4.3-d OUTLET PROTECTION

Alternative Names: Hydraulic Energy Dissipaters, Discharge Apron, Scour Protection, De-energizing Devices, Rock Discharge Armor, Armored Scour Hole

BMP DESIGN APPROACH
■ **Pollutant Source Control**
□ Hydrologic Source Control
□ Stormwater Treatment
SCALE OF APPLICATION
□ All SFR and MFR < 1 acre
■ **MFR 1-5 Acre and CICU < 5 acres**
■ **MFR and CICU > 5 acres and all WQIPs**
TYPE OF APPLICATION
■ **Temporary**
■ **Permanent**

Recently constructed rock outlet protection

DESCRIPTION

Outlet protection structures prevent scour and erosion at discharge outlets by dissipating the energy and reducing velocities. Typical applications include an apron lined with rock riprap, concrete, or vegetation.

APPLICABILITY

- Outlet protection is placed between the runoff conveyance structures and a stabilized drainage or infiltration system. Suitable at outlets of drainage conveyance systems where energy dissipation is needed because of the concentrated flow and increased velocities.
- Outlet protection is particularly appropriate at outlets discharging at the bottom of steep slopes.
- Appropriate for both systems that convey constant flows and those that convey short, intense flows.
- May also be suitable where lined conveyances transition to natural channels.

Advantages

- Prevents scour that may undermine the structure discharging concentrated stormwater runoff, and downslope erosion that may create gullies and scour holes.
- Reduces velocities of concentrated stormwater runoff.

Disadvantages

- May increase erosion if it is not properly designed and installed.
- Increases the cost of outlet installation.
- Requires periodic inspection and maintenance.

DESIGN CONSIDERATIONS

- All outlet protection structures should be designed by a licensed professional civil engineer.
- Select the most appropriate materials for outlet protection. A rock-lined apron is commonly used because it is stable and durable, requires little maintenance, and blends in with the natural environment. Consider using vegetation for outlet protection in channels subject to low volumes and velocities.
- For outlets on slopes steeper than 10 percent, provide additional protection using larger rock to accommodate higher flow energies.
- Base the design of an outlet protection structure on the size of the channel and peak flow volume, and on the peak shear stress of discharging water during the design runoff event.

INSTALLATION CONSIDERATIONS

Construct discharge aprons subject to smaller flows by hand as follows:

- Place a 3 inch to 6 inch filter layer of sand or gravel in a trapezoidal-shaped apron. Filter fabric or an erosion control blanket can be substituted for the filter layer of sand or gravel.
- Construct the apron width at the culvert outlet to be 3 times the culvert diameter.
- Flare the apron out at a ratio of 1 foot laterally for each 2 feet of length, until the apron is 3 times the width of the culvert.
- Manually place a base layer of rocks on top of the apron. The size of the rock is a function of the discharge velocity.

INSPECTION AND MAINTENANCE

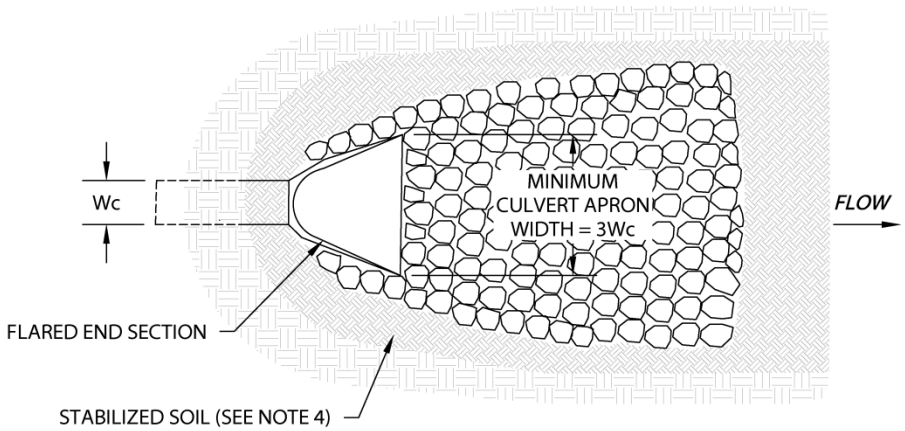
Inspection should include identifying erosion problems, documenting sediment accumulation, and identifying blocked or obstructed stormwater flow. The inspection crew may want to install a staff plate or ruler to monitor sediment accumulation if not already installed. Chronic sediment accumulation indicates a significant sediment source upstream in need of stabilization.

Maintenance crews should be prepared to replace riprap to provide erosion protection and remove accumulated sediment and debris to ensure unobstructed flow. Removal of trash and debris is another common maintenance practice.

