Mitigating Flood Damage to Vermont Local Roads

Properly constructing and maintaining a road drainage system is the most effective ways to reduce flood damage

Vermont Emergency Management

FEMA

VERMONT LOCAL ROADS

Vermont Local Roads Program
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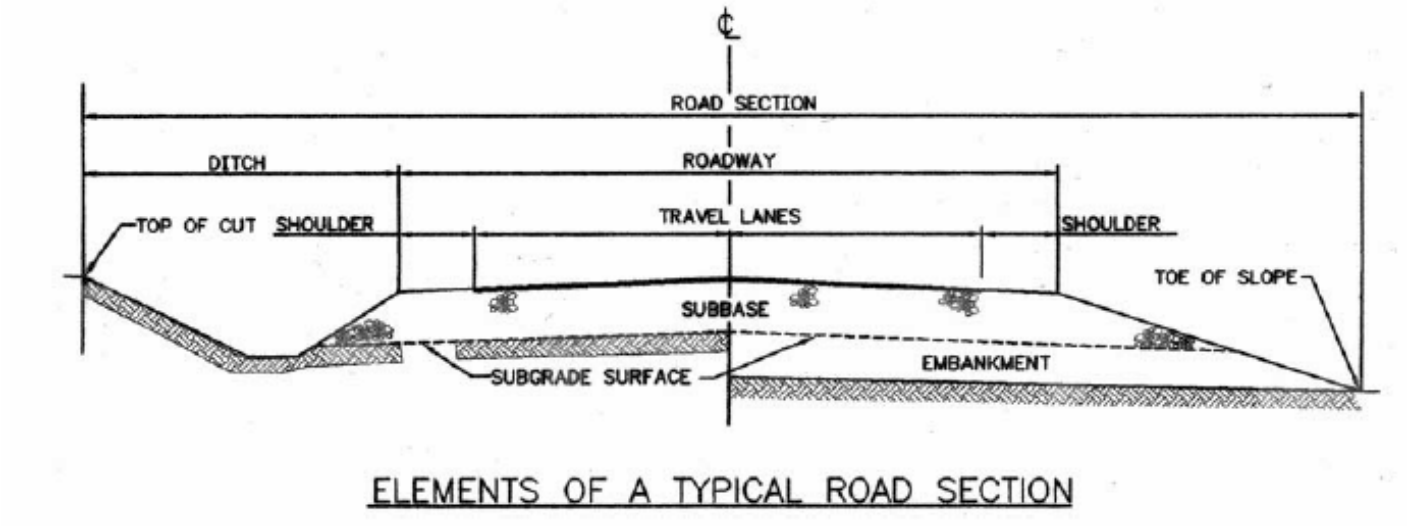
Roadway Drainage

Make sure the road surface is:

- Smoothly graded shoulder to road center
- Properly shaped and sloped
- Well compacted and “tight”



ELEMENTS OF A TYPICAL ROAD SECTION

Roadway and Shoulder Maintenance

- Remove woody roadside vegetation (not grass) from edge of the shoulder. Mow and remove brush, weeds and other debris frequently.

- Remove winter sand and debris from the road shoulder to prevent stormwater flow from being disrupted. Blade the edges of the shoulder to eliminate any build-up of sand and gravel.

- Ensure that the shoulder is flush with the pavement to prevent erosion at the road edge.

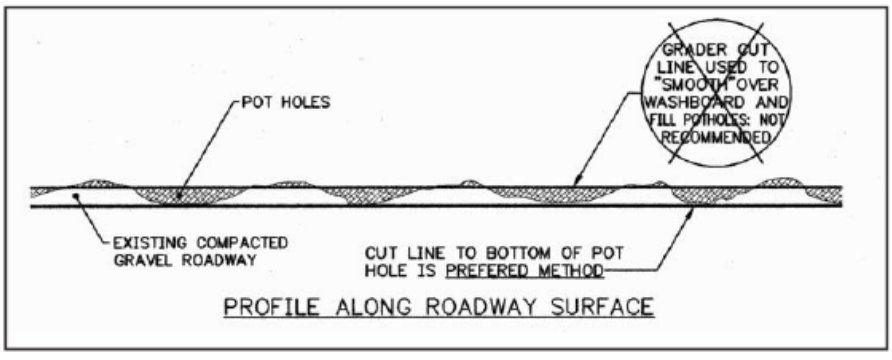
- Grade gravel roads and shoulders when they are moist, but not saturated, ideally in the late spring or after a light rain.

