	Bowling Green, Kentucky **Stormwater Best Management Practices (BMPs)** **Sediment Management Practices (SMPs)**	**SMP-08**
	Activity: Channel Linings (CL)	

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
Minimal

Estimated Unit Cost:
Medium

Monthly Maintenance:
Negligible

▨ **CL** ▨

CL

Target Pollutants

Significant ◆	Partial ◈	Low or Unknown ◇

Sediment ◆   Heavy Metals ◆   Nutrients ◆   Oxygen Demanding Substances ◆   Toxic Materials ◇
Oil& Grease ◆   Bacteria & Viruses ◇   Floatable Materials ◈   Construction Waste ◇

Description	Constructed or natural waterways will occasionally require vegetation or rock lining to protect it from erosion.
Suitable Applications	*Rock Lined Channels* ➢ Channels with runoff velocities exceeding 2 ft/sec. ➢ Channels or ditches with grades greater than 2 percent. ➢ Channels or ditches with highly erodible soils. ➢ Channels where the design velocity exceeds that allowable for grass lined channels. *Grass Lined Channels* ➢ Slopes that do not exceed a 5% grade. ➢ Sites where vegetation is required.
Approach	There are two types of channel lining: ➢ Rock lined channels

- Channel is required to carry the 10-year 24-hour peak flow where:
  - $Q = V*A$, where
    Q = Flow
    V = Velocity
    A = Flow Area
- The Manning Equation shall be used to determine the velocity
  - $V = \dfrac{1.486}{n} *R^{2/3} * S^{1/2}$, where
    V = Velocity
    R = flow area/wetted perimeter
    S = Slope in ft/ft
    $n = 0.0395 (D50)^{1/6}$

Approach (cont'd)

➤ Rock lined channels (cont'd)

- The maximum depth of channel shall be calculated with the following equation
    - $D_{max} = \tau / (62.4 * S)$, where
      D_{max} = maximum depth of flow
      S = Slope in ft/ft
      τ = maximum tractive force of the liner in lbs/ft^2
      (see Table SMP-08-01 for shear stress quantities)

- Side slopes shall be 2:1 or flatter
- Riprap thickness: The thickness shall be 1.5 times thicker than the stone diameter, unless shown otherwise in the plans. Minimum of 6 inches.
- Foundation: Extra-strength filter fabric or aggregate filter layered, as required.
- Channel outlet must be stable.

➤ Vegetative channels

- Grass channels are generally constructed with sides at a 3:1 slope to aid in establishment and safety in maintenance.
- Channel is required to carry the 10-year 24-hour peak flow where:
    - Q = V*A, where
      Q = Flow
      V = Velocity
      A = Flow Area
- The Manning Equation shall be used to determine the velocity
    - $V = \dfrac{1.486}{n} * R^{2/3} * S^{1/2}$, where
      V = Velocity
      R = flow area/wetted perimeter
      S = Slope in ft/ft
      n = 0.045 for grass
- The maximum depth of channel shall be calculated with the following equation
    - $D_{max} = \tau / (62.4 * S)$, where
      D_{max} = maximum depth of flow
      S = Slope in ft/ft
      τ = maximum tractive force of the liner in lbs/ft^2
      (see Table SMP-08-02 for shear stress quantities)
- *V-shaped Channels*
    - Typically used for smaller, roadside channels.
    - Use a grass or sod lining where velocities are low
- *Parabolic Channels*
    - Used for larger flows if space allows.
    - Riprap should be used wherever velocities are highest
    - Areas of continuous flows use grass channels with centered reinforcement mats.
- *Trapezoidal Channels*
    - For channels with large volume and flatter slopes.
    - In some cases concrete or riprapped channels may be required.

Activity: Channel Linings	SMP-08

Table SMP-08-01

KYTC Channel Lining Values

KYTC Channel Lining	D50	Manning's n	Shear (lb/ft²)
Class I	0.2	0.0302	1.00
Class II	0.5	0.0352	2.50
Class III	1.0	0.0395	5.00

Table SMP-08-01

Maximum Shear Stress of Liners

Material	Shear (lb/ft²)
Dense sod, fair condition (Class D/E), moderately cohesive soil	0.35
Bermuda grass, fair stand < 5" tall, dormant	0.90
Bermuda grass, good stand < 5" tall, dormant	1.10
Bermuda grass, excellent stand 20" tall, dormant	2.70
Bermuda grass, excellent stand 20" tall, green	2.80
Bermuda grass, excellent stand >20" tall, green	3.20
Turf (immediately after construction)	0.20
Turf (after 3-4 season)	2.04
Turf reinforcement mat, permanent	8.00
Straw reinforcement mat, temporary	0.45
Jute mat	0.45
Straw with net	1.45
Curled wood net	1.55
Synthetic mat	2.00

