7.0 Stabilized Conveyance

Definition: Stabilized conveyance structures are designed to carry runoff in a non-erosive manner to a receiving water or storm drain system.

Purpose: To convert sheet flow to channel or pipe flow and convey concentrated runoff water to a treatment structure or natural waterway without causing erosion.

Applicability: Conveyance structures are applicable for the collection and transport of runoff from impervious surfaces and other areas where the natural drainage regime has been altered by human activity. Stabilized conveyances are particularly appropriate along sloped road shoulders where accelerated stormwater flows may cause significant erosion. Improved conveyances are also used at the top of slopes to divert run-on from adjacent slopes and at the bottom and mid-slope to intercept sheet flow. Conveyance should only be considered after near-source treatment options have been considered.

Advantages: Prevents accelerated erosion caused by the discharge of runoff from roadside shoulders. Some conveyance structures can also provide treatment via infiltration and filtration.

Disadvantages: Concentrates the volume of runoff and increases flow velocities. Diverting flows from natural waterways may reduce riparian vegetation habitat.

Effectiveness: In order to limit sediment loads associated with storm water flows, streets and roadways should be designed to drain runoff from roadway surfaces into lateral runoff collection structures. Once roadway runoff has been collected, it must be transported to an appropriate treatment structure before discharge to natural waterways. Such transport can occur by closed underground pipes, open channels, or a combination of the two.

Underground conveyances include:

- **7.1 - Culverts**
- **7.2 - Storm drains**

Open channels are generally:

- **7.3 - Curb and gutter**
- **7.4 - Rock-lined ditches**
- **7.5 - Vegetated ditches/swales.**

When conveyed runoff is released to a waterway or to an erodible surface, the energy from high flow velocities must be dissipated using outlet protection structures such as:

- **7.6 - Flared culvert end sections**
- **7.7 - Discharge aprons**
- **7.8 - Level spreader**

References

More detailed construction specifications can be found in:

CalTrans. 2000. Statewide Storm Water Quality Practice Guidelines.

Goldman, et al. 1986. Erosion and Sediment Control Handbook. McGraw Hill.

TRPA. 1988. Handbook of Best Management Practices

Underground Conveyances

Definition: Pipes placed below grade to collect and convey surface runoff in non-erodible conduits to a stable discharge point.

7.1 Storm Drains

Please read section 7.0 for important information applicable to all stabilized conveyances.

Underground storm drain systems are preferred in heavily developed commercial or residential areas. When possible, storm drains should follow the same alignment as the original drainage. Large angular changes in alignment should be avoided and debris control devices such as trash racks should be used to prevent clogging and damage from flooding. A qualified professional engineer should conduct design and installation.

7.2 Culverts

Please read section 7.0 for important information applicable to all stabilized conveyances.

Culverts are conduits used to provide free passage of surface drainage under a highway, street, or driveway. Factors to consider in the design of culverts are: culvert alignment, culvert grade, culvert length, culvert geometry, debris control, allowable headwater, and energy dissipation. If fish are present, ensure adequate passage. Bottomless arch culverts may be appropriate where fish passage and bed load transport are important. Perforated culverts may be used to allow a portion of the flow to infiltrate into surrounding soils. In general, a qualified professional engineer should oversee design and installation.

Open Channels

Definition: A permanent, human-made or altered waterway designed, shaped, and lined or vegetated to convey surface runoff.

7.3 Curb and Gutter

Please read section 7.0 for important information applicable to all stabilized conveyances.

Curb and gutters are concrete or asphalt structures used to collect and convey surface runoff from paved streets, parking lots, or other impervious surfaces.

Advantages:

- Prevents the discharge of degraded runoff water from roadside shoulders and adjacent slopes.
- Allows for easy and cheap maintenance – sweeping and Vactor removal of collected sediments.
- Protects roadside soils from accelerated erosion.
- May help control vehicle parking and access (if using vertical curb).
- Protects soil from disturbance during snow removal.

Disadvantages:

- Concentrates runoff volume and increases flow velocity.

