Chapter 3 - Excavation

South Dakota Department of Transportation

Structures Construction Manual

Excavation - Chapter 3

The “What and Where of Excavation

“What” is Excavation

The removal of Earth material

“Where” is Excavating Done

- For Structure Foundations (Bridges, Retaining Walls, Etc.)
- Box Culverts
- Cofferdams & Cribs

Types of Excavation

- **Unclassified Excavation**
  - for building berms & channels
  - performed with earth moving equipment
- **Structure Excavation**
  - for structure foundations
  - box culvert bottom slabs
  - cutoff walls
  - performed w/front-end loader, Track Excavator, backhoe, clam, etc.

Types of Excavation cont.

- **Undercut**
  - for preparing grade for box culvert or pipe

Unclassified Excavation

Structure Excavation

Excavator, Crane & Clam

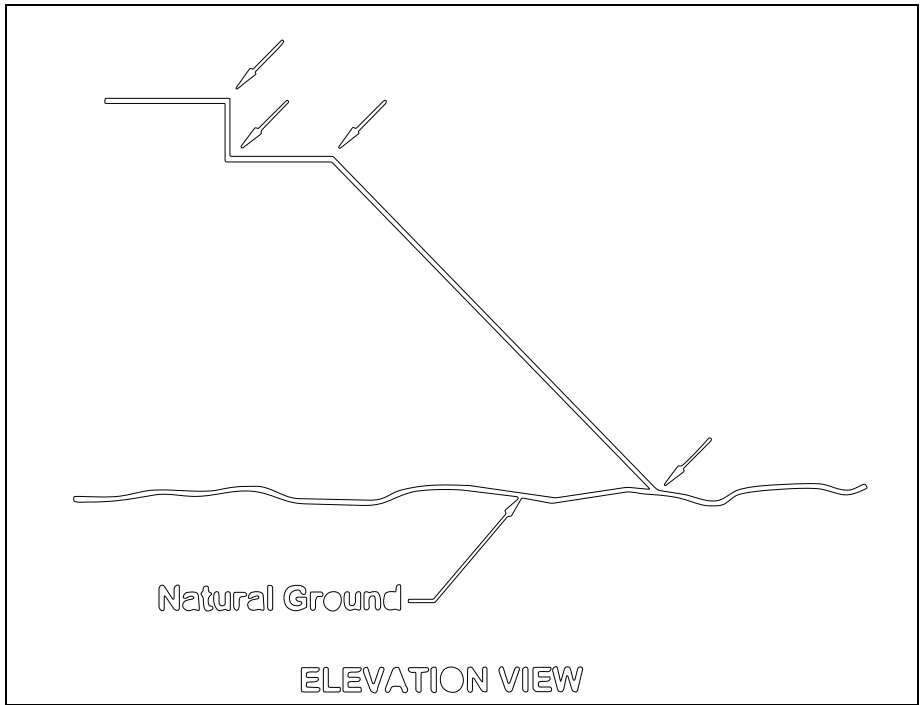

Box Culvert Undercut

Excavation for Bridges
How is the Quantity determined?

- **Unclassified Excavation**
  - preliminary cross sections first
  - they determine amount of excavation necessary

Excavation for Bridges

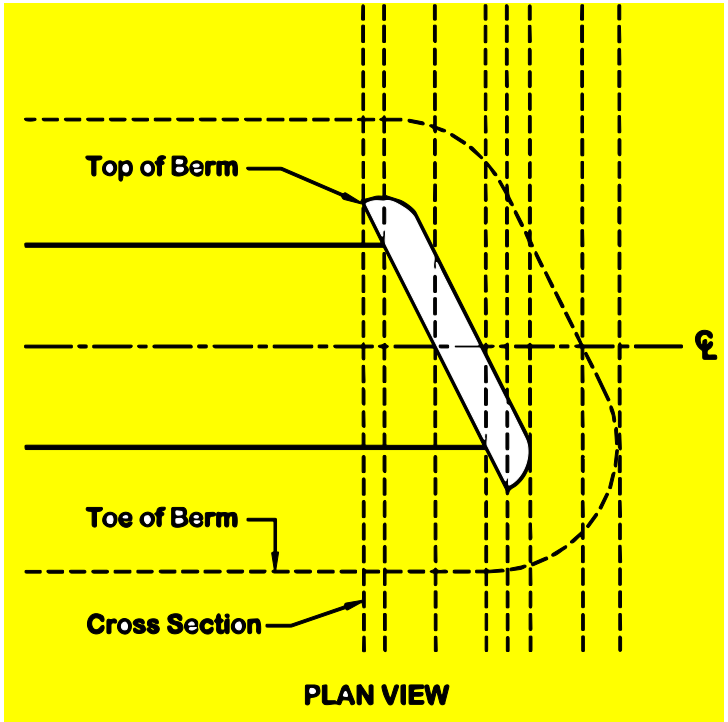
- **Unclassified Excavation**
  - Cross section at break points help determine if berm is correctly built



Pg 3-21
Fig 3.1

Excavation for Bridges

- **Unclassified Excavation**
  - skewed structure
  - more cross sections required



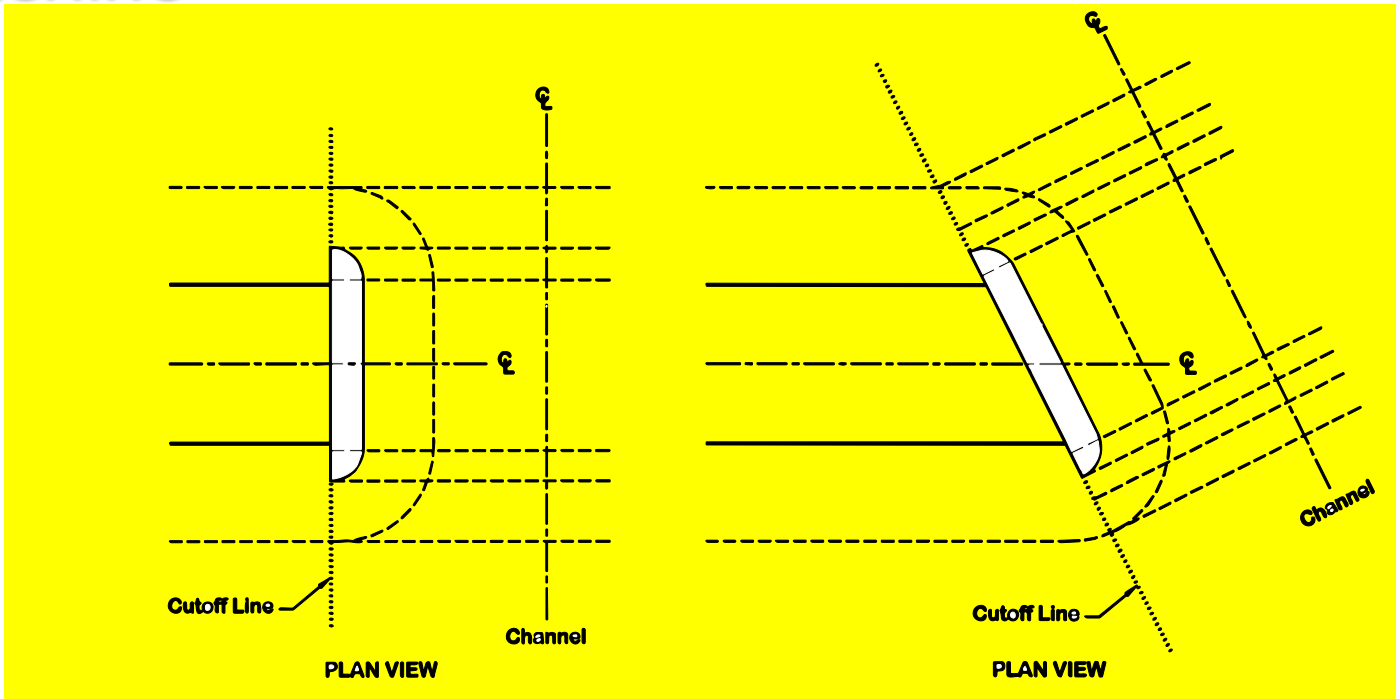
Pg 3-21, Fig 3.2

Excavation for Bridges

- **Unclassified Excavation (Channel)**
  - If channel work required
  - cross sections at right angles to channel centerline

Pg 3-22

Fig 3.3



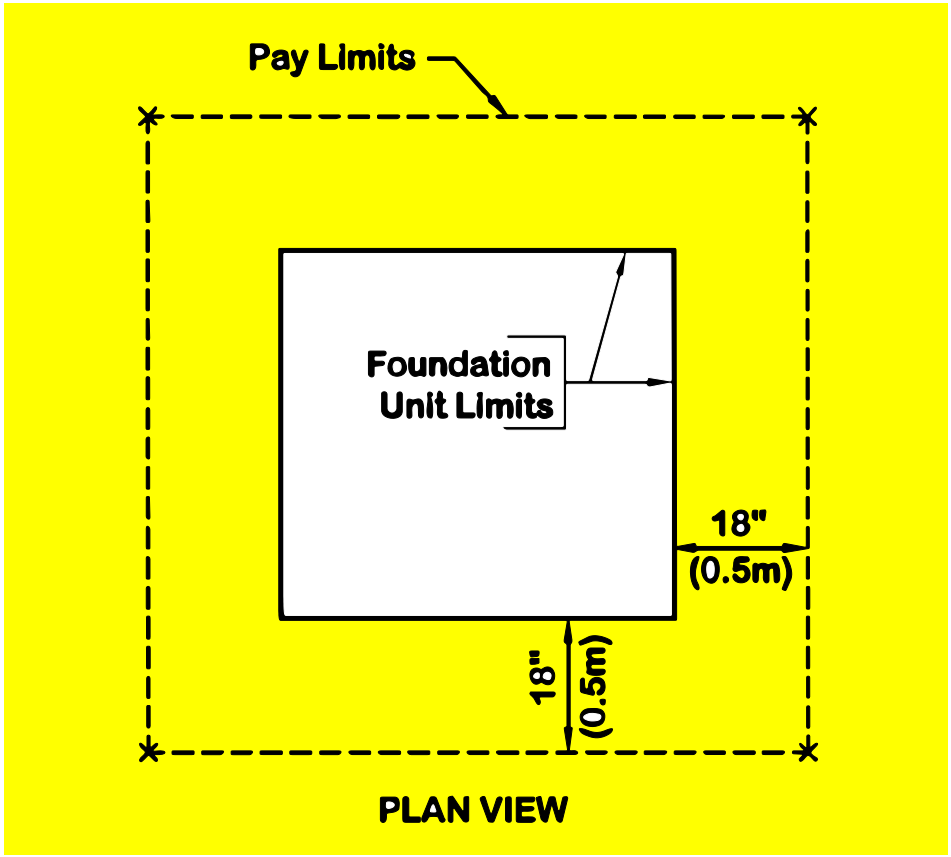
Excavation for Bridges

- **Structure Excavation**
  - Standard Specs state structure excavation will be paid for at plans shown quantities.
  - However, Engineer can request measurements of excavation be taken.