Source: Salix Applied Earthcare – Erosion Draw 5.0

Installation (cont'd)

Rock Lined Channels
➢ Cross sections shall be excavated according to the grade shown on plans
➢ Overcut for thickness of rock and filter
➢ As soon is foundation is prepared, place filter and/or fabric filter immediately.
➢ Rock should be placed such that it forms a dense, uniform, well graded mass with few voids. Hand placement may be required in places that machinery can not reach.
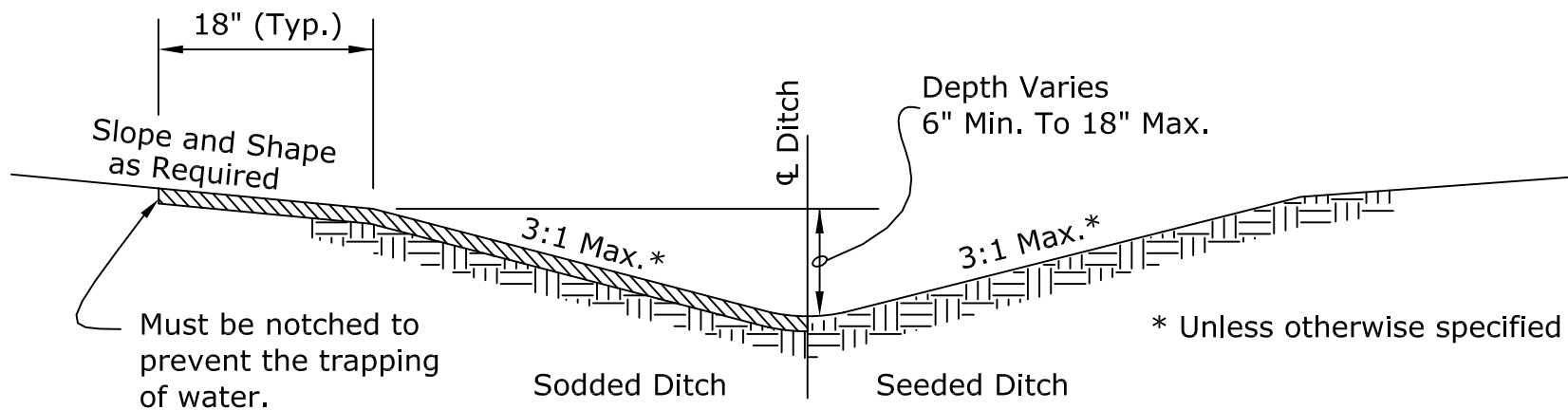➢ Channel outlet shall be stabilized.

Grass Lined Channels
➢ *See the specifications for seeding and erosion control blankets.*

Activity: Channel Linings	SMP-08

Maintenance
- ➢ Inspect after every storm event greater than 0.5 inches, if not every week.
- ➢ Check rip-rap BMP for appropriate installation and maintenance processes.
- ➢ Remove any deleterious debris.
- ➢ Repair eroded or damaged material immediately.
- ➢ Check grass lined channels for establishment.
- ➢ For grass lined channels, check to see if established cover is withstanding high velocity flows.

Inspection Checklist
- ❑ Adequate coverage is provided to prevent washout.
- ❑ Repair torn netting or mats.
- ❑ Slope of channel is consistent with contract documents.

18" (Typ.)

Slope and Shape
as Required

Depth Varies
6" Min. To 18" Max.

℄ Ditch

3:1 Max.*

3:1 Max.*

Must be notched to
prevent the trapping
of water.

* Unless otherwise specified

Sodded Ditch

Seeded Ditch

NOTES:

1. Sodded or seeded ditches should not be used where
   slopes are 10% or greater or where the velocity
   is greater than 4 feet per second.

