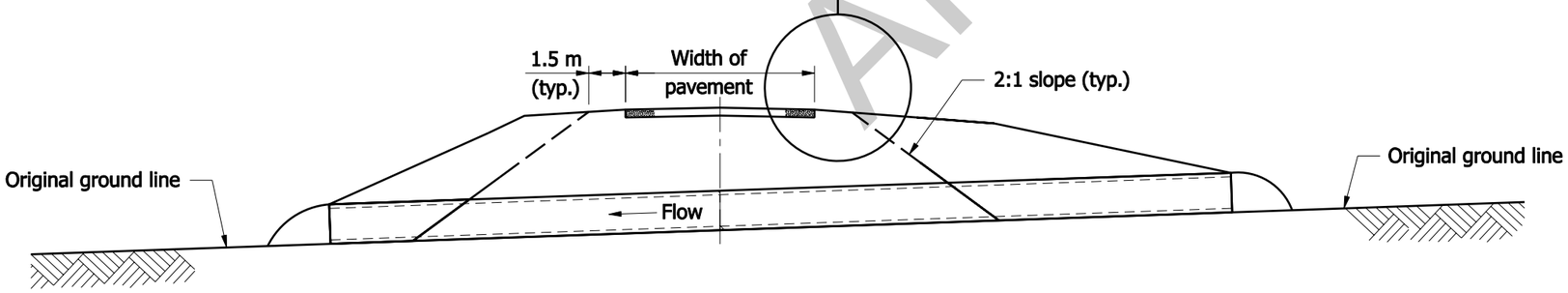
EDGE OF SIDEWALK
ADJACENT TO UTILITY
STRIP



or

EDGE OF PAVED
SHOULDER





ELEVATION

All Dimensions are in mm unless otherwise specified.

INDIANA DEPARTMENT OF TRANSPORTATION

PIPE BACKFILL LIMIT DETERMINATION

11-16-06