Excavation for Bridges

- **Structure Excavation Calculations**

Pg 3-22
Fig 3.4



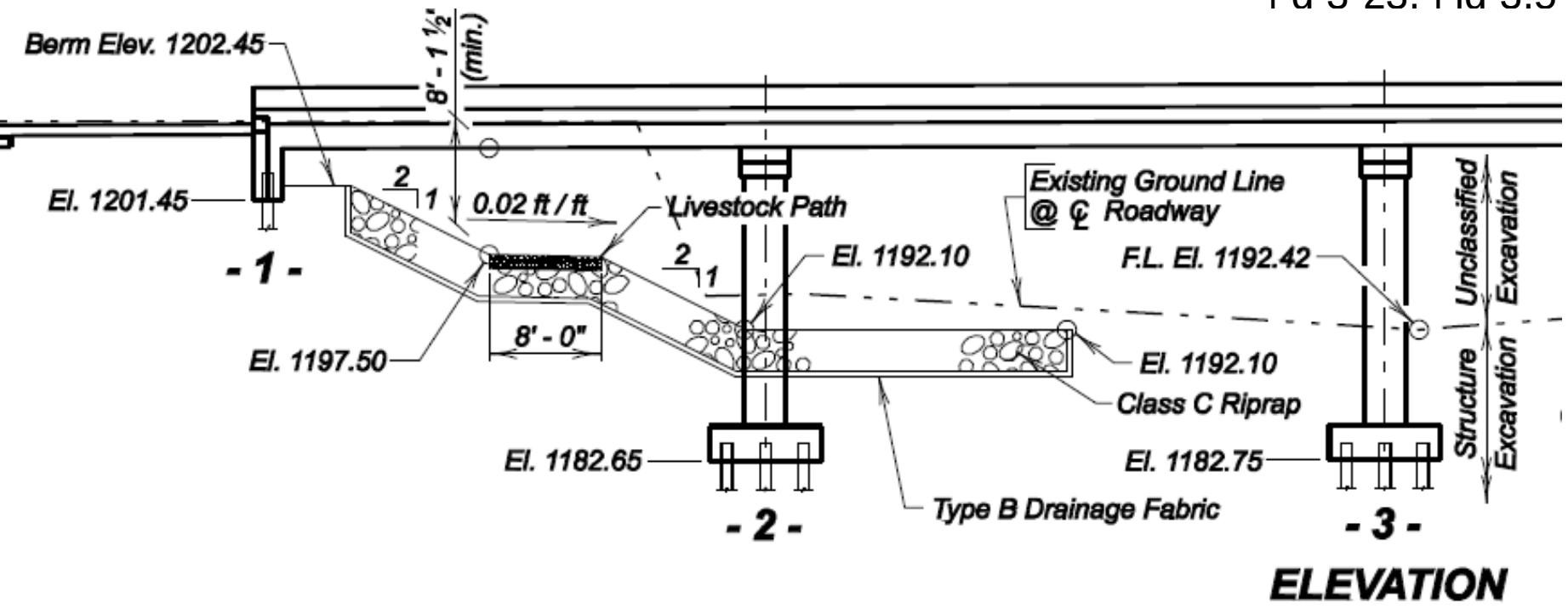
Excavation for Bridges

- **Structure Excavation Calculations**
  - some plans show dividing line between unclassified and structure excavation.

Excavation for Bridges

- **Structure Excavation Calculations**

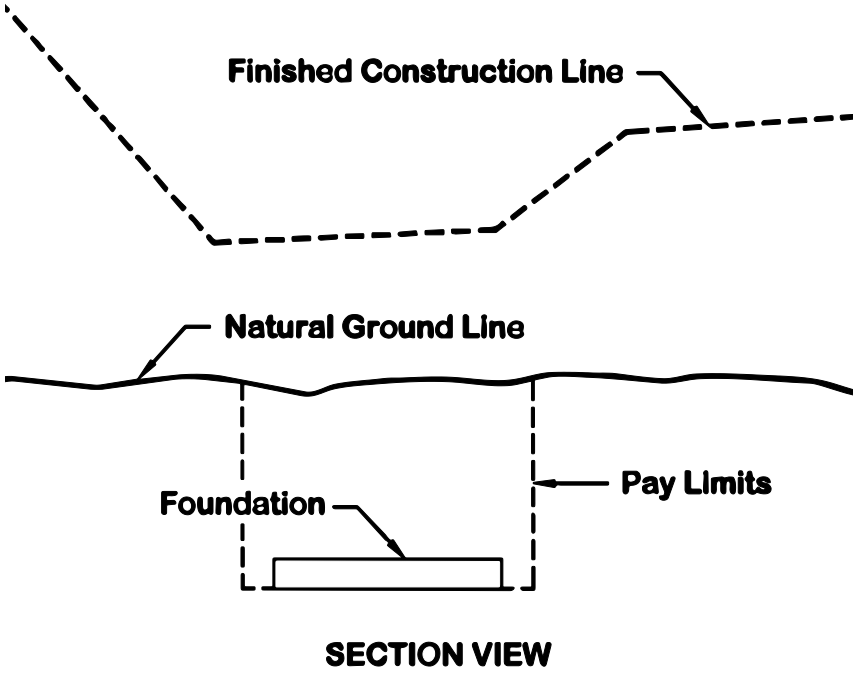
Pg 3-23. Fig 3.5



Excavation for Bridges

- **Structure Excavation Calculations-** using top elevation
  - fill has not begun

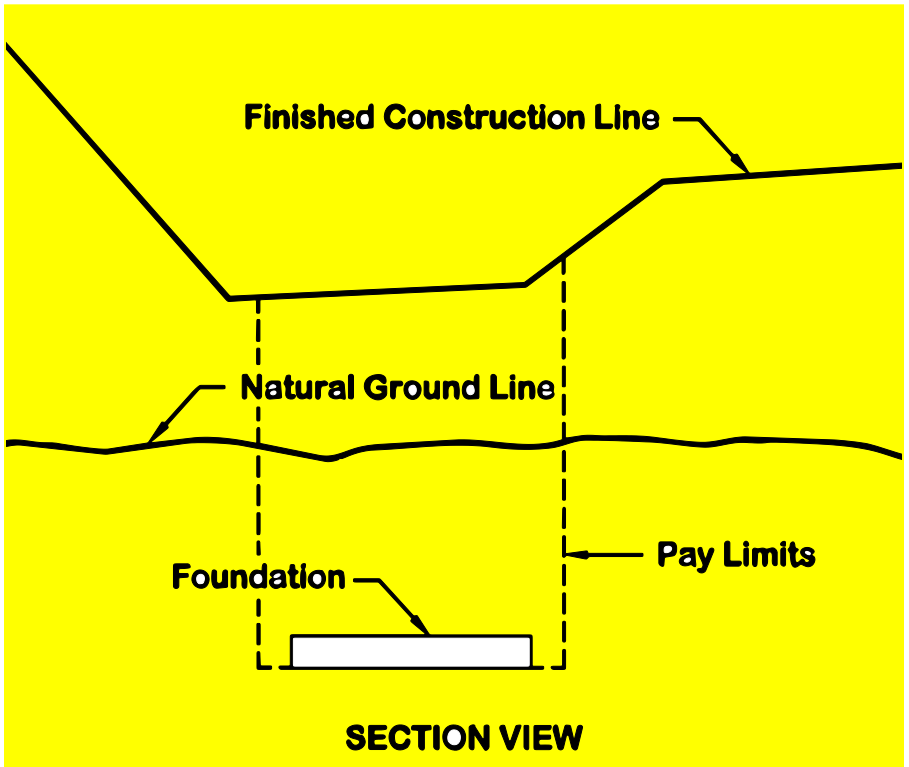
Pg 3-23
Fig 3.6



Excavation for Bridges

- **Structure Excavation Calculations-** using top elevation
  - fill is complete

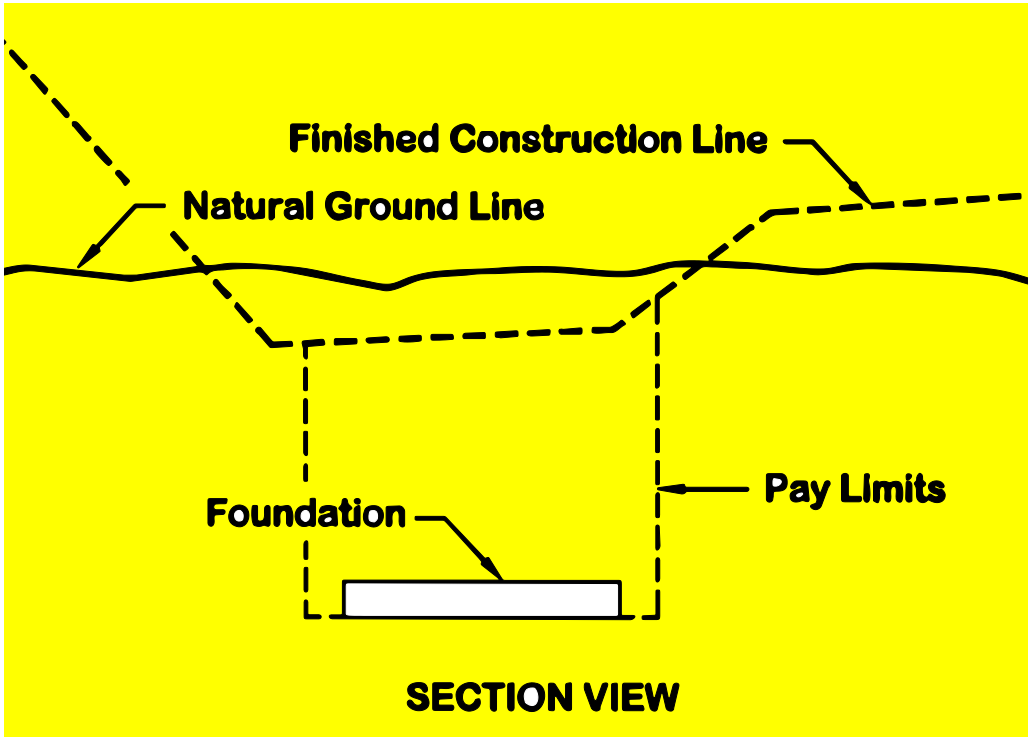
Pg 3-24
Fig 3.7



Excavation for Bridges

- **Structure Excavation Calculations-** using top elevation
  - fill is complete

Pg 3-24
Fig 3.8

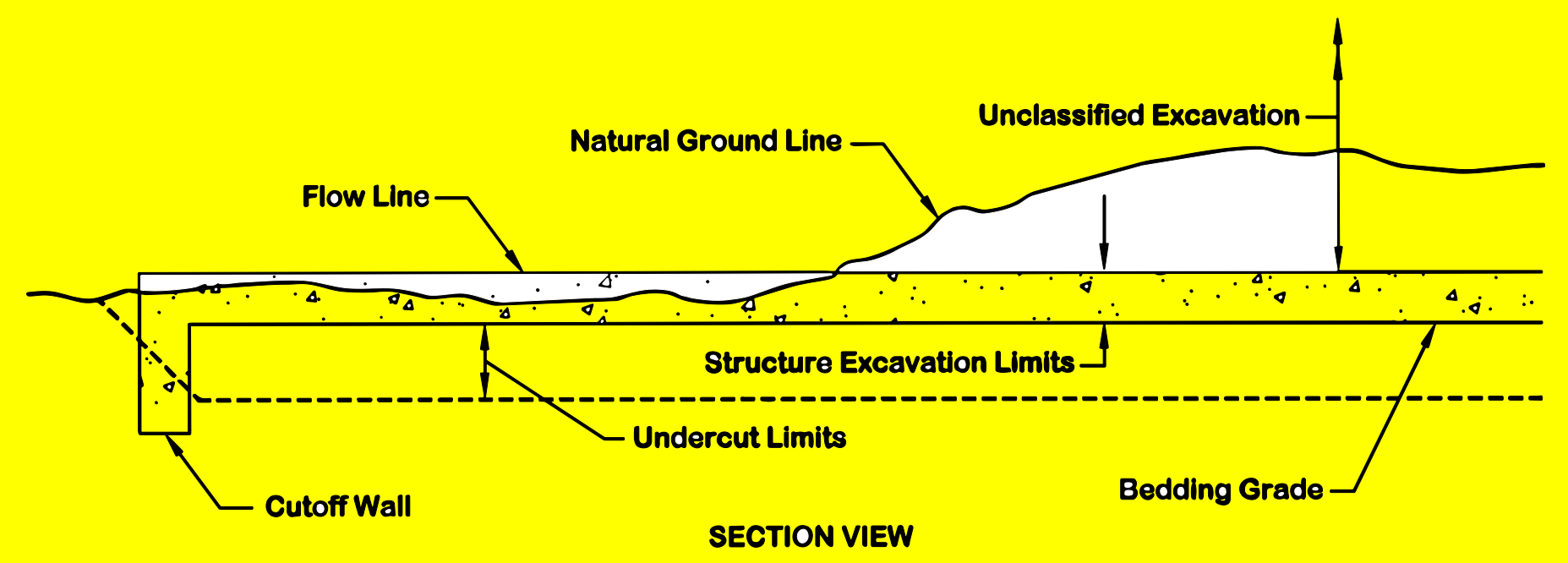


Excavation for Box Culverts

- **Split between unclassified & structure excavation is the flowline.**
- **Pay based on excavation from flowline to bedding grade**

