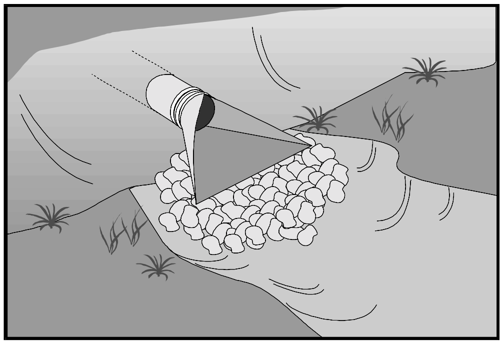
ACTIVITY: Temporary Outlet Protection	TCP – 25



Targeted Constituents				
● Significant Impact		◗ Partial Impact		○ Low or Unknown Impact
● Sediment	○ Heavy Metals	○ Floatable Materials	○ Oxygen Demanding Substances	
○ Nutrients	○ Toxic Materials	○ Oil & Grease	○ Bacteria & Viruses	○ Construction Wastes

Implementation Requirements				
● High		◗ Medium		○ Low
◗ Capital Costs	○ O & M Costs	◗ Maintenance	○ Suitability for Slopes >5%	○ Training

Description

Rock outlet protection is a physical device composed of rock, grouted rip-rap, or concrete rubble which is placed at the outlet of a pipe to prevent scour of the soil caused by high pipe flow velocities, and to dissipate flow energy to produce non-erosive velocities. This management practice is likely to create a significant reduction in sediment by reducing velocities.

Suitable Applications

- Outlet protection is needed where discharge velocities and energies at the outlets of culverts, conduits or channels are sufficient to erode the immediate downstream reach (>3 ft/s). This practice protects the inlet or outlet from developing small eroded pools (3 plunge pools), and protects against gully erosion resulting from scouring at a culvert mouth.
- Outlets of pipes, drains, culverts, conduits or channels.
- Outlets located at the bottom of mild to steep slopes (greater than 4:1 (H:V)).
- Outlets of channels which carry continuous flows of water.
- Outlets subject to short, intense flows of water.
- Where lined conveyances discharge to unlined conveyances.
- Rock outlet protection is best suited for temporary use during construction because it is usually less expensive and easier to install than concrete aprons or other energy dissipaters.
- A sediment trap below the pipe outlet is recommended if runoff is sediment laden.
- Grouted rip-rap should be avoided in areas of freeze and thaw because the grout will break up.

Installation/ Application Criteria

Permanent rip-rap protection should be designed and sized by a licensed professional civil engineer as part of the culvert, conduit or channel design. Rock outlet protection is effective when the rock is sized and placed properly. When this is accomplished, rock outlets significantly limit erosion at pipe outlets. Rock size should be increased for high velocity flows. Best results are obtained when sound, durable, angular or crushed rock is used.

- Rip-rap aprons are best suited for temporary use during construction.
- Carefully place rip-rap to avoid damaging the underlain filter fabric.
- For proper operation of apron:
  - Construct apron at zero grade.
  - Align apron with receiving stream and keep straight throughout its length. If a curve is needed to fit site conditions, place it in the upper section of the apron, placing additional bank reinforcement in the curved section and immediately downstream.
- See figure TCP-25-1 for proper sizing of rip-rap.

Maintenance

- Grouted or wire-tied rock rip-rap can minimize maintenance requirements.
- Inspect temporary measures weekly, before and after rainfall events.
- Inspect apron for displacement of the rip-rap and/or damage to the underlying fabric. Repair fabric and replace rip-rap which has washed away.
- Inspect for scour beneath the rip-rap and around the outlet. Repair damage to slopes or underlying filter fabric immediately.
- Temporary devices should be completely removed as soon as the tributary area has been stabilized, or at the completion of construction.

Limitations

- Large storms can wash away the rock outlet protection and leave the area susceptible to erosion.
- Sediment captured by the rock outlet protection may be difficult to remove without removing the rock.
- Grouted rip-rap may break up in areas of freeze and thaw.
- Grouted rip-rap may break up from hydrostatic pressure without adequate drainage.

Additional Information

Rock outlet protection is usually less expensive and easier to install than concrete aprons or energy dissipaters. It also serves to trap sediment and reduce flow velocities.

As with most channel design projects, depth of flow, roughness, gradient, side slopes, discharge rate and velocity should be considered in the outlet design. Compliance to local and state regulations should also be considered while working in environmentally sensitive streambeds. General recommendations for rock size and length of outlet protection mat is shown in the rock outlet protection figure. Best results are obtained when sound, durable, angular or crushed rock is used. Rock depth and outlet protection lengths are governed by the discharge pipe size, but hydraulic calculations and velocities should be used to determine length.

