NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION WATER CONVEYANCE
DITCH AND CANAL LINING, FLEXIBLE MEMBRANE

(Ft.)
Code 428B

DEFINITION

A fixed lining of impervious material installed in an existing or newly constructed irrigation field ditch or irrigation canal or lateral.

PURPOSE

- Prevent waterlogging of land.
- Maintain water quality.
- Reduce water loss.
- Improve management of irrigation water.

CONDITIONS WHERE PRACTICE APPLIES

Ditches and canals to be lined shall serve as an integral part of an irrigation water distribution or conveyance system designed to facilitate the conservation use of soil and water resources on a farm or group of farms.

Water supplies and irrigation deliveries for the area served shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used.

Lined ditches and canals shall either be located where they are not susceptible to damage from side drainage flooding or they shall be protected from such damage, e.g., flooding.

Provisions shall be made to protect the liner from external water pressures that could cause the liner to bulge and possibly fail.

CRITERIA

Capacity. A lined ditch or canal shall have enough capacity to meet its requirement as part of the planned irrigation water distribution system without danger of overtopping. Design capacity shall be based on the following, whichever is greater:

1. The capacity shall be enough to deliver the water needed for irrigation to meet the design peak consumptive use of the crops in the area served.
2. Capacity shall be sufficient to provide an adequate irrigation stream for all methods of irrigation, for existing and potential irrigated crops planned, for use in the area served.

Velocity. When soil material is used as a protective cover over a liner, the velocity in canals or ditches shall not exceed the nonerosive velocity for the soil material or the material through which the canal or ditch passes, whichever is less. Local information on velocity limits for specific soils may be used if available. If such information is not available, stability limits shall be based on the tractive stress design approach as discussed in USDA - ARS (Agricultural Research Service) Agriculture Handbook Number 667 - "Stability Design of Grassed-Lined Open Channels" or other comparable channel stability criteria.

The velocity in ditch reaches from which water is to be delivered onto the field through turnouts, siphon tubes, or similar means shall be sufficiently low to permit operation of the planned takeout structure or device.

Canals and laterals lined with flexible membranes must be designed with sufficient capacity to carry the required flows at the velocity that will be developed under the maximum probable retardance conditions.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact your Natural Resources Conservation Service State Office, or download it from the electronic Field Office Technical Guide.

For capacity design, the value "*n*" shall be selected according to the material in which the canal or lateral is constructed, taking into account alignment, hydraulic radius, and potential weed and moss hazard or other retardances.

A Manning's "*n*" no greater than 0.025 shall be used when evaluating designs in order that velocities do not exceed permissible values in erodible soils.

Freeboard. The required freeboard varies according to the size of the ditch or canal, the velocity of the water, the horizontal and vertical alignment, the amount of storm or waste water that may be intercepted, and the change in the water surface elevation that may occur when any control structure is operating. The minimum freeboard for any lined ditch or canal shall provide 3 inches (in.) of lining above the designed water surface. This minimum freeboard requirement is based on the assumption that the finished channel bottom elevations will vary no more than 0.1 foot (ft) from the design elevations. If a construction deviation greater than 0.1 ft is permitted, the minimum freeboard shall be increased.

Side slopes. Canals and ditches with buried membrane linings must be constructed with stable side slopes. Slope requirements vary according to the type of cover material, but the side slopes shall not be steeper than 3 (horizontal - H):1 (vertical - V).

Subgrade. Flexible membranes shall be placed on a relatively smooth and firm surface. The top 6 in. of the subgrade shall be free of organic material, particles larger than 3/8-inch in size, angular particles, other sharp objects, or anything else that could damage the liner. If the subgrade does not meet these criteria, a 6 in. layer of soil free of particles larger than 3/8-in., angular particles, and other sharp objects or 8 ounce (oz.) non-woven geotextile material shall be used as padding beneath the liner.

Protective cover. Flexible membrane liners shall be protected by an earth or an earth and gravel covering not less than 6 in. thick and must extend not less than 6 in. above the top edge of the lining unless recommended by manufacturer to leave uncovered. In areas subject to traffic by livestock, the minimum thickness of the protective cover shall be 9 in. and be free of particles larger than 3/8-in., angular particles, and other sharp objects. Any manufactured material shall have sufficient ultraviolet protection to prevent deterioration.

The material in the bottom 3 in. of cover shall be soil free of particles larger than 3/8-in., angular particles, and other sharp objects. Lining in bottom of ditch or canal may need to be thicker, as recommended by manufacturer.

Covered liners require cutoffs and anchor trenches to secure the liner to the subgrade.

Exposed liners. Exposed liners require cutoffs and anchor trenches to secure the liner from uplift or tearing away from the bottom and sides if the seams release.

Polyurethane/geotextile composite may be exposed as the canal lining but installed according to manufacturer's recommendations.

Membrane thickness. The required flexible membrane thickness depends on the expected subgrade conditions, the hydrostatic forces that will be acting on the flexible membrane and the susceptibility of the lining to damage during or after installation.

The minimum nominal thickness of flexible membrane liners shall be:

Material	Covered Condition	Exposed Condition
	Minimum thickness (mil)	Minimum thickness (mil)
PVC	20	N/A
GCL	0.75 lb/sq ft‡ of sodium bentonite	NA
EPDM	45	45
EPDM (reinforced)	45	45
Polyurethane/geotextile composite	45	45
HDPE	40	40
LLDPE	40	40
PP (reinforced)	36	36
Bituminous geomembrane	120	120

‡Minimum cover thickness – 12 inches of soil

Key:

PVC - poly-vinyl chloride

GCL – geosynthetic clay liner

EPDM - ethylene propylene diene monomer (synthetic rubber)

HDPE – high-density polyethylene

LLDPE - linear low-density polyethylene

PP - polypropylene

Water surface elevations. All lined ditches and canals shall be designed so that the water surface elevations at field takeout points are high enough to provide the required flow onto the field surface. If ditch checks or other control structures are to provide the necessary head, the backwater effect must be considered in computing freeboard requirements. The required elevation of the water surface above the field surface varies according to the type of takeout structure or device used and the amount of water to be delivered. A minimum head of 4 in. shall be provided.

Related structures. Plans for ditch or canal lining installations shall provide for adequate inlets, outlets, turnouts, checks, crossings, and other related structures needed for successful conservation irrigation. These structures can be installed before, during, or after the lining placement. They must be constructed or installed in such a way as to not damage or impair the effectiveness of the lining.

Materials. Flexible membrane liners shall equal or exceed the physical requirements indicated for materials under “Plans and Specifications.”

CONSIDERATIONS

1. Effects on the water budget, especially effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.
2. Effects on downstream flows or aquifers that would affect other water uses or users.
3. Potential changes in growth and transpiration of vegetation located next to the conveyance because of the elimination of leakage from the system.
4. Abrasive effects of sediment on the liner itself or the erosive effects on the protective cover over the liner.
5. Effects of the practice on the movement of dissolved substances to ground water.
6. Effects of wetlands or water-related wildlife habitats.
7. Effects on the visual quality of water resources.
8. Protect liner from external water pressures.

PLANS AND SPECIFICATIONS

Plans and specifications for installing flexible membrane irrigation ditch and canal lining shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purposes.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall be developed for flexible membrane ditch and canal linings. The plan should document needed actions to ensure that practices perform adequately throughout their expected life.

O&M requirements shall be determined as part of the design. Any requirements should be documented as brief statements in the plans, specifications, the conservation plan narrative, or as a separate O&M plan. Typical O&M may include sediment/debris removal, patching of tears, replacement of deteriorated linings, reanchoring edges or resealing seams.