Excavation for Box Culverts

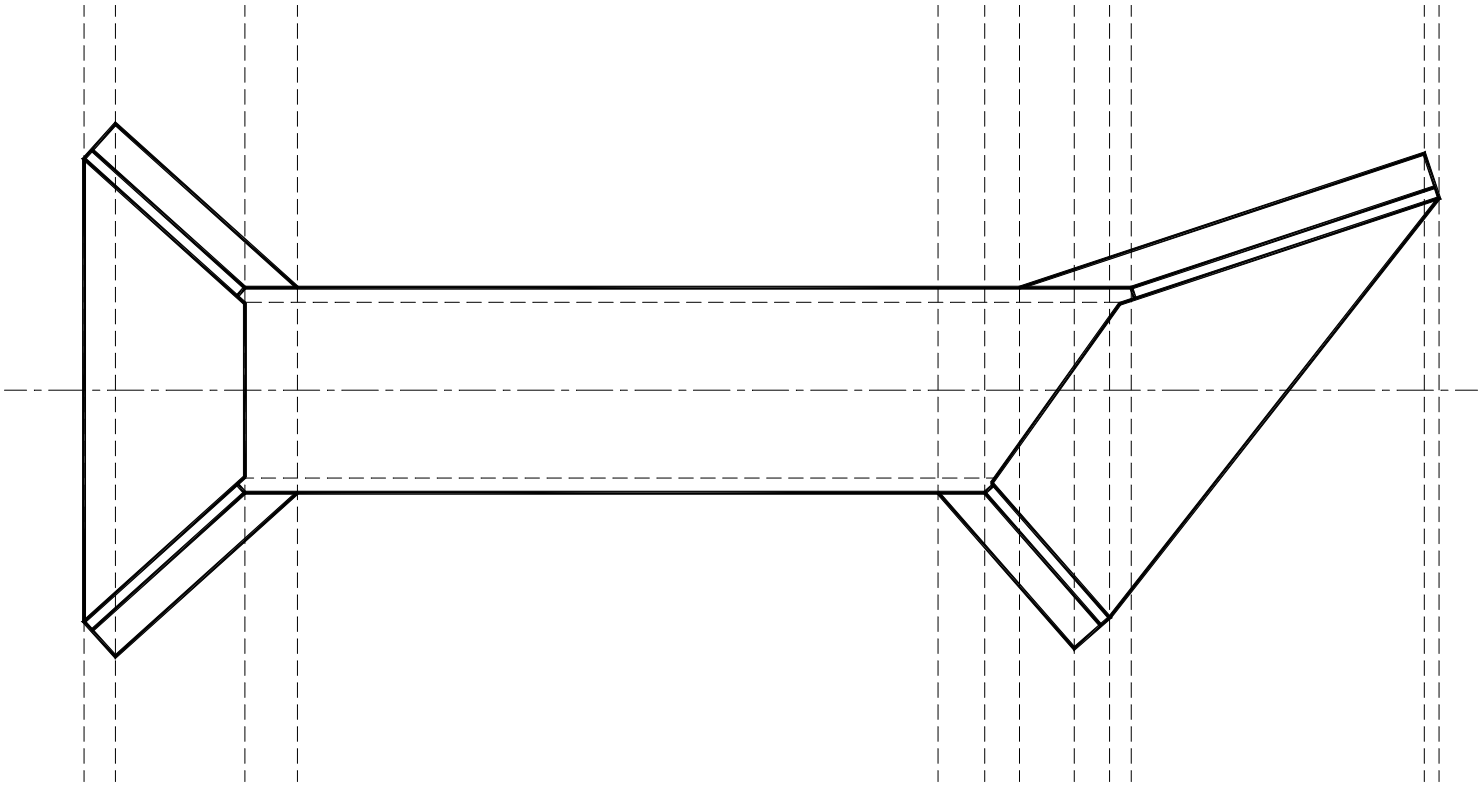
- Excavation Limits for Box Culvert



Pg 3-25, Fig 3.9

Excavation for Box Culverts

- Cross Section Locations



Pg 3-25
Fig 3.10

Foundation Bearings

- Spread Footings
- Box Culvert

Foundation Bearing

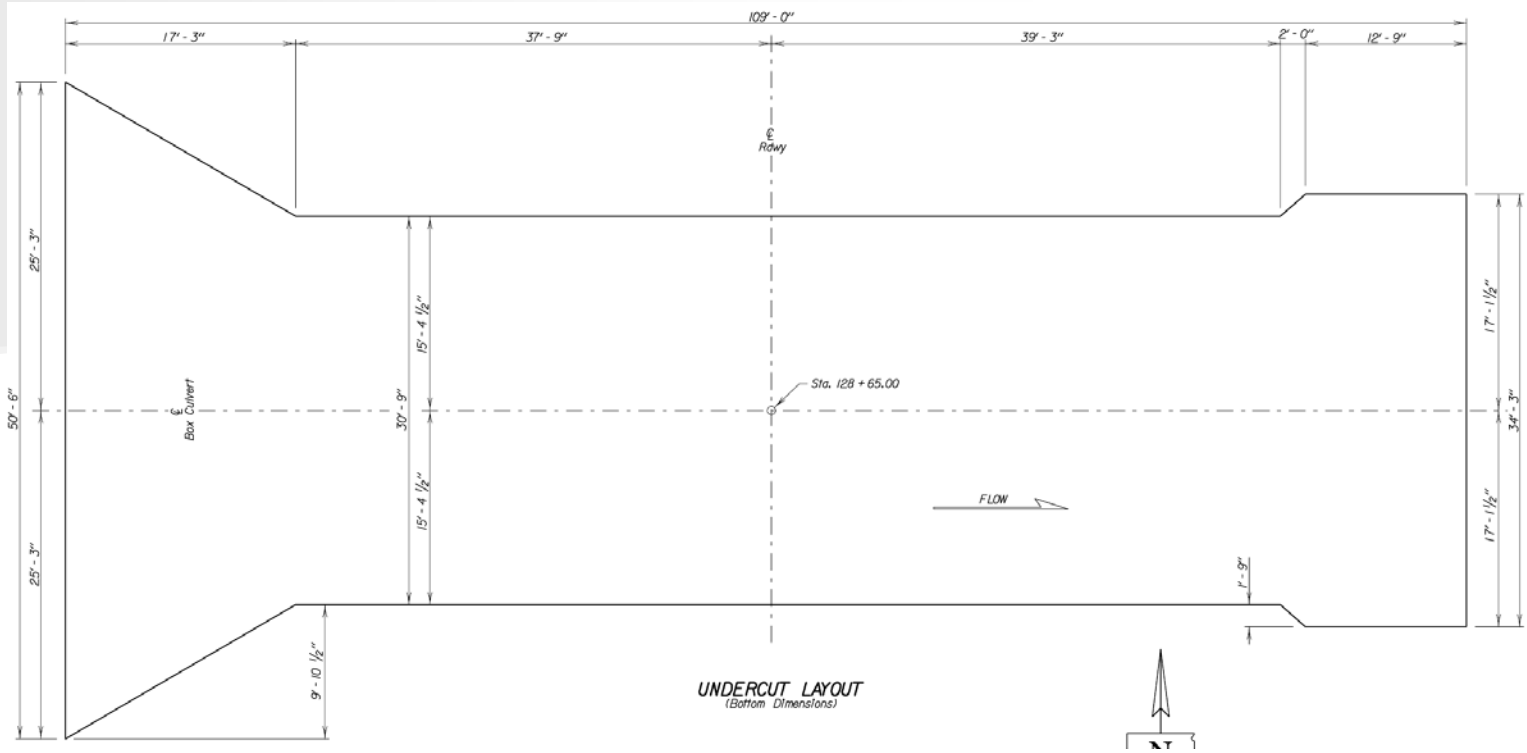
- Spread Footings
  - large reinforced concrete pad that distributes load
  - size depends on bearing strength of soil under footing
  - check plans for framing method
    - Cast to neat lines in undisturbed material
    - Place concrete shortly after excavation

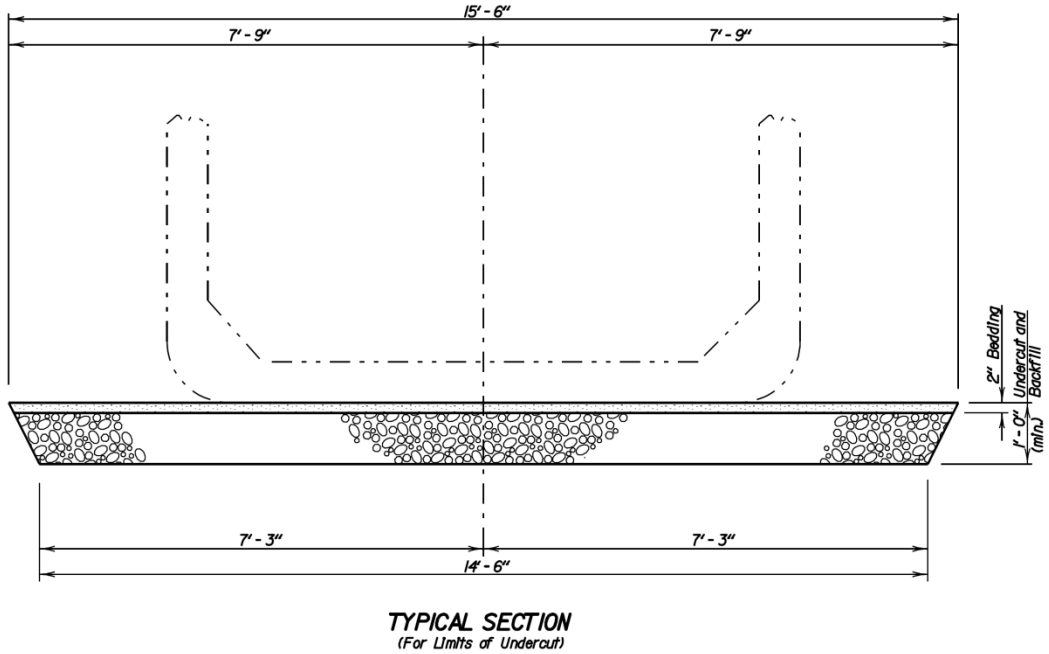
Spread Footing w/ Neat Lines

Foundation Bearing

- **Box Culverts**
  - monitor excavation near bottom of box culvert excavation for suitable bearing material
  - Substrata rock, gravel or moist sand is adequate base.
  - no simple method to determine bearing adequacy of other materials.
  - experience

