

4.3-a CULVERT

Alternative Names: Cross Drain

DESCRIPTION

A culvert is a conduit allowing unimpeded passage of water under a highway, street, driveway, or trail. A strategically placed culvert can help distribute water to a desired location, such as a vegetated swale. Modern culverts are hydraulically designed and installed to address both stream grade control and fisheries passage issues. Culverts are comprised of different materials such as corrugated metal pipe, reinforced concrete pipe, and polyethylene.

Culverts typically have no water quality benefits by themselves; however, in a developed watershed they are often a necessary component of a drainage system.



Culvert conveying stormwater under a road and discharging to a vegetated swale.

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

APPLICABILITY

- Culverts are applicable to permanent roads, driveways, or trails crossing a surface drainage system including streams.
- In the Lake Tahoe Region, culverts may be blocked by snow. For this reason it is important to ensure a culvert gradient at least 2 percent steeper than ground slope, to minimize pooling of water behind snow dams. Pooled water may freeze and block flow paths.

Advantages

- Results in a durable, uninterrupted flow pathway for stormwater, surface water, and/or groundwater to pass beneath a road or trail, without causing upstream or downstream channel erosion, road/trail washout, or flooding.
- Minimize stormwater runoff entering surface waters directly from road surfaces and drainage ditches.
- Modern culverts have the proper hydraulic design to facilitate fish passage, including upstream migration of adults and downstream migration of juveniles.

Disadvantages

- Concentration of stream flow through culverts tends to increase velocities, which may result in downstream channel erosion.
- Concentration of stream flow through long culverts or piped storm drain systems reduces the time of hydraulic concentration, thus increasing peak runoff.
- Culverts require ongoing maintenance due to accumulation of sediment and debris.
- Improperly sized or installed culverts, or plugged culverts, may result in streams overtopping their banks and causing road/trail washout.

DESIGN CONSIDERATIONS

- The following guidelines are water quality design considerations for culverts. Refer to applicable drainage design manuals within the responsible jurisdiction for requirements associated with structural integrity, drainage design, public safety, and other factors.
- Culverts should be designed by a qualified hydrologist or licensed professional civil engineer.
- Specify the following elements during culvert design: culvert size, alignment, and grade; type of material comprising the culvert; inlet and outlet structures; sediment and debris control; and energy dissipation.
- Avoid abrupt changes in direction of flow, as they can cause erosion and increase the potential for blockage.
- Design culverts to accommodate the bankfull flow of the stream or drainage way, to prevent washouts and culvert failure. At a minimum, culverts draining roadside ditches shall be designed for the 10-yr/24-hr storm and culverts for stream crossings shall be designed to the 50-yr/1-hr storm.

- Design energy dissipaters at culvert outlets/outfalls as needed to prevent scour and erosion.
- Design culverts to accommodate the natural drainage pattern and to prevent upstream or downstream channel adjustments.
- When channels may be unstable, design culverts in a manner that will maintain existing channel profiles.
- Design culverts with at least 2 percent gradient to limit standing water and to reduce the chance for ice formation.
- When fish migration is a concern, design culverts such that inlets and outlets allow fish passage. Check with the local Fish and Wildlife Department for design specifications.
- The edge of the culvert should be rounded or flared to improve flow into it.

INSTALLATION CONSIDERATIONS

- Install culverts when flows are low and a storm event is not expected. Complete installation before the next storm event whenever possible.
- Minimize disturbance of stream channels during construction. If stream flow will be present during installation, divert stream flow with a clean water diverter (Refer to Section 4.5-d Clean Water Diversion) and discharge to a stable stream channel downstream of the construction site.
- Ensure that all temporary BMPs required for culvert installation are installed and functional prior to construction. Temporary BMPs include fiber rolls, silt fences, clean water diverters, vegetation protection, and outlet protection.
- Align and set elevation of culverts to provide continuity with the existing stream channel thalweg.
- Install a device providing coarse-debris control, if debris accumulation may be substantial at the culvert site.
- Install a culvert riser if substantial sediment is expected to accumulate.

