

4.3-j ROCK LINED AND VEGETATED SWALE

Alternative Names: Permanent Waterway, Drainage Ways, Riprap Channel



Rock lined swale surrounded by vegetation.

DESCRIPTION

Rock lined and vegetated swales are conveyance systems designed, shaped, and lined to convey surface runoff in a non-erosive manner downstream, preferably to a treatment and/or infiltration system. The primary function is to convey stormwater runoff and there is minimal water quality benefit; however, rock lined and vegetated swales may decrease the velocity of water and facilitate some infiltration. Vegetated swales may have the added benefit of filtering stormwater as it flows through the swale. A vegetated swale is not to be confused with a bioswale, whose primary purpose is biofiltration and detention, not collection and conveyance. Refer to Section 4.4-b, Bioswale, for more details regarding these systems.

APPLICABILITY

- Swales are suitable in all drainage systems which collect, concentrate, and convey stormwater at the ground surface. Swales can be used to convey runoff both to and from underground storm drain systems.
- Special design consideration should be given for swales adjacent to plowed snow areas, snow storage areas, or areas receiving runoff from snow that has accumulated significant amounts of sand or other winter abrasives. Sand and abrasives applied during the winter months can quickly fill rock-lined and vegetated swales, which are difficult to maintain.

BMP DESIGN APPROACH

- | | |
|--------------------------|---------------------------|
| <input type="checkbox"/> | Pollutant Source Control |
| <input type="checkbox"/> | Hydrologic Source Control |
| <input type="checkbox"/> | Stormwater Treatment |

SCALE OF APPLICATION

- | | |
|-------------------------------------|--------------------------------------|
| <input checked="" type="checkbox"/> | All SFR and MFR < 1 acre |
| <input checked="" type="checkbox"/> | MFR 1-5 Acre and CICU < 5 acres |
| <input checked="" type="checkbox"/> | MFR and CICU > 5 acres and all WQIPs |

TYPE OF APPLICATION

- | | |
|-------------------------------------|-----------|
| <input type="checkbox"/> | Temporary |
| <input checked="" type="checkbox"/> | Permanent |

Advantages

- Swales may be less expensive to install than other conveyance measures.
- Prevents the discharge of stormwater runoff from the site.
- Vegetated swales may enhance the aesthetics of a property.
- Swales have the added benefit of reducing velocities, infiltrating, and filtering stormwater compared to other collection and conveyance systems that have no contact with the underlying soil.

Disadvantages

- Converts sheet flow to channel flow, which may increase flow velocities and erosive energy.
- Concentrates the volume of runoff.
- Vegetated swales are not practical on slopes greater than 6 percent or when velocities are high.

DESIGN CONSIDERATIONS

- Ensure that the swale has sufficient capacity to convey a 10-year, 24-hour storm and is resistant to erosion during the peak flow.
- Line all swale regardless of slope. In choosing linings, consider flow velocities, cost, aesthetics, desirability of infiltration, and maintenance. Use permeable lining materials to promote infiltration unless the slope is unstable or steep, in which case design an impermeable lining. Permeable lining materials include vegetation, rock, or a combination of both.
- Determine the capacity of the swale and the velocity of flow from the type of swale lining, cross-sectional area and shape, and the slope of the swale.
- Give priority consideration to vegetated swales because they have the capability to filter sediment and uptake nutrients as well as being aesthetically pleasing. Vegetated swales may provide the entire stormwater conveyance system and have several advantages over rock lined swales; however, they require more space and are not suitable on steep slopes.
- If the slope exceeds 3 percent incorporate check dams to decrease the velocity and promote infiltration. Vegetated swales shall in no case exceed 6 percent.
- Choose native vegetation that establishes a dense cover and is tolerant to varying degrees of saturation.
- Use rock-lined swales to withstand high velocities (3-10 feet per second), using larger rock for the greater flow velocities. Consider incorporating sediment traps or check dams into the swale system at specific, regular intervals to encourage sedimentation, where high rates of sedimentation occur.

INSTALLATION CONSIDERATIONS

- Use qualified professionals to design and install permanent swales.
- For installation on private property, install swales within the property boundaries and not within public rights-of-way, and do not design them to convey water to a public right-of-way.
- Install small riprap-lined channels as follows:

- Size the channel to convey the peak flow during the design storm (10-year, 24-hour storm).
- Place a layer of filter fabric in a channel and up to at least 0.5 feet above the water surface during the design storm.
- Place a layer of riprap on top of the filter fabric, using a rock size gradation that will be stable during the design flood, as determined by a licensed civil engineer.