Typical Undercut Limits



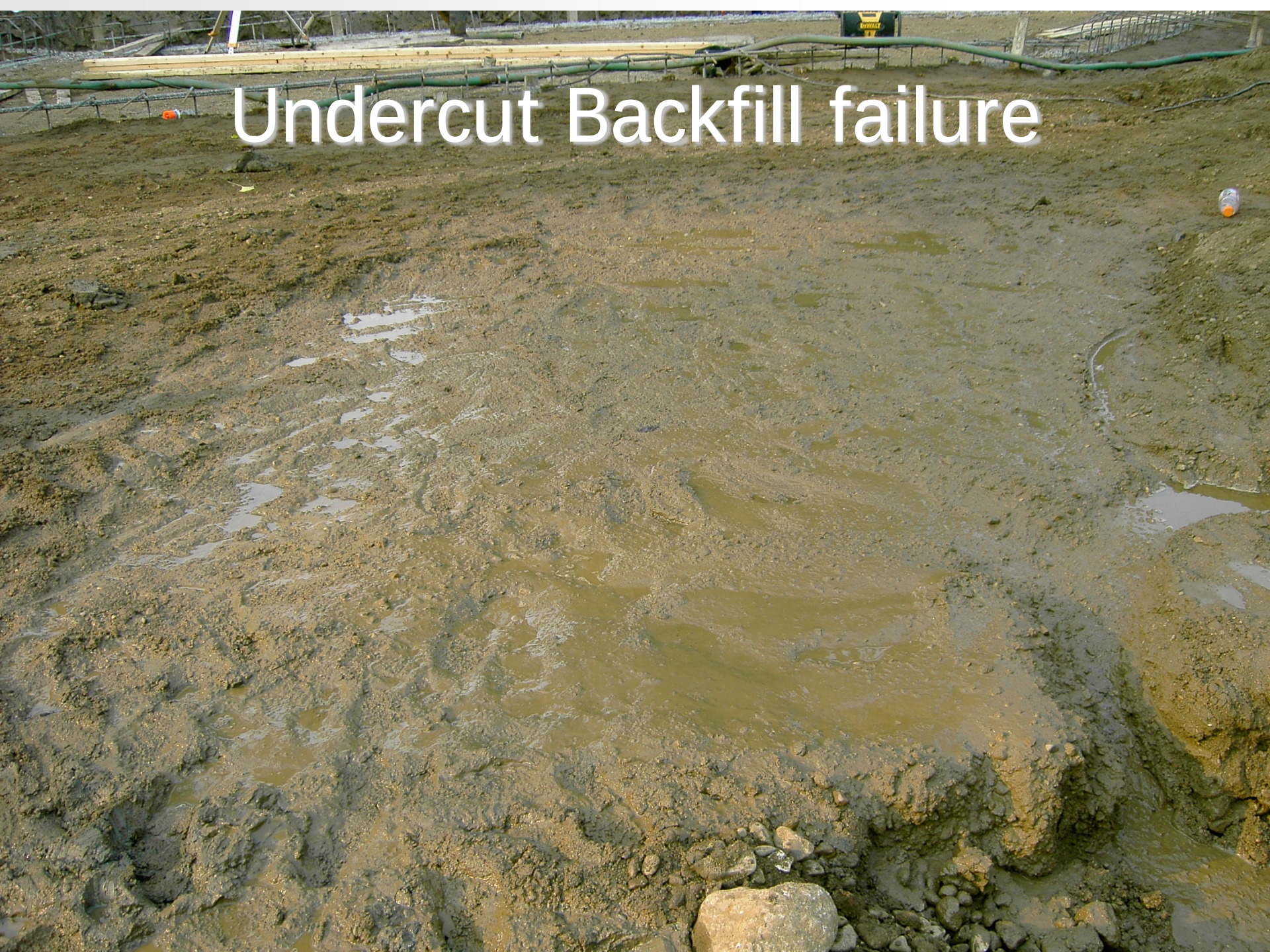


TYPICAL SECTION
(For Limits of Undercut)

Foundation Bearing

- **Box Culverts-Backfilling**
  - materials conform to Section 421
  - placed in horizontal lifts not to exceed 6” each
  - compact to 95% of max. dry density
  - take periodic tests to verify compaction per the SDDOT Materials Manual

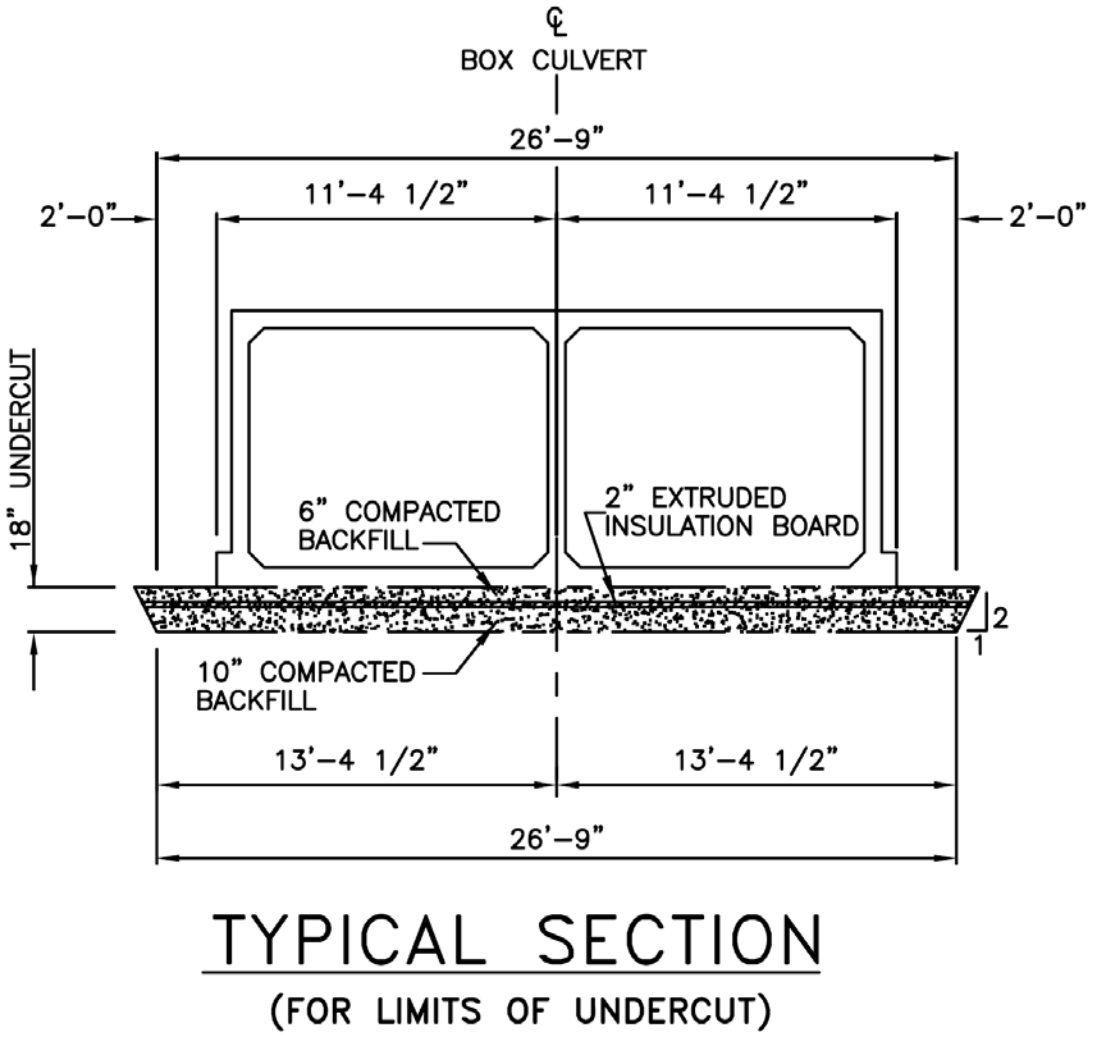
Sump Pump and Rock Substrata


Undercut Backfill failure

Foundation Bearing

- Box Culverts-Extruded Insulation Board
  - reduces effects of frost heave
  - insure equipment used to place & spread top layer of backfill is only operated on full depth of backfill
  - Pg 3-29, Fig 3.11

RCBC Insulation Board



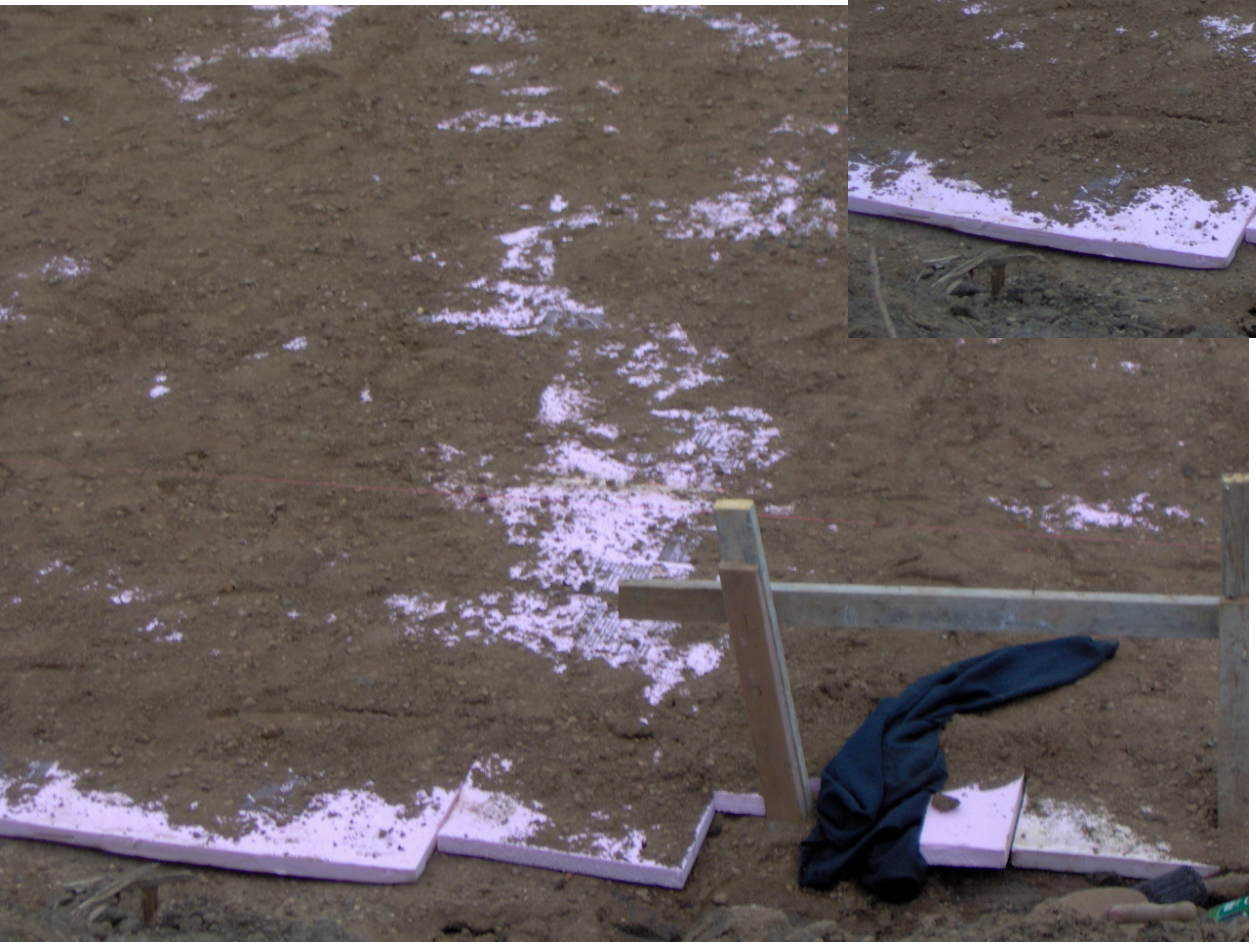
TYPICAL SECTION

(FOR LIMITS OF UNDERCUT)