2. Sod shall be placed so that ditches shall be
   free-draining at the edge of all pavements and driveways.

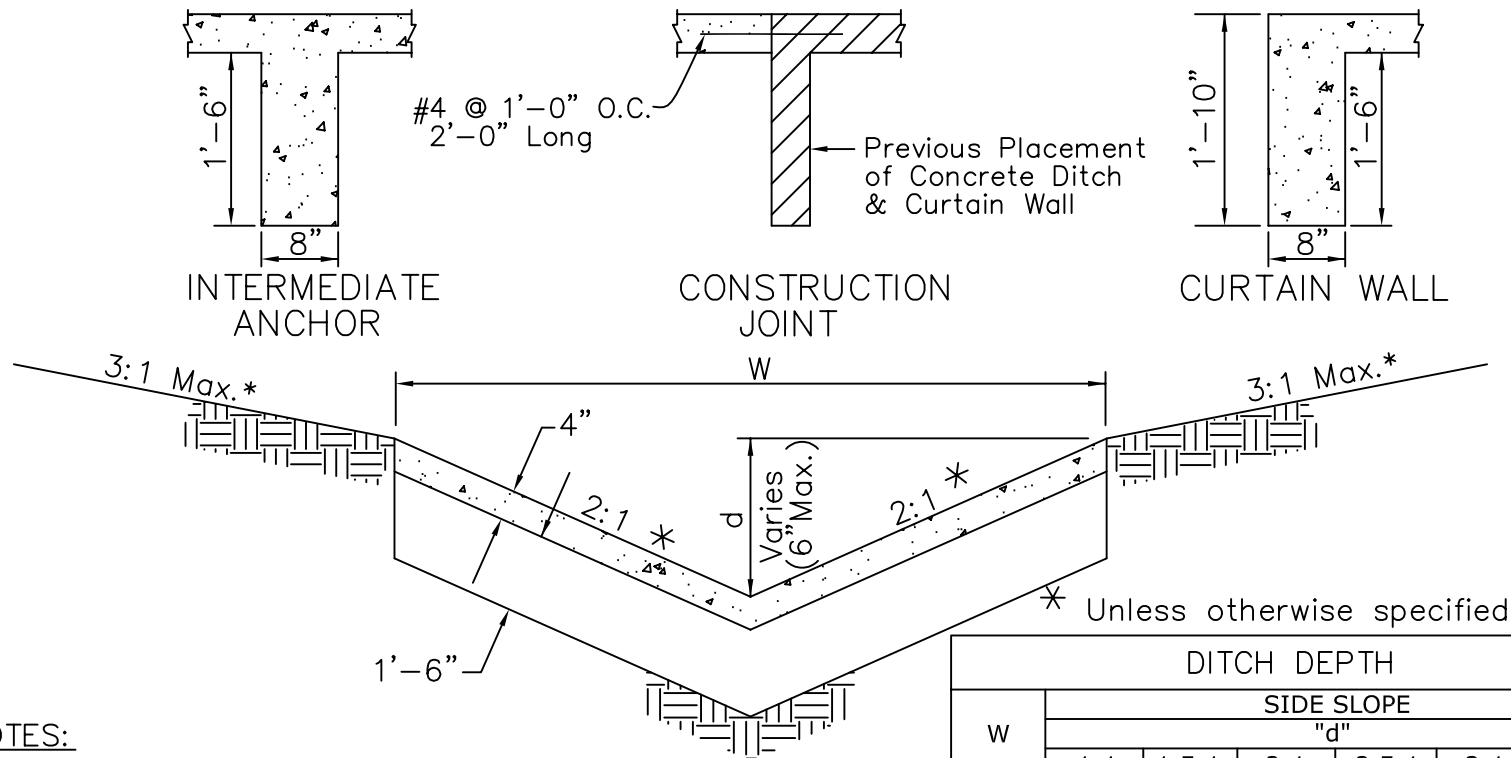3. Ditch lining shall be designed for full bank flow.

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EARTH "V" DITCH

STANDARD DRAWING NO. SMP-08-01

SOURCE: LOUISVILLE MSD

APPROVED BY: _____ _____
                    DIRECTOR OF ENGINEERING   DATE

1'-6" 8"

#4 @ 1'-0" O.C.
2'-0" Long

INTERMEDIATE ANCHOR

Previous Placement
of Concrete Ditch
& Curtain Wall

CONSTRUCTION JOINT

1'-10" 1'-6" 8"

CURTAIN WALL

W

3:1 Max.*

3:1 Max.*

4"

2:1 *

2:1 *

d

Varies (6" Max.)