Primary References

California Storm Water Best Management Practice Handbooks, Construction Handbook, CDM et.al. for the California SWQTF, 1993.

Caltrans Storm Water Quality Handbooks, CDM et.al. for the California Department of Transportation, 1997.

Subordinate References

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Mariposa County, Arizona, September 1992.

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Environmental Criteria Manual, City of Austin, TX, 1989.

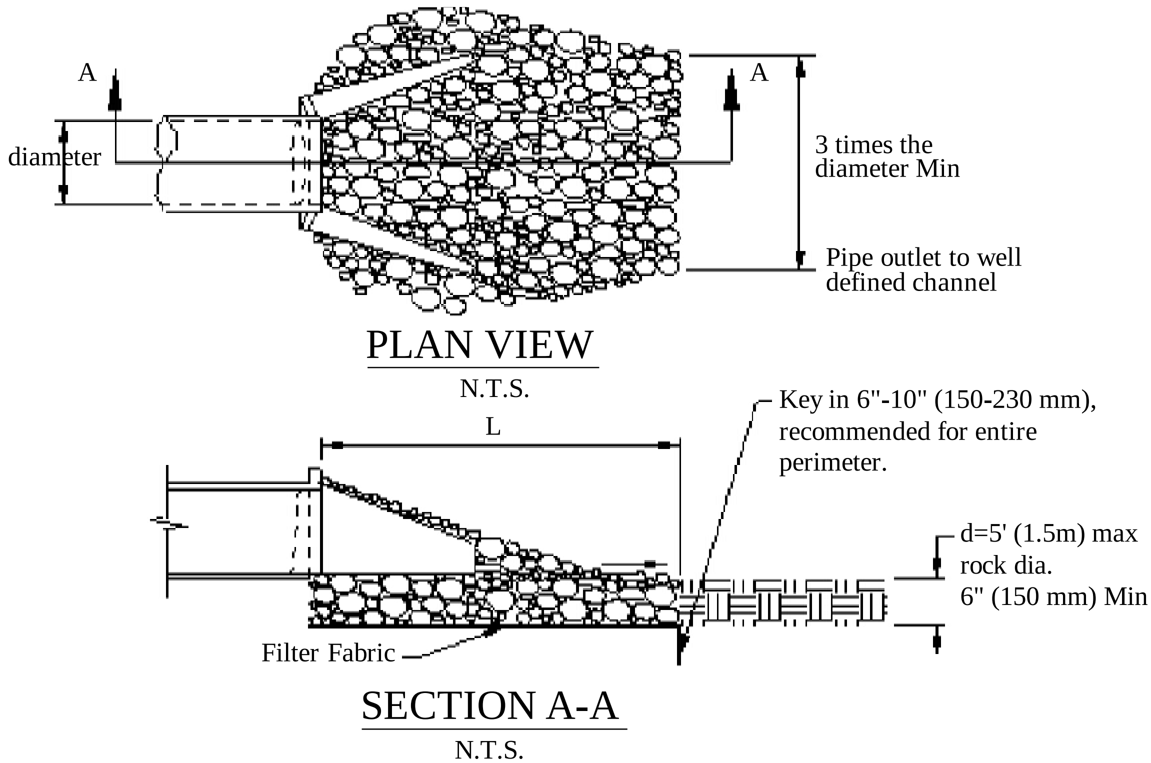
Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursztynsky, P.E., McGraw Hill Book Company, 1986.

Handbook of Steel Drainage & Highway Construction, American Iron and Steel Institute, 1983.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, June 1981.

Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual – February 1992, Publication #91-75.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency – November 1988.



Adapted from: Virginia Erosion & Sediment Control Handbook, 1992

Pipe Diameter in (mm)	Discharge $ft^3/s(m^3/s)$	Apron Length, L ft (m)	Rip-Rap D_{50} Diameter Min in (mm)
12 (300)	4.9 (0.14)	10 (3)	4 (100)
	9.89 (0.28)	13 (4)	6 (150)
18 (450)	9.89 (0.28)	10 (3)	6 (150)
	20.13 (0.57)	16 (5)	8 (200)
	30.01 (0.85)	23 (7)	12 (300)
	39.90 (1.13)	26 (8)	16 (400)
24 (600)	30.01 (0.85)	16 (5)	8 (200)
	39.90 (1.13)	26 (8)	8 (200)
	50.14 (1.42)	26 (8)	12 (300)
	60.03 (1.70)	30 (9)	16 (400)
For larger or higher flows, consult a registered civil engineer			

Source: USDA-SCS

Figure TCP-25-1
Outlet Protection Sizing