EFFECTIVENESS CONSIDERATIONS

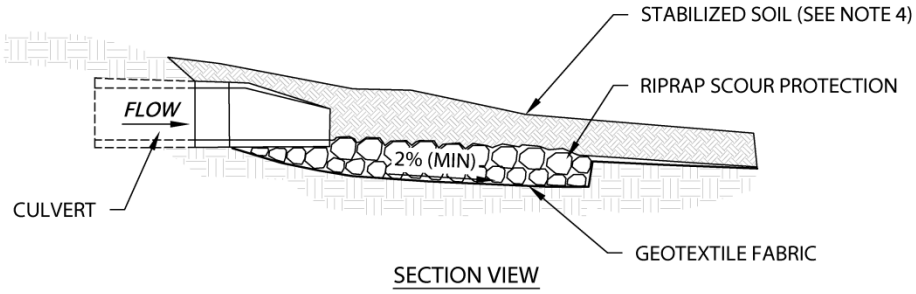
Outlet protection structures are effective at preventing erosion and scour at the end of a stormwater pipe discharge location if they are properly designed and installed.

Outlet Protection Figure



PLAN VIEW

Wc = WIDTH OF CULVERT



SECTION VIEW

NOTES:

1. THE MINIMUM THICKNESS OF RIPRAP SHOULD BE 1.5 TIMES THE MAXIMUM STONE DIAMETER, BUT NOT LESS THAN 4".
2. INSTALL FABRIC TO PREVENT SOIL EROSION BENEATH RIPRAP.
3. RIPRAP MAY BE INSTALLED USING MECHANICAL EQUIPMENT. AVOID DAMAGING FABRIC.
4. STABILIZE ALL DISTURBED AREAS IMMEDIATELY AFTER CONSTRUCTION.
5. INSPECT RIPRAP OUTLET STRUCTURES AFTER HEAVY RAINS AND SPRING SNOWMELT. REPAIR AS REQUIRED.

Outlet Protection Inspection and Maintenance Table

INSPECTION AND MAINTENANCE ACTIVITIES	SUGGESTED FREQUENCY	INSPECTION EQUIPMENT	MAINTENANCE EQUIPMENT
Inspect that conveyance is unobstructed and able to access the outlet protection. ▪ Repair any blocked or diverted conveyances.	Monthly (April–Oct) and before major storms		Trash Bag Shovel
Inspect for trash and debris. ▪ Remove trash and debris from the area.	Monthly (April–Oct)		Trash Bag
Inspect for erosion, scour, and undercutting, especially at the drainage outlet and along the edges of the outlet protection. ▪ Stabilize eroded and undercut areas. ▪ Improve outlet protection to dissipate energy and prevent future erosion.	Monthly (April–Oct)		Additional Armor Rocks and Tools as needed
Inspect for invasive weeds[1]. ▪ Remove invasive weeds monthly during the first two growing seasons. Thereafter, weed annually, or as needed.	Monthly during first growing season and annually thereafter	Invasive Weeds Inspector	Tools as needed to control infestation
Inspect for accumulated sediment and debris. Measure depth of sediment and mark where measurement was taken. ▪ If accumulated material has covered outlet protection, removal of material is needed. ▪ Remove accumulated sediment with vactor truck or shovel and dispose of sediment at a TRPA approved stable on-site location or out of the Lake Tahoe Region. ▪ If chronic sediment accumulation is a problem consider retrofitting a sediment trap upstream to ease sediment removal. ▪ Stabilize eroding slopes and bare soil areas to prevent sediment entry into conveyance system. ▪ Routinely sweep the street/driveway to remove sediment before it enters the conveyance system.	Semi-annually (spring and fall) and after major storms	Staff Plate, Stadia Rod or Ruler	Shovel, Backhoe, or Vactor Truck Pickup or Dump Truck
Inspect site for unusual or unsafe conditions and structural damage especially displaced rocks. ▪ Repair components as necessary to restore proper function.	Annually in spring	Qualified Individual (safety/structural condition)	Tools as needed
Monitor ongoing effectiveness and determine whether another BMP type or additional BMPs could improve long-term effectiveness and improve benefits to costs versus the existing outlet protection. ▪ Analyze Inspection and Maintenance Log for trends and recurring issues. ▪ Prepare a plan that more effectively addresses stormwater capture, reduces long term maintenance costs and improves overall effectiveness and safety of the BMP.	Every 5 years	Qualified Inspector or Consultant	Qualified Inspector or Consultant

[1] Lake Tahoe Basin Weed Coordinating Group. http://www.tahoeinvasiveweeds.org/.