LINED CHANNEL OR OUTLET

(feet)
CODE 872

(Source: Kane-DuPage SWCD)

DEFINITION

A constructed channel or outlet having an erosion-resistant lining of turf reinforcement mat, rock, a flexible concrete block system, or other flexible permanent material.

PURPOSE

The purpose of this constructed channel is to provide safe conveyance of concentrated runoff without damage from erosion or flooding, prevent gully erosion, and protect water quality.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where the following or similar conditions exist:

1. Concentrated runoff is such that a lining is required to control erosion;
2. Steep grades, wetness, prolonged base flow, seepage, or piping would cause erosion;
3. Damage from use by people or animals precludes vegetation alone as suitable cover;
4. Limited space is available for design width, resulting in higher velocities;
5. Soils are highly erodible or other soils or climatic conditions preclude using vegetation only.

CRITERIA

Maximum design velocity and rock gradation limits for rock riprap-lined channel shall be determined using Appendix 16A of the NRCS Engineering Field Handbook unless a detailed design analysis applied to the specific gradient, flow depth and hydraulic conditions indicate a higher velocity is acceptable.

Capacity – The maximum capacity of the waterway flowing at design depth shall not exceed 50 cfs. The minimum capacity shall be adequate to carry the

peak rate of runoff from a 10-year, 24-hour frequency storm. Where flood hazards exist, the capacity shall be increased according to potential damage.

Lining – The lining selected shall be durable and erosion resistant, capable of withstanding the anticipated flow conditions.

Velocity – Velocity shall be computed by using Manning's equation with a coefficient of roughness "n" as follows:

Lining	"n" Value
Riprap/Angular rock*	$n=0.047(D_{50}S)^{0.147}$
Turf Reinforced Mats and Flexible Concrete Block Systems	Manufacturer's recommendations

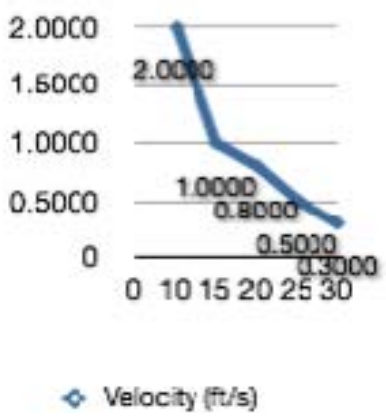

Figure 2. Maximum velocity versus depth of flow for flexible concrete block systems.

* Applies on gradients between 2% and 40% with a rock mantel thickness of 2 x D_{50} where:
D_{50}=median rock diameter (in.)
S=lined section gradient (ft/ft) ($0.02 \leq S \geq 0.4$)

The maximum design velocity for flexible concrete block system sections shall not exceed those determined using Figure 2.

Maximum design velocity for synthetic turf reinforcement mats and Flexible Concrete Block Systems shall not exceed manufacturer's specifications. See practice standard **EROSION BLANKET: TURF REINFORCEMENT MAT (TRM) 831**. Turf reinforcement mat linings shall include a vegetative component.

See first paragraph of Criteria for maximum design velocity for rock riprap.

Stable rock sizes and flow depths for rock-lined channels having gradients between 2% and 40% shall be determined using the following detailed design process. This design process is from, "Design of Rock Chutes" by Robinson, Rice, and Kadavy.

Channel gradients between 2% and 10%:

$$D_{50} = [q(S)^{1.5}/4.75(10)^{-3}]^{1/1.89}$$

Channel gradients between 10% and 40%:

$$D_{50} = [q(S)^{0.58}/3.93(10)^{-2}]^{1/1.89}$$

$$z = [n(q)/1.486(S)^{0.5}]^{3/5}$$

D_{50} = Particle size for which 50% of the sample is finer (in.)

S = Bed gradient (ft/ft)

Z = flow depth (ft)

Q = unit discharge ($ft^3/s/ft$)

(Total discharge ÷ Bottom width)

Except for short transition sections, flow in the range of 0.7 to 1.3 of the critical gradient shall be avoided unless the channel is straight. Velocities exceeding critical velocity shall be restricted to straight reaches.