1'-6"

* Unless otherwise specified

NOTES:
1. Invert may be finished as a radius.
2. Curtain wall shall be constructed at beginning and end of ditch.
3. If a construction joint is used in the placing of the paved ditch, it shall be constructed with a curtain wall as detailed.
4. The ditch shall be Class "A" concrete with polypropylene fiber.
5. Intermediate anchors shall be used on grades 20% or steeper and spaced every 20 feet.
6. Sawed or tooled joints shall be spaced every 20 feet, (max.).
7. Broom finish perpendicular to flow.

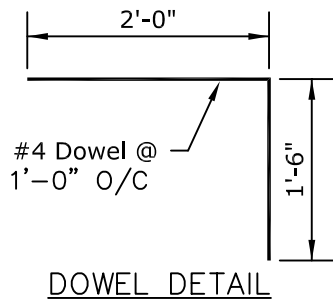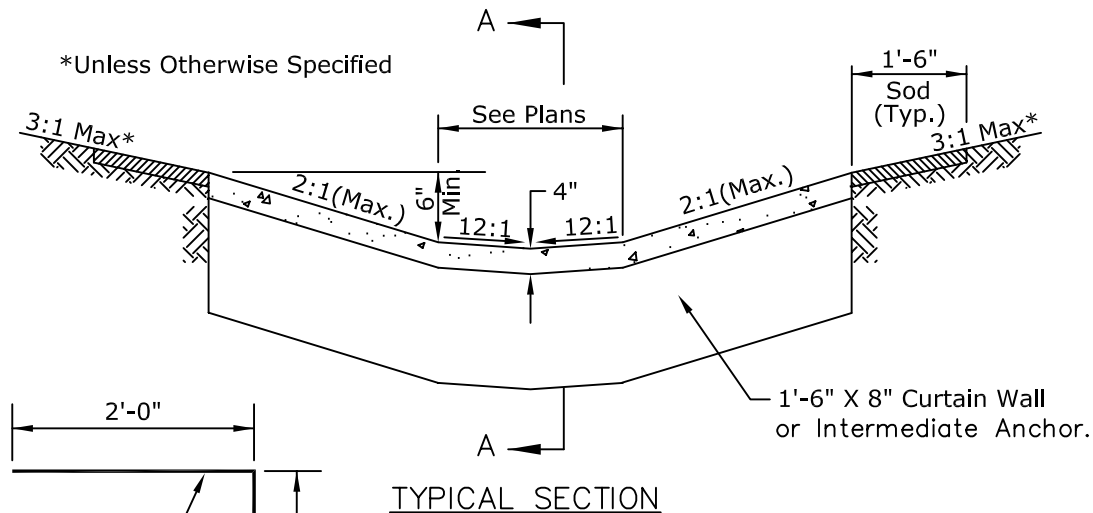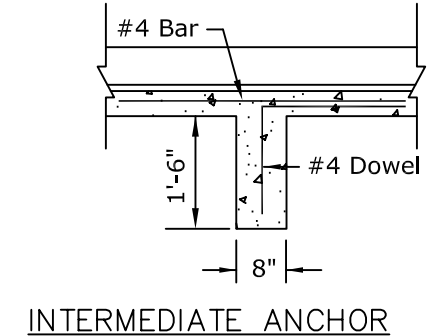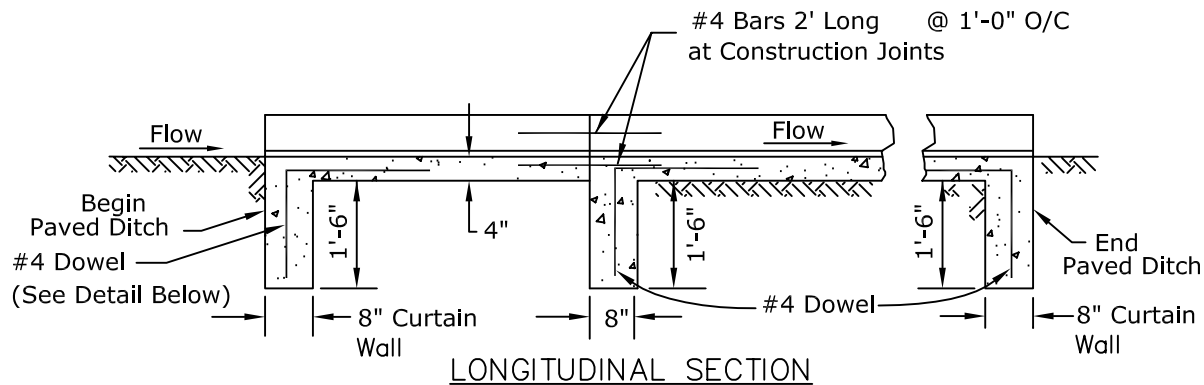|	DITCH DEPTH					
	SIDE SLOPE					
W	"d"					
	1:1	1.5:1	2:1	2.5:1	3:1	4:1
1'-0"	6"	4"	3"	2 3/8"	2"	1 1/2"
1'-6"	-	6"	4 1/2"	3 5/8"	3"	2 1/4"
2'-0"	-	-	6"	5"	4"	3"
2'-6"	-	-	-	6"	5"	3 3/4"
3'-0"	-	-	-	-	6"	4 1/2"
4'-0"	-	-	-	-	-	6"