- Reduces or eliminates possible on-site infiltration.
- Increases peak runoff, which can negatively impact downstream areas.
- Asphalt curb and gutters may be damaged by snow removal equipment.
- Curb and gutter can dramatically change the character of a rural neighborhood, resulting in a more urban appearance.
- Rolled curb and gutter allow vehicle access to road shoulders causing compacted soils and damaged vegetation. Additional barriers may be needed to keep vehicles off unpaved areas.

Tips for Curb and Gutter Installation:

1. To meet most transportation department safety standards, curb and gutters should be placed back from the travel way a minimum of 4 feet – Additional width provides for even greater safety.
2. Placement should allow for some snow storage during snow removal activities.
3. Rolled curb (opposed to vertical curb) is better for snow removal and may be safer (not a vehicle barrier).
4. Source control is important to prevent mass wasting directly into curb and gutter systems.

Field Experience:

- Crystal Bay ECP – concrete curb and gutter placed near the edge of the pavement due to steep slopes and limited space has created a problem for snow removal.
- Washoe County reports curb and gutter installed as part of several projects would be more effective if it were placed further from travel way.
- Ski Way Water Quality Improvement Project – curb and gutter was installed 4-6 feet from the old edge of the pavement. A paved gutter was installed between the pavement and the curb and gutter to allow room for snow storage. Sediment and debris also collects in the paved gutter, allowing for easy removal.
- Placer County and the City of South Lake Tahoe no longer use vertical curb.
- TRPA's BMP Retrofit Program recommends rolled curbs.

7.4 Rock-Lined Ditch

Please read section 7.0 for important information applicable to all stabilized conveyances.

Rock-lined ditches are permanent channels constructed of riprap designed to convey storm water flows, reduce runoff velocities, and allow for infiltration.

Advantages:

- Prevents erosion from uncontrolled surface flows along roadways.
- Stabilized conveyance offers limited treatment and retention to attenuate stormwater peak flows.
- If located behind a curb, can capture run-on as well as runoff
- If planned for, may allow for vegetation between rocks.

Disadvantages:

- Grade changes cause plugging – if plugged, may cause erosion.
- If sediment loads are high, rock lined ditches require extensive maintenance.
- Maintenance is expensive – mostly hand work.
- Rock lined ditches allow for limited nutrient uptake.

- May accumulate unsightly trash.

Tips for Rock Lined Ditch Installation:

1. Proper rock size must be determined by a qualified professional to prevent displacement during peak flows and prevent disturbance during maintenance activities.
2. Use angular or fractured rock to help prevent displacement.
3. Avoid placing directly adjacent to roadways where they can collect road abrasives – use curb and gutter and drop inlets and pretreatment vaults before discharging to rock lined ditches.
4. Aesthetic issues such as rock color should be considered. When possible, design features to help create a natural appearance.
5. Ditch must be sized by a qualified professional engineer.

Field Experience:

- Washoe County has had extensive problems with several projects. Improperly designed rock lined ditches frequently plug with debris causing elevated maintenance costs and premature shoulder erosion. Some ditches have failed completely, losing rock shortly after construction.
- El Dorado County has had success using rock lined ditches on several projects. On Pioneer Trail, fractured rock measuring 16 inches by 18 inches was installed using method A placement (long axis sticks into channel). There has been no significant displacement for nearly 10 years. For the Apache 2 and Ottowa projects, rock lined ditches were installed on 2:1 slopes and provide 18 inches of storage. There has been no rock rotation since installation. Rock lined ditches were also successfully installed as part of the North Upper Truckee Road project.
- The California Tahoe Conservancy reports success with rock lined ditches installed on slopes of 10-70%. Over-sizing allows for flow path integrity even with moderate debris deposition.
- Placer County has found the cost/benefit of implementing rock lined ditches prohibitive due to labor intensive maintenance.

7.5 Vegetated Ditch/Swale

Please read section 7.0 for important information applicable to all stabilized conveyances.

Vegetated ditches are shallow, vegetated depressions designed to convey runoff. The grass in the swales slows the flow of runoff water, which allows sediment to settle out and water to infiltrate into the soil.