Velocities exceeding critical velocity shall discharge into an energy dissipator to reduce discharge velocity to less than critical.

Channel gradient – The maximum channel gradient allowed under this standard is 10:1 (Horizonal:Vertical).

Side Slope – The steepest permissible side slopes, horizontal to vertical, shall be:

Rock riprap.....2:1
Synthetic Turf Reinforcement Fabrics....2:1
Flexible Concrete Block Systems.....1:1

Cross Section – The cross section shall be triangular, parabolic, or trapezoidal.

Freeboard – Freeboard requirements are determined by the local governing authority. In absence of other requirements, the lined channel or outlet shall be designed so flows exceeding the capacity of the lined channel or outlet shall not damage the integrity of the structure and further to minimize erosion.

Related Structures – Side inlets, drop structures, and energy dissipators shall meet the hydraulic and structural requirements for the site conditions.

Outlets – All lined channels shall have a stable outlet with adequate capacity to prevent erosion and flooding damages.

Geotextiles– Geotextiles shall be used as a separator between rock or concrete blcok systems and the soil to prevent migration of soil particles from the subgrade, through the lining material.

Geotextiles shall be selected according to material specification **592 GEOTEXTILE**.

Bedding – Bedding shall be used where appropriate to prevent piping. Drains shall be used to reduce uplift pressure and to collect water, as required. Weep holes shall be used with drains if needed.

Disposition of Spoil – Spoil material from clearing, grubbing, and channel excavation shall be disposed of in a manner that will:

1. Not confine or direct flows so as to cause instability when the discharge is greater than the bankfull flow.
2. Provide for the free flow of water between the channel and floodplain unless the valley routing and water surface profile are based on continuous dikes being installed.
3. Not hinder the development of travelways for maintenance.
4. Leave the right-of-way in the best condition feasible, consistent with the project purposes and adjacent land uses.
5. Direct water accumulating on or behind spoil areas to protect outlets.
6. Maintain or improve the visual quality of the site to the extent feasible.
7. Will not damage trees.

CONSIDERATIONS

Work within a waterbody may be subject to local, county, state and federal rules and regulations. Failure to procure, and comply with, the appropriate permit(s) may result in significant fines.

This practice standard describes construction or retro-fit of man-made channels to convey stormwater with the goal of erosion prevention and water quality protection. Other linings may be appropriate for stormwater conveyance when safety alone is the concern.

Grass-lined channels should be used whenever feasible to reduce flow

velocity and promote filtration of runoff. Grass-lined and Flexible Concrete Block System channels can be used in combination, with Flexible Concrete Block System channels at grade transitions, steep reaches, or points of flow confluence to prevent scour and erosion.

Native vegetation should be added to the sides and tops of the lined channel or outlet for wildlife habitat whenever feasible.The design should provide crossings as necessary to prevent damage to the channel. Whenever possible, buffer strips should be established on each side of the lined channel to improve water quality.

Rock delivered to the site is often segregated by size or does not conform exactly to the specified gradation. Therefore, when designing riprap linings and specifying rock gradations, an adequate safety factor should be incorporated.

PLANS AND SPECIFICATIONS

Plans and specifications for installing a lined channel or outlet shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

1. Channel location and alignment
2. Grade, depth, width, and side slope grade
3. Channel cross section type
4. Material specifications
5. Channel soil erosion/sediment control plan

All plans shall include the installation, inspection, and maintenance schedules with the responsible party identified.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be provided for the lined channel or outlet.

A maintenance program shall be established to maintain the channel capacity and outlet stability. Damaged lining shall be repaired promptly.

The lined channel shall be inspected regularly, especially following heavy rains. Damaged areas shall be repaired immediately.

REFERENCES

Robinson, K.M., C.E. Rice, and K.C. Kadavy. 1998. Design of Rock Chutes. Transactions of ASAE, Vol. 41 (3): 621-626.

Pennsylvania Association of Conservation Districts. Seletected BMPs: Lined Channel. Harrisburg, PA. 2003.

United States Department of Agriculture / National Resources Conservation Service. National Engineering Handbook. Chapter 16 – Streambank and Shoreline Protection. Washington, D. C. December 1996.

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