INSPECTION/MAINTENANCE

A pretreatment BMP designed to remove trash and allow coarse sediment to settle out may ease the maintenance burden for the vegetated or rock lined swale. Refer to the Rock Lined and Vegetated Swale Inspection and Maintenance Table.

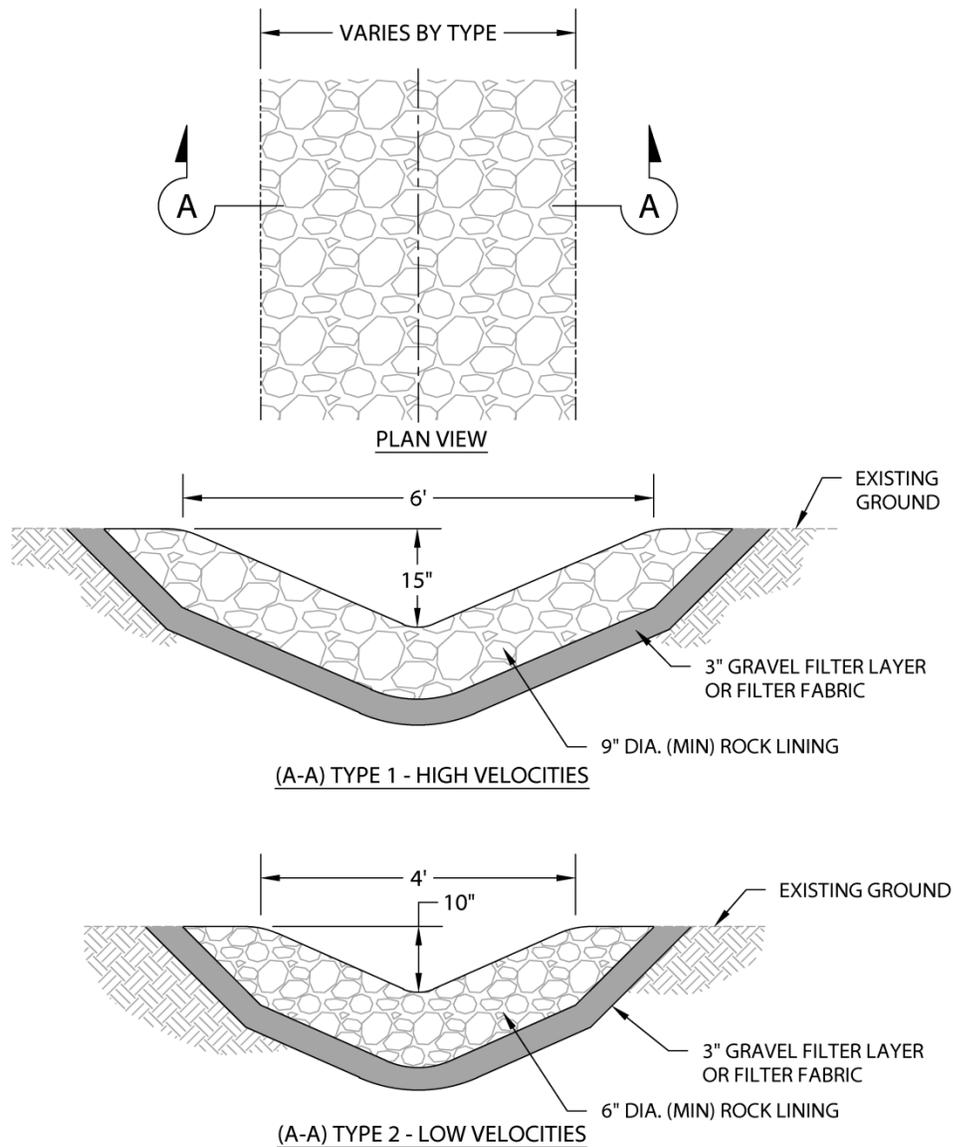
EFFECTIVENESS CONSIDERATIONS

- High maintenance costs can reduce the effectiveness of rock-lined channel.
- They are effective if properly designed and installed as part of a drainage system.