Advantages:

- Prevents erosion from uncontrolled surface flows along roadways.
- Allows for infiltration – provides treatment and helps attenuate peak flows.
- Can be aesthetically pleasing.
- Vegetation may improve nutrient removal efficiency (Ref?)

Disadvantages:

- If vegetation is not well established, the conveyance may prove unstable.
- May be subject to erosion during winter when vegetation is dormant.

- Not well suited for conveying large volumes of runoff; allowable velocities are lower than for other structures.
- May accumulate unsightly trash.

Tips for Installation:

1. Guidelines for establishing sustainable vegetation can be found Chapter 4.0 - Revegetation.
2. Do not install where erosive forces may overcome vegetative stability.
3. Use erosion control blanketing during initial installation to prevent erosion during vegetative establishment.
4. Where possible, use existing vegetated swales for storm water conveyance. Consider the impact of elevated flows and determine if additional stabilization is necessary.
5. Flat-bottomed or rounded cross sections are preferred. Flows will be less concentrated and thus less erosive.

Field Experience:

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Outlet Protection Structures

Definition: A structure designed to control erosion at the outlet of a channel or conduit by reducing flow velocity and dissipating flow energy.

7.6 Culvert End Sections

Please read section 7.0 for important information applicable to all stabilized conveyances.

Culvert end sections are designed to improve hydraulic operation, retain the embankment near pipe conveyances, and to help minimize erosion at inlets and outlets.

Advantages:

- Well suited for returning sheet flow to natural drainage areas or infiltration structures.
- Inexpensive and easy to install.
- Prevents scour and minimizes potential for downstream erosion.

Disadvantages:

- If not properly installed or sized, flared culvert outlets may lead to erosion problems.

Tips for Culvert End Section Installation:

1. The outlet receiving area must be uniformly sloped and not susceptible to erosion.
2. Care should be taken to construct the outlet lip completely level in a stable, undisturbed soil to avoid formation of an outlet channel and subsequent erosion.
3. Surface exposure of pipe and end section should be minimized by backfill and revegetation.
4. Additional energy dissipation such as rock rip rap may be required.

Field Experience:

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7.7 Discharge apron

Please read section 7.0 for important information applicable to all stabilized conveyances.

A discharge apron is a structure placed at outlets of pipes and channels to reduce the

velocity and dissipate the energy of exit flows. Most discharge aprons are lined with riprap or grouted riprap for stability. Concrete may also be used to stabilize discharge aprons, but can be considered unattractive. In most cases, design by a qualified engineer is appropriate.

Advantages:

- Helps prevent scour and minimizes potential downstream erosion.
- Inexpensive and easy to install

Disadvantages:

- If not properly designed and installed, drainage aprons may lead to erosion problems.

Tips for Discharge Apron Installation:

1. A layer of smaller gravel or filter fabric should be placed beneath larger riprap.
2. In most cases, the apron width at the culvert outlet should be at least three times the culvert diameter.
3. Align apron with receiving water, if appropriate.
4. Use large, angular rock to prevent displacement by high flows or during Vactor truck maintenance.
5. Consider aesthetic issues such as rock color.

Field Experience:

- Placer County prefers cobble at pipe outlets over culvert end sections and drainage aprons due to ease of maintenance.

7.8 Level spreader

Please read section 7.0 for important information applicable to all stabilized conveyances.

A level spreader is an outlet designed to convert concentrated runoff to sheet flow and disperse it uniformly to prevent erosion. Level spreaders are generally shallow trenches with a level discharge lip to distribute flow to stable or undisturbed vegetated areas.

Advantages:

- Prevents erosion by reducing the velocity of concentrated storm water.
- Allows uniform distribution to improve vegetative treatment and infiltration.

Disadvantages:

- If not properly designed and installed, level spreaders may cause erosion.

Tips for Level Spreader Installation:

1. Primarily for small drainage areas.
2. Level spreaders are *not* intended to trap sediment. Flows must be treated before released into a level spreader.
3. Care must be taken during construction to insure that the lower lip of the structure is level (zero slope).
4. Construct level spreaders on undisturbed soil, not on fill material.
5. Outlet area must be uniform and well vegetated.

Field Experience:

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