INSPECTION AND MAINTENANCE

- Inspect culverts semiannually, after the spring snowmelt and before winter begins. Inspect for flow obstruction, sediment accumulation, structural integrity, and safety hazards.
- Culverts comprised of different materials deteriorate at different rates and by different processes. Corrugated metal is subject to corrosion particularly along the bottom of the pipe. Concrete is subject to spalling (chipping and fragmentation). Polyethylene becomes brittle due to ultra-violet deterioration. The inspection crew must tailor the inspection toward the type of material present to ensure that deterioration has not compromised function. Once a culvert cracks or deteriorates, water will undermine the system and start to erode the stormwater system foundation.
- Many culverts are accessible only through manholes or grates; a manhole cover hook is convenient for removing these covers.
- Regularly sweep streets to reduce maintenance cost of culverts.

- Consider periodically video inspecting culverts that cannot be completely viewed, starting when the culverts are around 15 years old.

EFFECTIVENESS CONSIDERATIONS

- Culverts are only effective if they are properly installed in accordance with the design criteria.
- Effectiveness is lost once the culvert is clogged with sediment and debris.

Culvert Inspection and Maintenance Table

| INSPECTION AND MAINTENANCE ACTIVITIES | SUGGESTED FREQUENCY | INSPECTION EQUIPMENT | MAINTENANCE EQUIPMENT |
|--|--|---|--|
| Inspect that the culvert properly captures and conveys runoff. <ul style="list-style-type: none"> ▪ Repair any blocked or diverted conveyances. | Annually in spring and during major storms | Manhole Cover Hook Socket set | Manhole Cover Hook, Socket Set, Shovel Vector Truck |
| Inspect for and document any trash, debris, and accumulated sediment at the inlet, outlet, and in the culvert. <ul style="list-style-type: none"> ▪ Remove any trash, debris, and sediment from the culvert and at the inlet and outlet. | Monthly (April–Oct) | Manhole Cover Hook Socket set Stadia rod or Ruler | Manhole Cover Hook, Socket Set, Shovel Trash Bag, Vector Truck |
| Inspect culvert for structural integrity. This is best performed after cleaning the culvert of debris. Use a screwdriver on metal pipes to probe for corrosion, deterioration, and durability. <ul style="list-style-type: none"> ▪ Repair or replace structurally damaged culverts. ▪ Reform crushed ends of metal culverts with a long pry bar and mark or protect ends from further damage. | Annually in spring | Manhole Cover Hook Socket set Screwdriver | Manhole Cover Hook, Socket Set, Long Pry Bar, Tools as needed to repair or replace |
| Inspect for erosion, undercutting, and scour, especially at the inlet and outlet and to any fill burying the culvert. <ul style="list-style-type: none"> ▪ Stabilize eroded and undercut areas. ▪ If necessary, backfill and compact supporting soil around culvert to ensure structural stability and proper function. | Annually in spring and after major storms | Manhole Cover Hook Socket set | Manhole Cover Hook, Socket Set, Rock Armor, Fill Dirt |
| Inspect upslope areas for contributing sediment sources to reduce the accumulation of sediment in the culvert. <ul style="list-style-type: none"> ▪ Stabilize contributing eroding slopes and bare soil areas to prevent sediment entry into culvert. ▪ Routinely sweep the street to remove sediment before it enters culvert and stormwater system. | Annually in spring and before major storms | | Tools as needed to stabilize slopes and bare soil areas, Streetsweeper |
| 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 | Manhole Cover Hook Socket set | 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 culverts. <ul style="list-style-type: none"> ▪ Prepare a plan that more effectively addresses water conveyance, 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 |
| Video inspect inaccessible culverts. <ul style="list-style-type: none"> ▪ Analyze video and prepare maintenance plan to restore safe/structural/unobstructed conditions. | Every 5 years starting at 15 years old | Robotic Video Camera | Tools as needed |