Fig 3.11

Pg 3-30

Insulation Board Installation



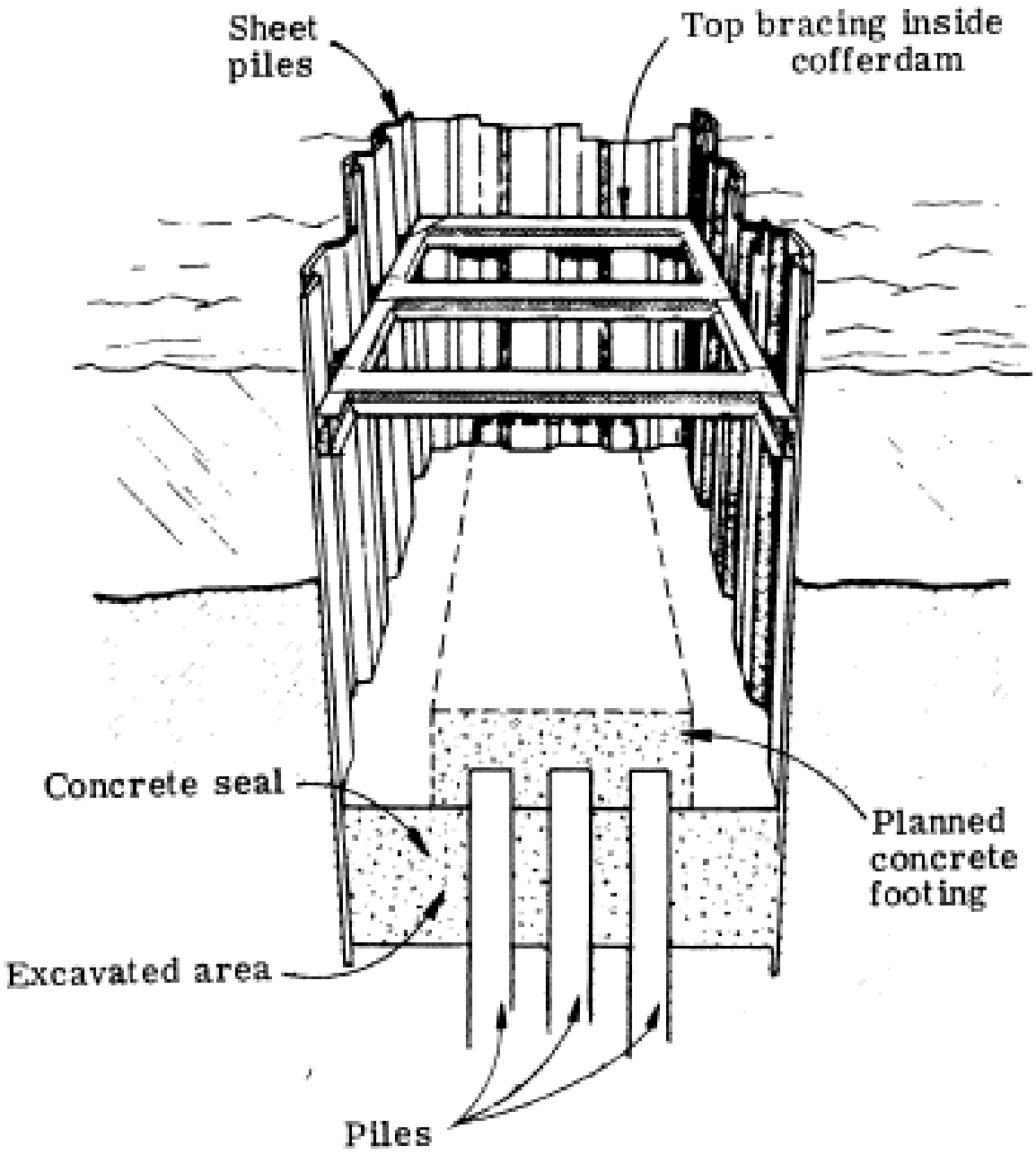
Cofferdam and Crib

- **Cofferdam**

Cofferdam and Crib

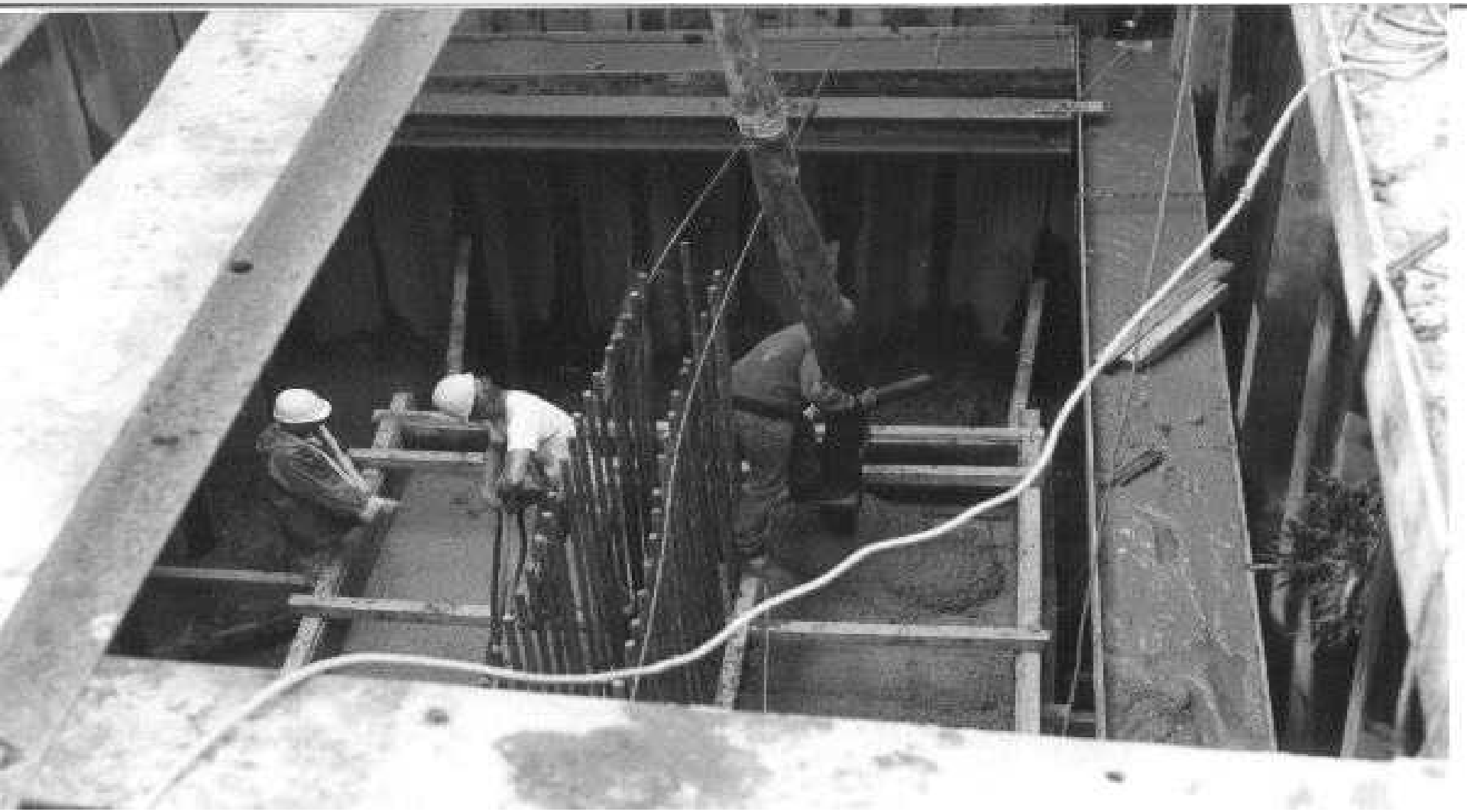
- **Cofferdam**
  - Bracing ring placed inside
  - built by driving sheet pile around excavation area
  - Interior material removed from back side

Typical Cofferdam



Cofferdam and Crib

- **Cofferdam**



Cofferdam and Crib

- **Crib**
  - built complete with bracing
  - set over area to be excavated
  - sinks as area is excavated

Steel Crib

Cribs
Trench Box

Cofferdam and Crib

- **Problems to watch for**
  - water buildup in excavation area
  - remove with pumps or well points
  - insure sheet piling is deep enough to prevent “blow-in” failures
  - foundation seal
  - area large enough to allow work on foundation. Allow 2-3’
  - Safety concerns should be coordinated with Project Engineer, Temporary Work Spec

Cofferdam Failure

Backfilling

- Most structural concrete units **can not** be backfilled until the concrete reaches full design strength, Sec 460.3.Q of Standard Spec
- Backfill material usually is the same material that was originally removed.
- Place in layers - 3” to 6” in depth
- Compaction with pan type vibrating equipment to same density as surrounding material
- Backfill brought up evenly on both sides structural member


CAT
CATERPILLAR
CAT
325B

Backfilling
Box Culverts and Large Pipe

- Standard Backfill Method with like Materials.
  - Backfill brought up evenly in < 6” lifts and compacted by mechanical compactors
  - Usually same material as excavated material but may be a backfill material as specified in plans
- Imperfect Trench
- Flowable Fill
- Special Provisions may apply

Imperfect Trench

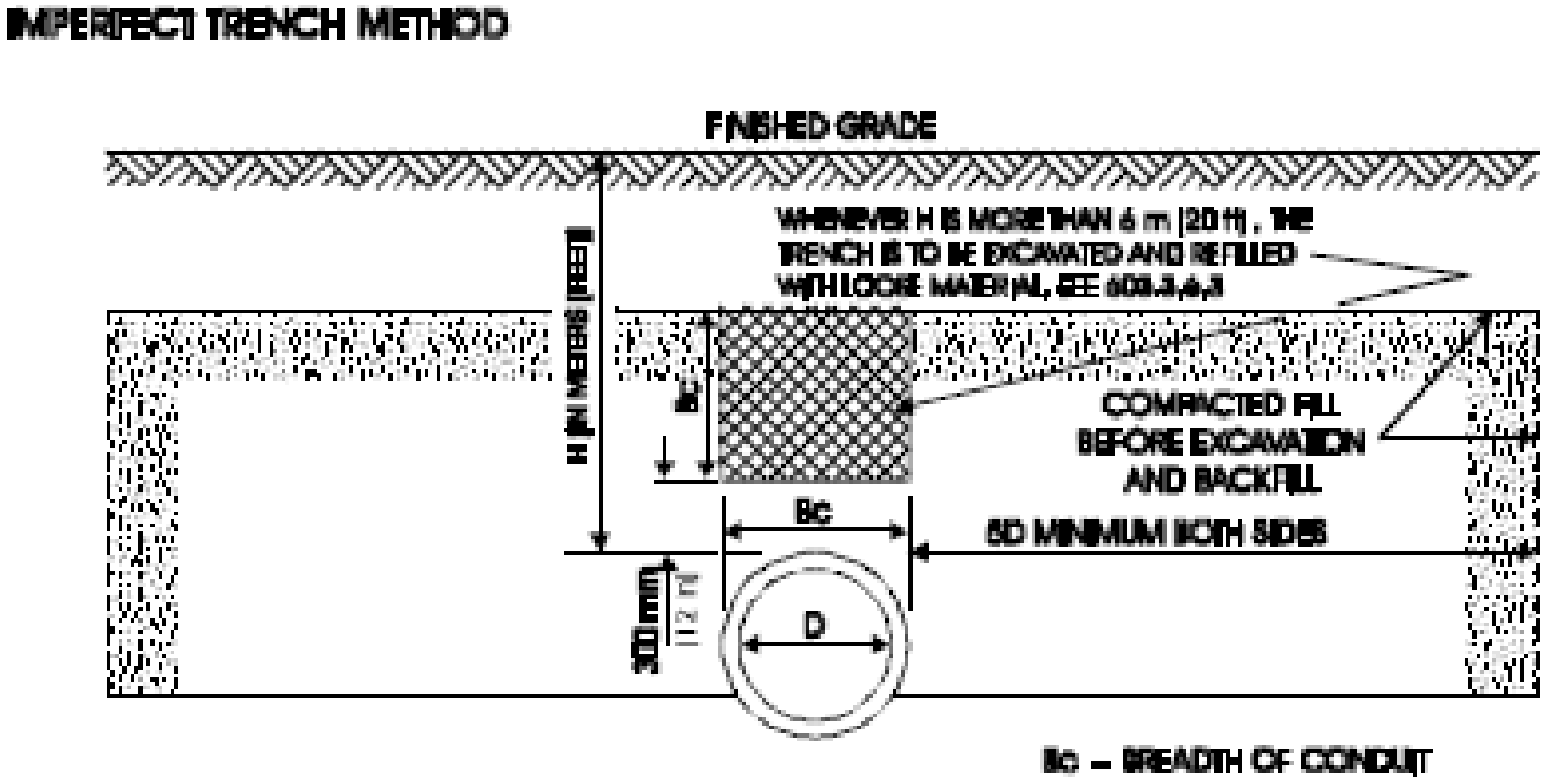


FIG. 1-E - CULVERT DETAILS

Backfilling

- Flowable Fill
  - Portland Cement
  - Fine Aggregate
  - FlyAsh
  - Water

Bridge End Backfill

- Bridge Berm Constructed per Plans and Cross Sections
- Review Special Provision, Plans and Specifications
- Construct Bridge Backfill per plans.