Rock Lined and Vegetated Swale Inspection and Maintenance Table

INSPECTION AND MAINTENANCE ACTIVITIES	SUGGESTED FREQUENCY	INSPECTION EQUIPMENT	MAINTENANCE EQUIPMENT
Inspect for signs that runoff is properly accessing and being conveyed by the swale. <ul style="list-style-type: none"> ▪ Repair any blocked or diverted conveyances. ▪ If standing water remains 96 hours after a storm, vector control for mosquitoes and rehabilitation of the swale is needed. 	Before and during major storms		Trash bag Shovel
Inspect for trash and debris. <ul style="list-style-type: none"> ▪ Remove trash and debris from swale. 	Monthly (April–Oct)		Trash bag
Inspect for erosion and undercutting, especially along the swale bottom and adjacent slopes. <ul style="list-style-type: none"> ▪ Stabilize eroded and undercut areas. ▪ Improve swale lining to dissipate energy. 	Monthly (April–Oct)		Erosion Control Blanket, Coir Logs
For vegetated swales: Inspect for successful vegetation establishment (80% cover) and initial die off to determine if any remedial actions are needed, such as reseeding and irrigation the first year. <ul style="list-style-type: none"> ▪ Amend soils, reseed/replant, mulch, and irrigate as necessary to achieve desired vegetative establishment. ▪ Flows may have to be redirected if major work to the swale exposes bare soil for an extended time period. 	Monthly during first growing season	Vegetation Inspector	Soil Amendment Seeds/Plants Mulch Irrigation
For rock lined swales: Inspect for dislodged or unstable rock and any erosion, especially along the channel bottom and adjacent slopes. <ul style="list-style-type: none"> ▪ Repair dislodged or unstable rock. ▪ Stabilize eroded and undercut areas. 	Monthly (April–Oct)		Tools as needed to replace rock and address erosion
Measure depth of sediment to determine accumulated depth. <ul style="list-style-type: none"> ▪ If accumulated material has decreased swale capacity by 10%, is deeper than 3" in any spot or covers vegetation, removal of accumulated material is needed. ▪ Scrape bottom (shovel, backhoe, or vactor) to remove sediment and restore original cross-section. ▪ Dispose of sediment at a stable on-site location or outside of the Lake Tahoe Region. ▪ Aerate the bottom of swale to restore Ksat rate and reseed/replant if necessary. 	Semi-annually (spring and fall) and after major storms	Staff Plate, Stadia Rod, or Ruler	Shovel, Backhoe, or Vactor Truck Pickup or Dump Truck Aerator for basin bottom
For vegetated swales: If vegetation exceeds 12", mow to 6" height, use care (such as not mowing while ground is moist) to avoid excess compaction. <ul style="list-style-type: none"> ▪ Remove and compost cut vegetation from the site to avoid release of sequestered nutrients. 	Spring and fall	Qualified inspector	Clippers, Loppers Mower, Trash Bag
Inspect site for unusual or unsafe conditions (snowplow damage, structural damage, dumping, vandalism, etc.). <ul style="list-style-type: none"> ▪ Repair structural components as necessary. 	Annually in spring		Tools as needed
Inspect for animal burrows, holes, and mounds. <ul style="list-style-type: none"> ▪ If burrows are causing erosion or compromising structural integrity, backfill firmly. 	Annually in fall after vegetation trimming		Tools as needed to repair
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 riprap. <ul style="list-style-type: none"> ▪ Prepare a plan that more effectively addresses soil stabilization, 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