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PAVED "V" DITCH

STANDARD DRAWING NO. **SMP-08-02**

APPROVED BY: _____
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SOURCE: LOUISVILLE MSD

#4 Bars 2' Long @ 1'-0" O/C
at Construction Joints

Flow

Flow

Begin
Paved Ditch

#4 Dowel
(See Detail Below)

1'-6"

4"

1'-6"

1'-6"

End
Paved Ditch

8" Curtain
Wall

8"

#4 Dowel

8" Curtain
Wall

LONGITUDINAL SECTION

#4 Bar

1'-6"

#4 Dowel

8"

INTERMEDIATE ANCHOR

A

*Unless Otherwise Specified

3:1 Max*

See Plans

2:1(Max.)

6" Min

4"

12:1

12:1

1'-6"
Sod
(Typ.)

3:1 Max*

2:1(Max.)

1'-6" X 8" Curtain Wall
or Intermediate Anchor.

A

TYPICAL SECTION

2'-0"

#4 Dowel @
1'-0" O/C

1'-6"

DOWEL DETAIL

NOTES:

1. Class A Concrete with Polypropylene Fiber.
2. Curtain Wall shall be constructed at Beginning and End of Ditch.
3. If a Construction Joint is used in the placing of the Ditch, it shall be constructed as Detailed.
4. Intermediate Anchors shall be used on Grades 20% or Steeper and spaced every 20 feet.
5. Tooled Joints shall be placed every 20 feet (Max.)
6. Broom finish perpendicular to flow.
7. All Reinforcing Steel shall be Grade 60.
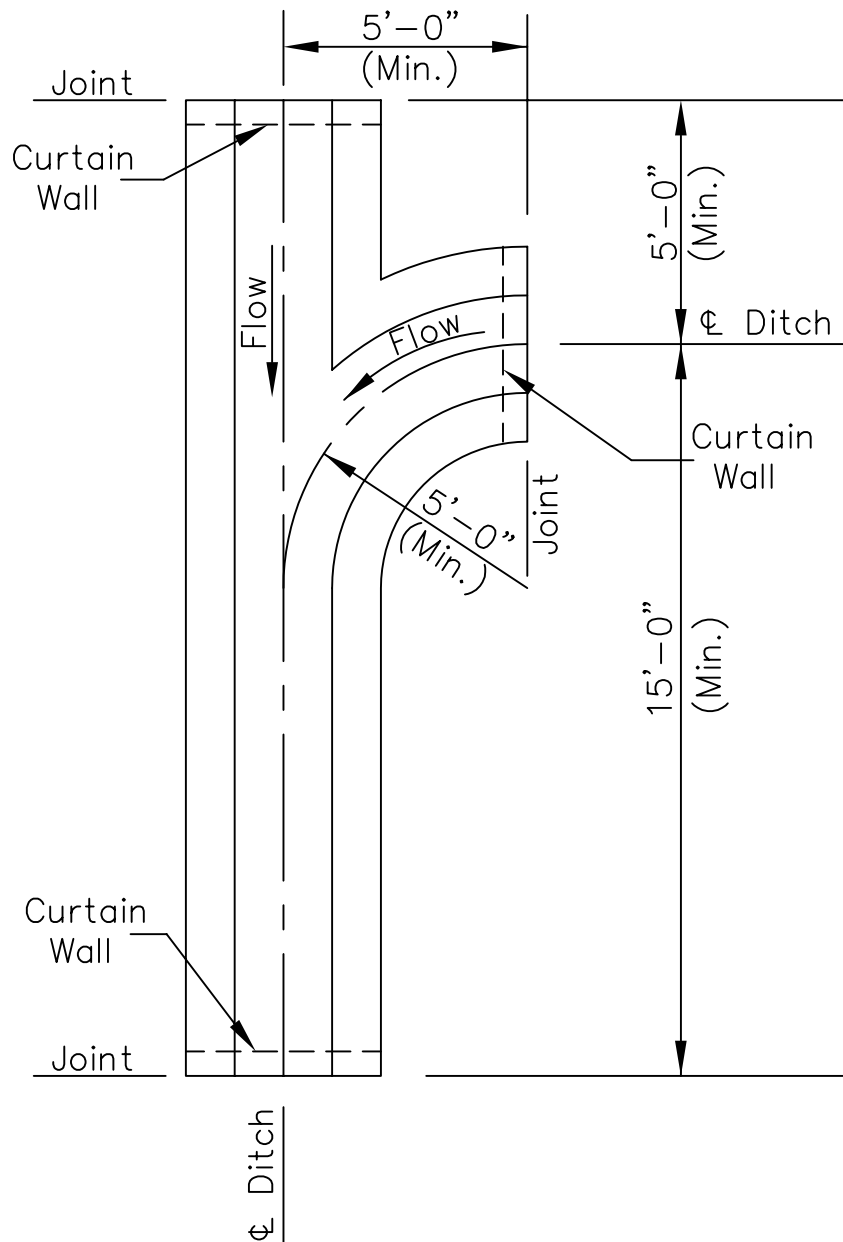
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SLOPED BOTTOM
PAVED DITCH