Bridge End Backfill

- **Construct Embankment to plan configuration**
  - Embankment optimium moisture: < 25%
  - Complete the necessary embankment densities (97% of maximum dry)
  - Backfill limits: 100 ft back of abutment bound by toe of bridge berm
    - **3 equally spaced densities for embankments less than 7 ft**
    - **4 equally spaced densities for embankments greater than 7 ft**

Bridge End Backfill

STATE OF SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
BRIDGE END BACKFILL

JUNE 17, 2010

Delete Section 430 of the Standard Specifications for Roads and Bridges and replace with the following:

430.1 DESCRIPTION

This work consists of backfilling bridge abutments and sills.

Bridge End Backfill

- **Select Granular Backfill - plan sheet on 3-32**
  - Excavate to plans lines, scarify top 6 inches and recompact the area to 97% of max. dry density
  - Install underdrain system
  - Layout drainage fabric in which granular material is wrapped in
  - Place embankment and granular material in 8” lifts and compact each layer
  - Wrap fabric around granular material
  - Place Poly sheeting over the granular material

Bridge End Backfill Sequence of Operation

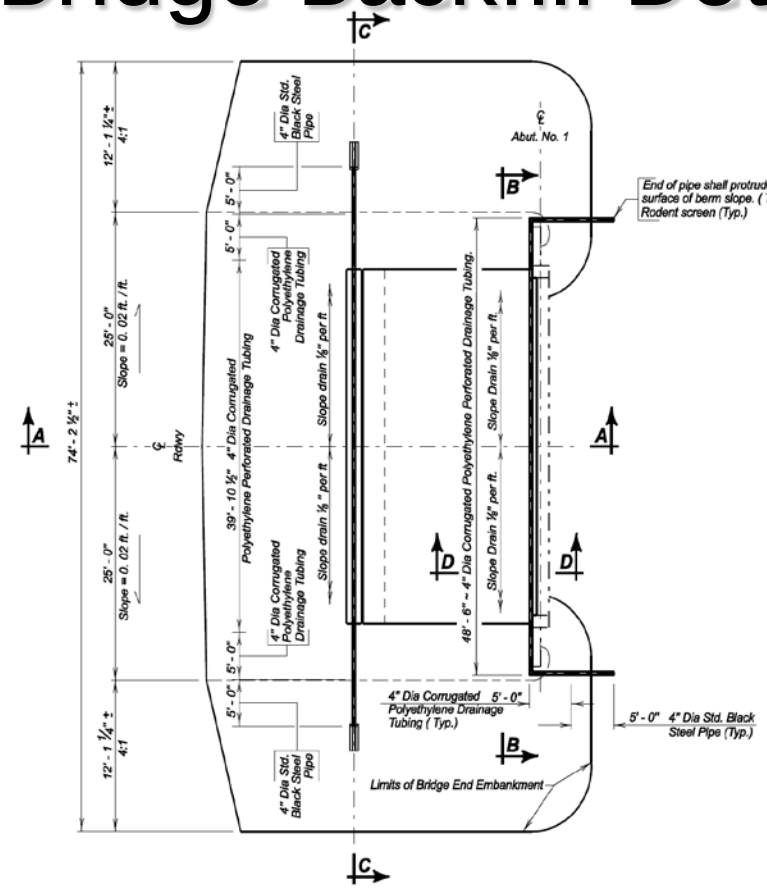
- Install Underdrain System Adjacent to Abutment Backwall
  - Place polyethylene sheeting
  - Install vertical drain
  - Place porous backfill and 4 in drainage tubing @ 1/8 inch per foot

Bridge End Backfill Sequence of Operation

- Placement of Granular Bridge End Backfill
  - Material must meet plan or special provision specifications.
  - Testing requirements per the MSTR of the SDDOT Materials Manual
  - Two Densities at even interval throughout the height of the abutment.

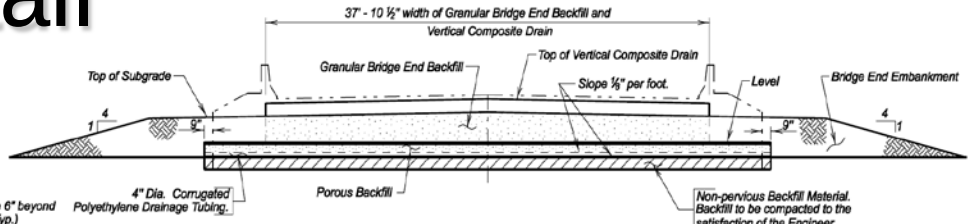
Bridge Backfill Detail

STATE OF	PROJECT	SHEET NO.	TOTAL SHEETS
S.D.	IM 29-9(00)208	E12	E42

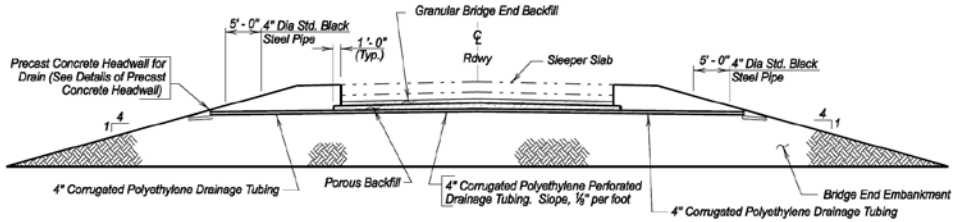


PLAN

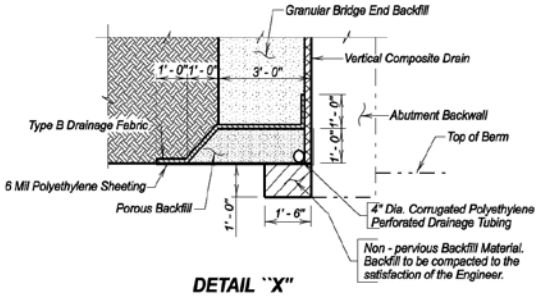
NOTE: Bridge End Backfill shown adjacent to Abut. No. 1. Abut. No. 5 similar by rotation except as shown.



SEC. B - B



SEC. C - C



DETAIL "X"
(Normal to ℄ Abutment)

ESTIMATED QUANTITIES
(For 2 Bridge Ends)

	ITEM	UNIT	QUANTITY
	Granular Bridge End Backfill	Cu.Yd.	61
⊛	Bridge End Embankment	Cu.Yd.	613
☆	Porous Backfill	Ton	28.0
	4" Underdrain Pipe	Ft.	257
	Approach Slab Underdrain Excavation	Cu. Yd.	18
	Precast Concrete Headwall for Drain	Each	4

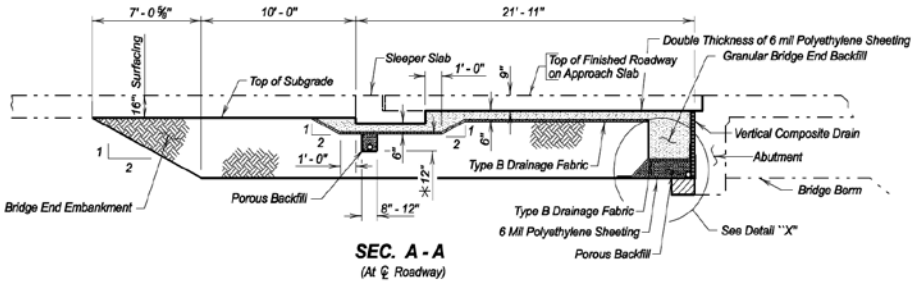
1. 6 mil Polyethylene sheeting (not including laps) 1901 Sq. ft.
2. Type B Drainage Fabric 262

Items 1 and 2 are approximate quantities contained in the Granular Bridge End Backfill bid item and are for information only.

3. 4" Dia. Corrugated Polyethylene Perforated Drainage Tubing 177 ft.
4. 4" Dia. Corrugated Polyethylene Drainage Tubing 40 ft.
5. 4" Dia Black Steel Pipe with Rodent Screens 40 ft.
6. Vertical Composite Drain 297 Sq. ft.

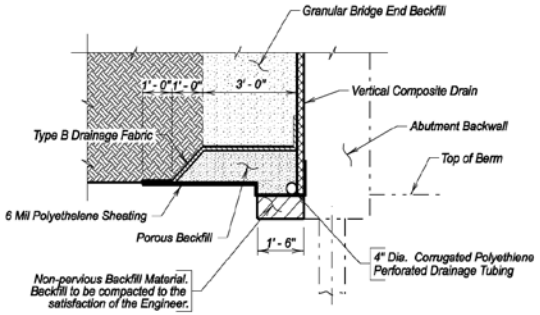
Items 3 thru 6 are approximate quantities contained in the 4" Underdrain Pipe bid item and are for information only.

☆ For estimating purposes only, a factor of 1.89 tons/cu. yd. was used to convert Cu. Yds. to Tons.
⊛ Shrinkage Factor of 1.25 used.



SEC. A - A
(At ℄ Rosdway)

✳ 12" at ℄ Roadway. Bottom of Trench Shall Match ⅛" per Foot Pipe Slope.