Rock Lined Swale Figure

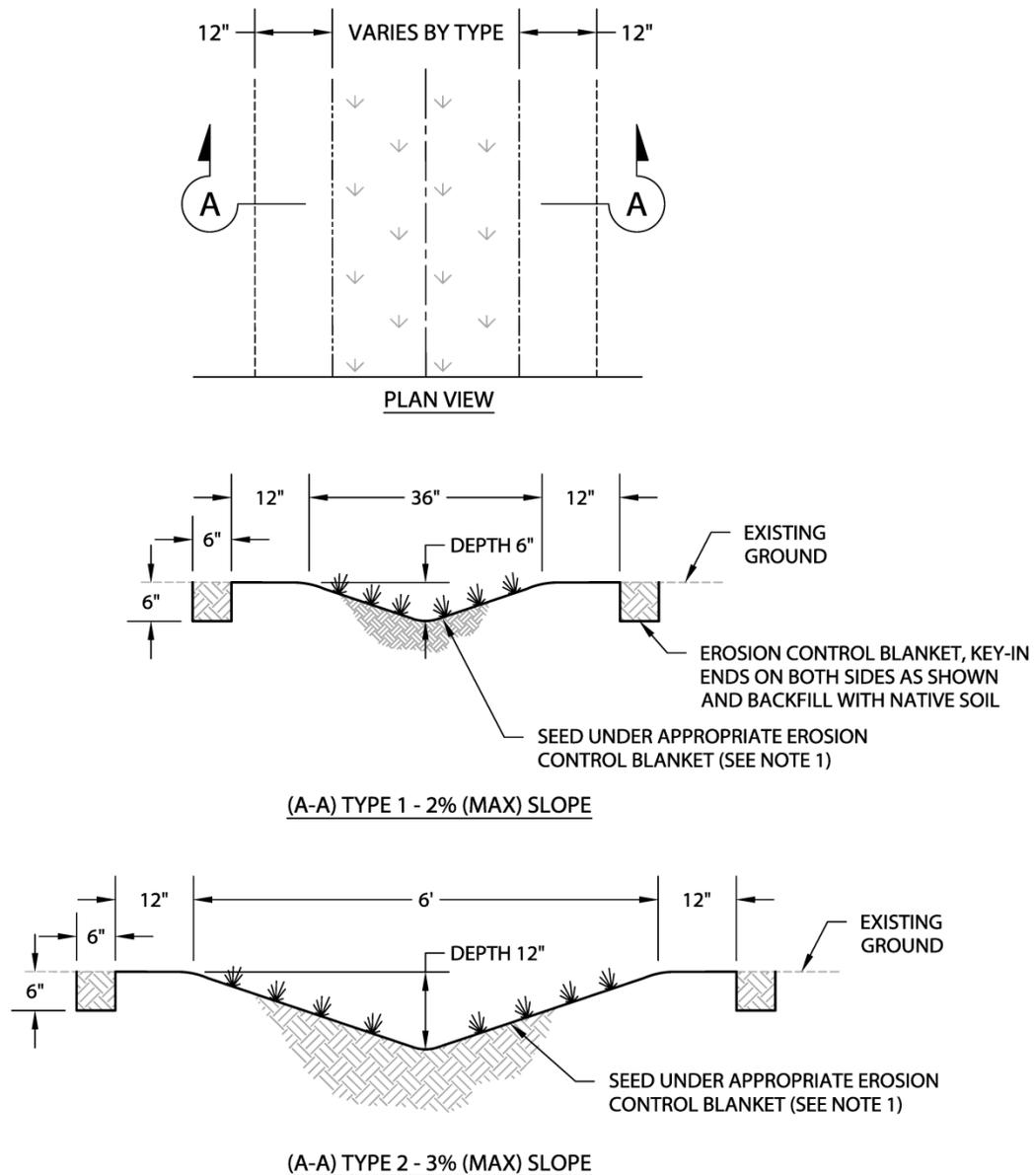


NOTES:

1. ROCK LINING TO BE INSTALLED TO FORM A STABLE STRUCTURE WITH A MINIMUM OF VOIDS, AND EACH PLACED IN CONTACT WITH ADJACENT ROCKS.
2. ROCK LINING SHALL BE SOUND, DENSE, AND DURABLE ANGULAR ROCK WITH A MINIMUM SPECIFIC GRAVITY OF 2.6.
3. ROCK LINED CHANNELS LARGER THAN THE DIMENSIONS SHOWN, OR ON SLOPES STEEPER THAN 5% SHALL BE DESIGNED BY A CIVIL ENGINEER.
4. IF A GRAVEL FILTER LAYER IS SUBSTITUTED FOR FILTER FABRIC, MATERIAL SHALL BE A MIXTURE OF CLEAN, WASHED SAND AND GRAVEL, COMPRISED OF MATERIAL LESS THAN 1 1/2" DIA. IN SIZE.
5. CHECK DAMS MAY BE INSTALLED IN ROCK LINED SWALE DEPENDING UPON APPLICATION AND SITE CONDITIONS. SEE BMP-310.

THE TAHOE REGIONAL PLANNING AGENCY (TRPA) SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS DETAIL.

Vegetated Swale Figure



NOTES:

1. FOR NON-PERMITTED PROJECTS, PREPARE SOIL AND SEED IN ACCORDANCE WITH THE TRPA BMP HANDBOOK. FOR PERMITTED PROJECTS, PREPARE SOIL AND SEED PER SPECIFICATIONS OF REVEGETATION PLAN.
2. THE APPLICABILITY OF THIS DETAIL TO A SLOPE STEEPER THAN RECOMMENDED SHOULD BE VERIFIED BY THE APPROPRIATE REVIEW AGENCY AND/OR ENGINEER.
3. INSTALL INLET OR OUTLET PROTECTION.

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