STANDARD DRAWING NO. SMP-08-03

APPROVED BY: _____
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SUORCE: LOUISVILLE MSD

5'-0"
(Min.)

Joint

Curtain
Wall

Flow

Flow

5'-0"
(Min.)

℄ Ditch

Curtain
Wall

5'-0"
(Min.)

Joint

15'-0"
(Min.)

Curtain
Wall

Joint

℄ Ditch

NOTES:

1. Class "A" concrete with polypropylene fiber.
2. Curtain walls shall be used at beginning and end of ditches.
3. Broom finish perpendicular to flow.

1'-6"

Begin or End
Paved Ditch

8"
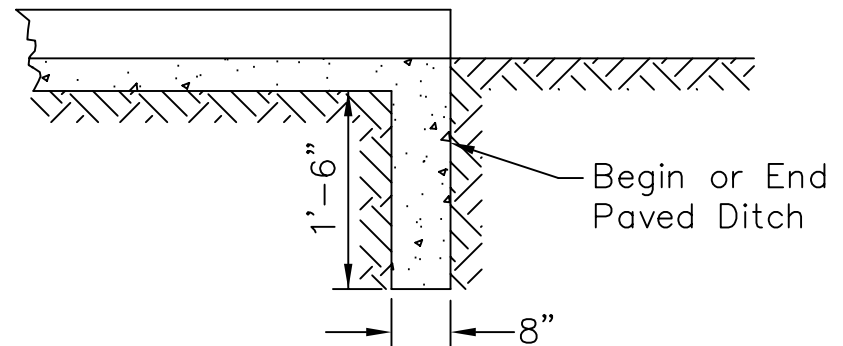
SECTION THRU CURTAIN WALL
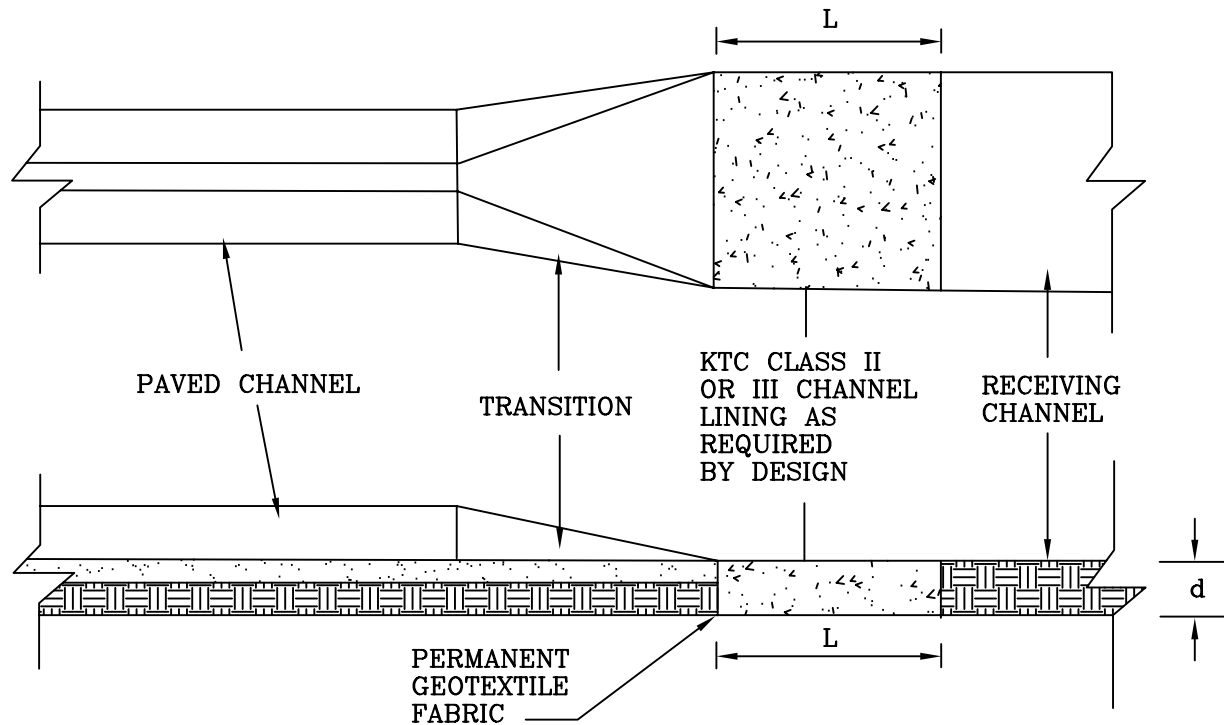
SOURCE: LOUISVILLE MSD