SEC. D - D

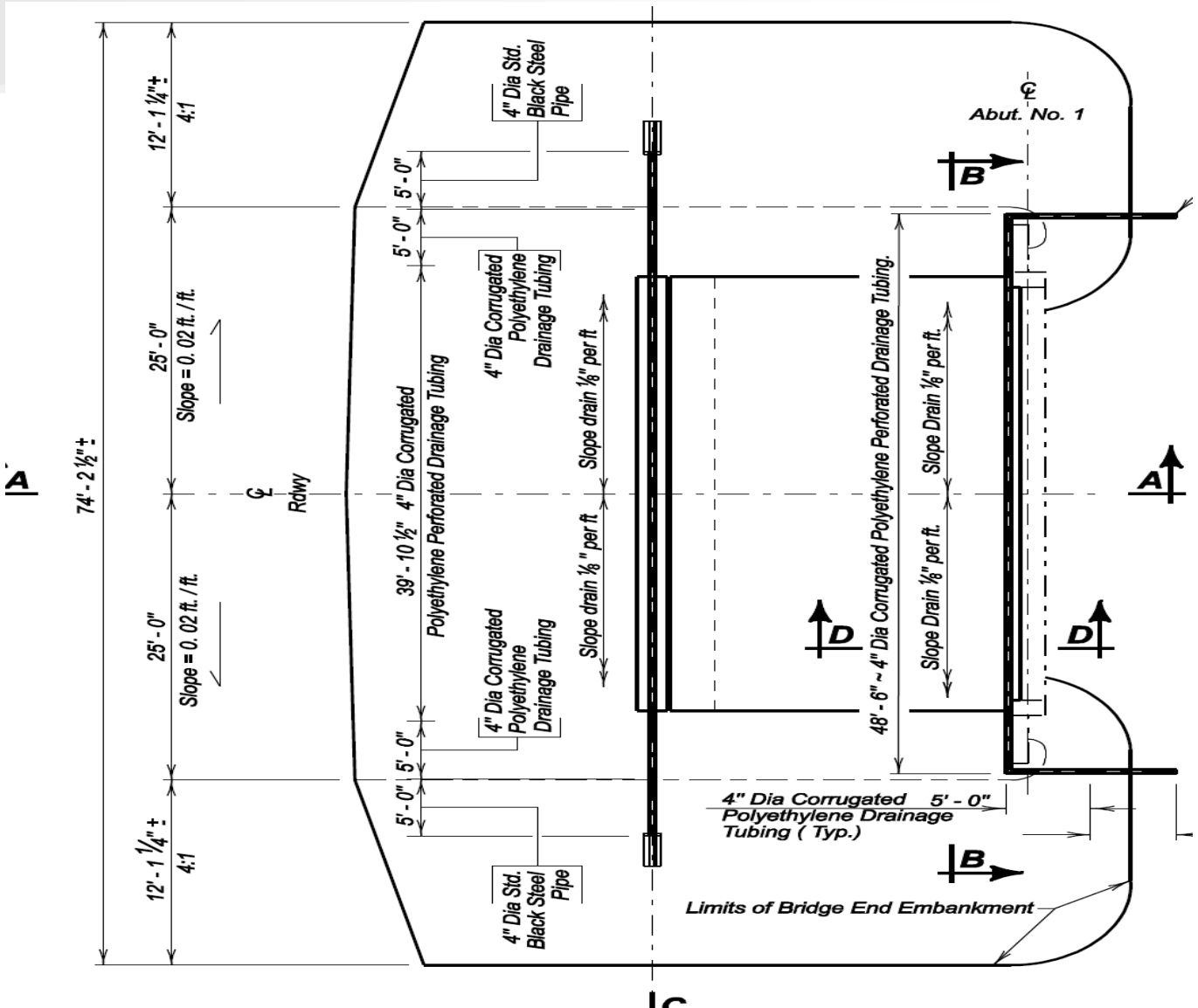
DETAILS OF BRIDGE END BACKFILL FOR 162'-6" CONTINUOUS CONCRETE BRIDGE

36'-0" ROADWAY 0° SKEW
OVER LONETREE CREEK SEC. 3/10-T97N-R58W
STA. 98+04.28 TO 99+66.78 P-BRF 0018(126)387
STR. NO. 34-217-180 HL-93

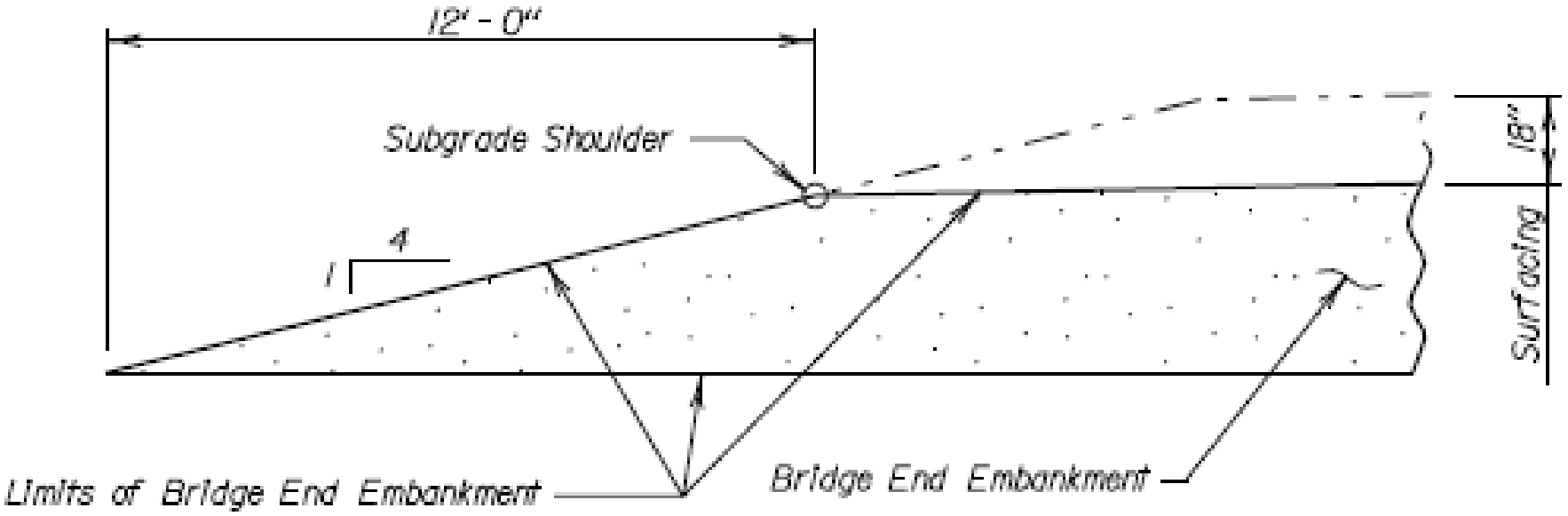
HUTCHINSON COUNTY
S. D. DEPT. OF TRANSPORTATION
NOVEMBER 2009 (10) OF (18)

DESIGNED BY	DRAWN BY	CHECKED BY	
PW/DO HUCHOOGU	MC OOGUWAIO	DO/PW	Kevin N. Goeden BRIDGE ENGINEER

Bridge End Backfill Excavation Limits

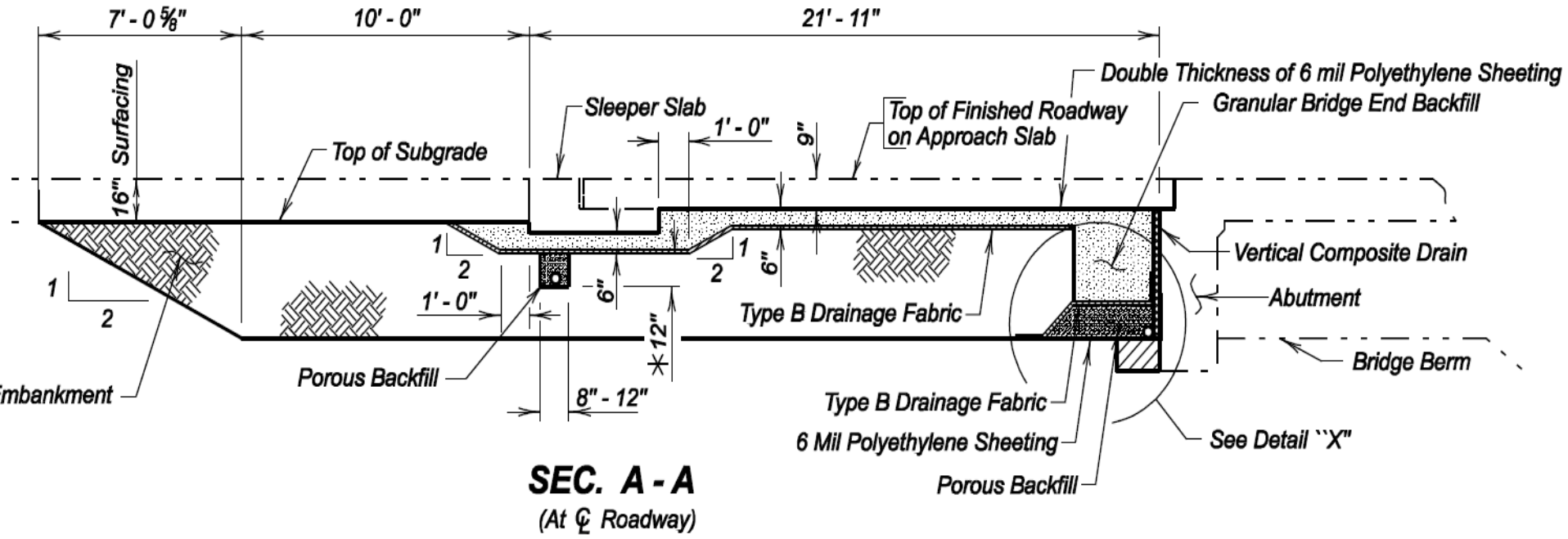


Backfill Daylight on Shoulder



SEC. A - A

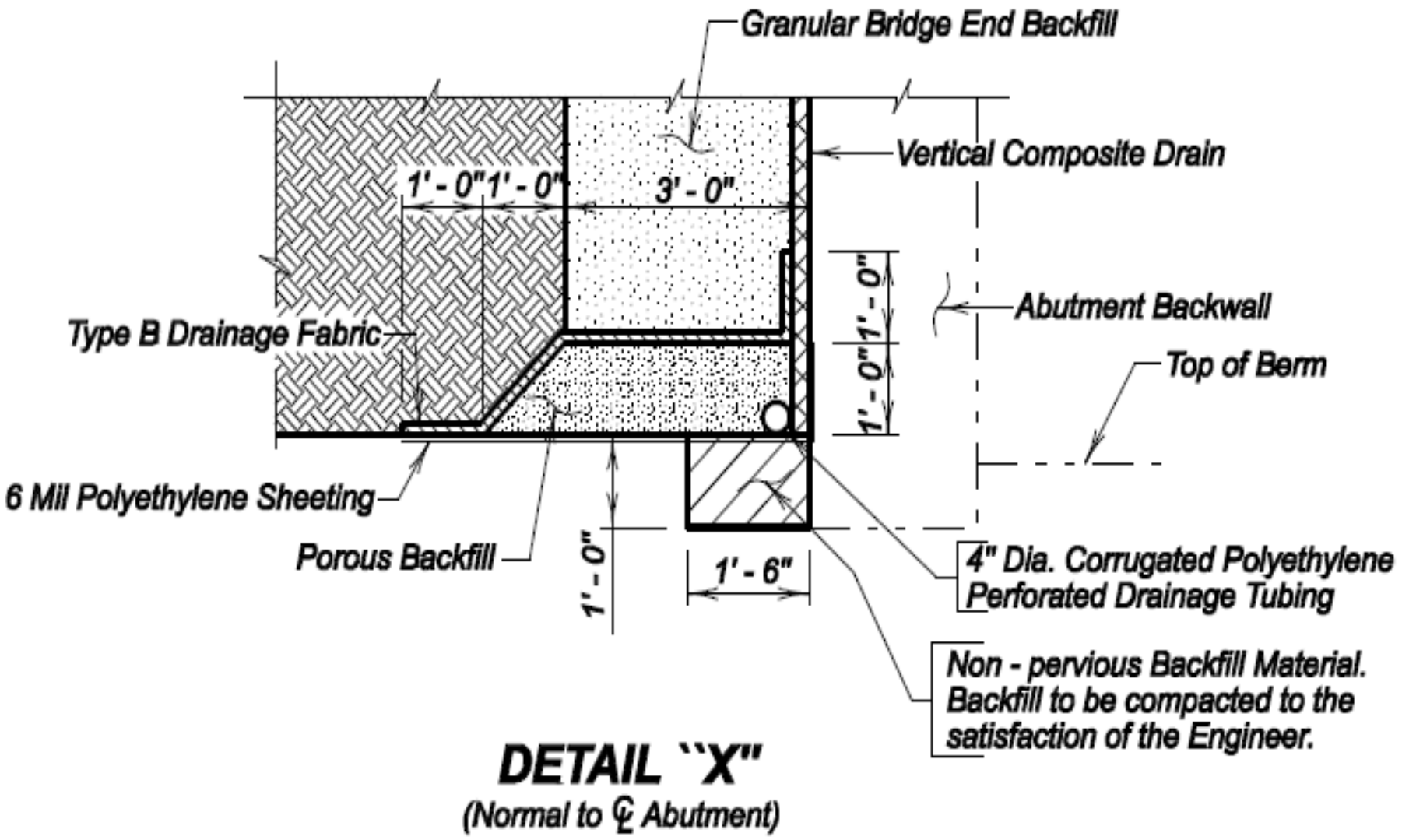
Bridge Backfill Profile



SEC. A - A
(At ℄ Roadway)

✳ 12" at ℄ Roadway. Bottom of Trench Shall Match ⅛" per Foot Pipe Slope.