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PAVED DITCH INTERSECTION

STANDARD DRAWING NO. SMP-08-04

APPROVED BY: _____
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L

PAVED CHANNEL

TRANSITION

KTC CLASS II
OR III CHANNEL
LINING AS
REQUIRED
BY DESIGN

RECEIVING
CHANNEL

PERMANENT
GEOTEXTILE
FABRIC

L

d

NOTES:

1. RIPRAP APRON REDUCES THE FLOW VELOCITY BELOW THE PERMISSIBLE
VELOCITY OF THE NATURAL RECEIVING CHANNEL.

2. TRANSITION SIDE DIVERGENCE IS 1 IN 3F, WHERE

F = FROUDE NUMBER = $\dfrac{V}{\sqrt{gd}}$, WHERE

V = VELOCITY AT THE BEGINNING OF THE TRANSITION
d = DEPTH OF FLOW AT THE BEGINNING OF THE TRANSITION
g = 32.2 FT/SEC^2

SOURCE: LOUISVILLE MSD

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PAVED CHANNEL OUTLET

STANDARD DRAWING NO. SMP-08-05

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Installation:

Excavate subgrade below design elevation to allow *for* thickness *of* geotextile filter and riprap. thickness 1.5 times the maximum stone diameter.

Install riprap to a minimum

Compact the fill used in the subgrade to the density of the surrounding undisturbed material.
enough to protect the geotextile blanket *from* tearing.
Placement of the underlying geotextile blanket should be done immediately after subgrade preparation. The upper and lower ends of the blanket should be buried a minimum of 12-inches deep. Care should be taken not to damage the blanket when placing the riprap.

Subgrade should be smooth

Placement of riprap should follow immediately after placing the geotextile blanket. it produces a dense, well-graded mass of stone with minimum voids.
Hand placing the riprap may be necessary to achieve the required grades and a good distribution *of* stone sizes.

The riprap should be placed so that

Immediately following installation, stabilize all disturbed areas with vegetation. Pipe or channel outlets at the top of cut slopes *or* on slopes steeper than 1% should not be protected using just outlet protection as a result of the re-concentration and large velocity *of* flow encountered as the flow leaves the structural apron.

Inspection and Maintenance:

Once properly installed, outlet protection should require little maintenance. However, outlet protection should be inspected periodically to determine if high flow rates have caused erosion and scouring to dislodge any of the stone.

Any necessary repairs should be made promptly. Do not re-install stones above finished grade.

SOURCE: LOUISVILLE MSD

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**PAVED DITCH
OULET NOTES**

STANDARD DRAWING NO. **SMP-08-06**

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