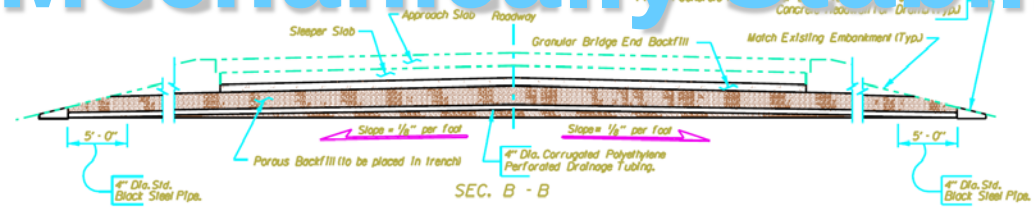
Bridge End Backfill Underdrain Detail



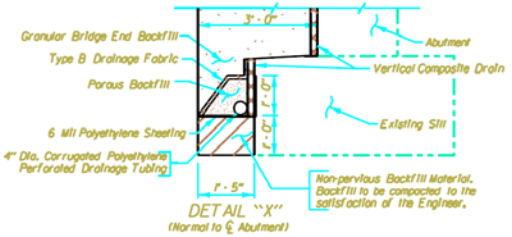
Bridge End Backfill Phased Construction

- Phase Construction shall be mechanically stabilized in accordance with the plans
- Verify all Geotextile Fabric is taut & free of wrinkles.
- Repair all torn and punctured Geotextile Fabric per Special Provisions. Overlapped 3 ft.
- Seams shall be overlapped a minimum of 2 ft
- Seams shall sewn using High Strength Polyester, Polypropylene or Kevlar thread.
- **Nylon thread shall not be used.**
- **Geotextile Fabric shall be enclosed in a heavy duty opaque wrapping to protect from direct sunlight during storage.**

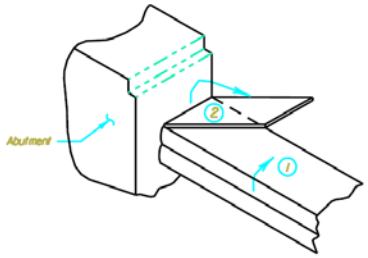
Mechanically Stabilized backfill



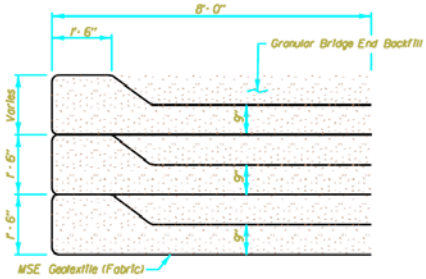
SEC. B - B



DETAIL "X"
(Normal to ℄ Abutment)



DETAILS OF FABRIC FOLDING



Typical Fabric Lift and Wrap at Sides

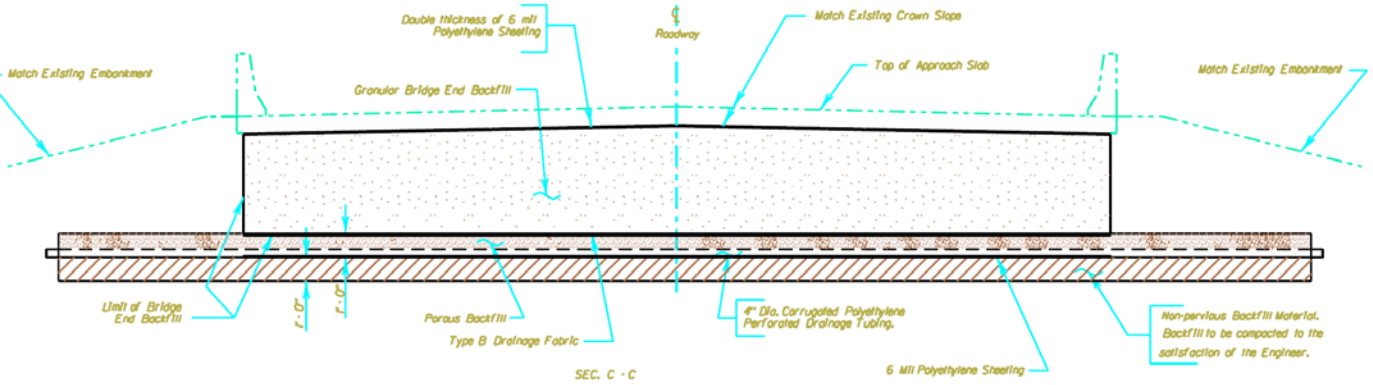
ESTIMATED QUANTITIES (For 2 Abutments and 2 Approach Slab Underdrains)			
ITEM	UNIT	PHASE 1 QUANTITY	PHASE 2 QUANTITY
Granular Bridge End Backfill	Cu.Yd.	30.4	28.5
⊛ Bridge End Embankment	Cu.Yd.	48.0	45.1
★ Porous Backfill	Ton	8.5	8.0
Bridge End Backfill Excavation	Cu.Yd.	54.7	54.3
❸ 4" Underdrain Pipe	Ft.	140	136
Approach Slab Underdrain Excavation	Cu.Yd.	2.3	2.3
Precast Concrete Headwall for Drain	Each	2	2

	PHASE 1	PHASE 2
❹ 1. 6 mil Polyethylene sheeting (not including laps)	1678 Sq.ft.	1576 Sq.ft.
❹ 2. Type B Drainage Fabric	99.7 Sq.yd.	93.6 Sq.yd.
❸ 3. 4" Dia. Corrugated Polyethylene Perforated Drainage Tubing	108 ft.	104 ft.
❸ 4. 4" Dia. Corrugated Polyethylene Plastic Pipe	12 ft.	12 ft.
❸ 5. 4" Dia Black Steel Pipe with Rodent Screens	20 ft.	20 ft.
❸ 6. Vertical Composite Drain	180 Sq.ft.	176 Sq.ft.

Items 1 thru 6 are approximate quantities contained in the above bid items and are for information only.

★ For estimating purposes only, a factor of 1.89 tons/cu.yd. was used to convert Cu.Yds. to Tons. Quantity Based on 1' - 0" deep x 1' - 0" wide trench.

⊛ Shrinkage Factor of 1.25 used.



SEC. C - C

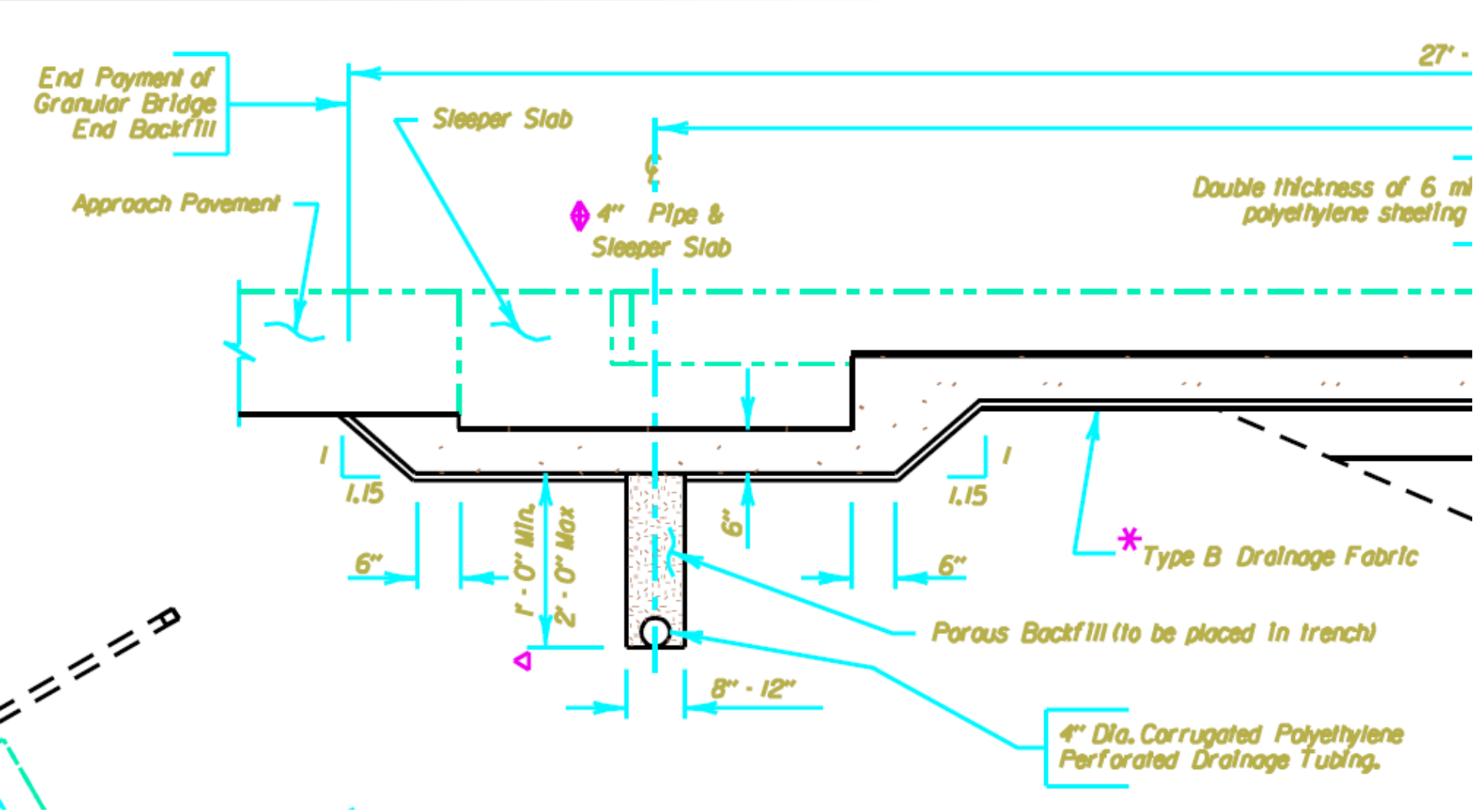
BRIDGE END BACKFILL AND UNDERDRAIN SYSTEM
FOR
143' - 3 3/4" CONT. COMP. GIRDER BRIDGE
30' - 0" ROADWAY — SEC. 30-T19N-R29E
OVER SNAKE CREEK — 30° SKEW R.H.F.
STR. NO. 16-689-259 — NH 0012(128)164
CORSON COUNTY
S. D. DEPT. OF TRANSPORTATION
DECEMBER 2006 — 19 OF 36

DESIGNED BY	DRAWN BY	CHECKED BY	
SO/VM	JK	SO/VM	Kevin N. Goeden
CORS566I	5661S019		BRIDGE ENGINEER

Bridge End Backfill Sequence of Operation cont.

- Approach Slab Underdrain:
  - Complete embankment constructed prior to excavating for approach slab underdrain
  - Trench shall be 8 to 12 inches wide with vertical sides
  - Trench bottom transversely graded @ 1/8th inch/ft for proper drainage
  - Place 4 inch perforated drainage tubing and backfill trench with porous backfill .
  - Compact porous backfill to the satisfaction of the Engineer.

Approach Underdrain



Bridge End Backfill

- Tools

Bridge End Backfill

More Information?

- **Review Plans**
- **Special Provisions**
- **Review Spec Book**
- **Check chapter 3 of the Structures Construction Manual**
- **Ask your supervisor**
- **Questions?**
  - **Call Office of Bridge Design 605-773-3285**

Not all goes well.


10/28/2008 09:38 am


PC
300
LC
KOMATSU


JAIL
MDA UP
GOT BAIL?
Hadly

10 Minute Bathroom Break