- Avoid creating a false ditch when grading gravel roads. Never leave a berm along the road edge as this will keep water flowing in the road and cause the road surface to erode.

- Grade from the shoulder toward the road center to avoid losing material into the ditch. Attempt to capture any road material that has been previously pushed out onto the road shoulder.

- Assure that all grading maintenance operations are properly performed as to establish and maintain an adequate road crown.

- Always grade the road surface to reform the crown or super elevation before adding new surface gravel. (This ensures that an even layer of new material is applied and uniformly compacted to the correct slope.)



PROFILE ALONG ROADWAY SURFACE

- Use liquid calcium chloride or other available agents to retain moisture in the road surface. This keeps the road surface tight and helps reduce road dust.

- Cut to the bottom of the potholes or wash boarding, then regrade or add material to bring the road surface to the desired elevation.

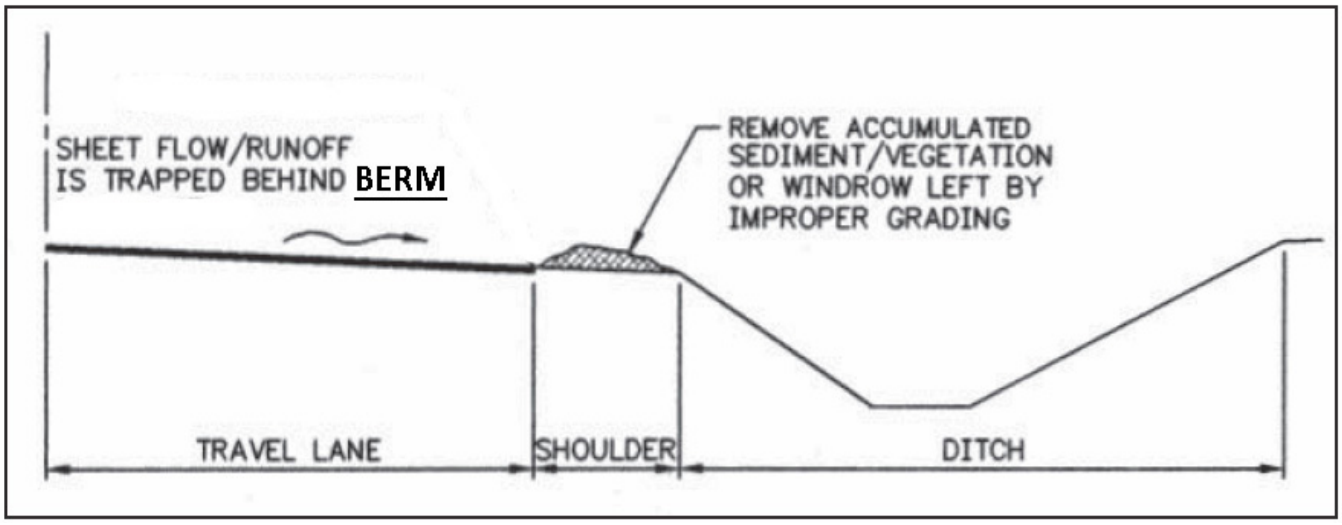
Roadway Drainage

Properly maintained shoulders should:

- Have a uniform cross slope equal to or steeper than the travelled lane.
- Have a well-compacted base material made as watertight as possible to prevent erosion, washout, and to minimize water infiltration into the subbase.

TABLE 4-1
Desirable Minimum Surface Dimensions of
Low to Medium Volume Roads (250 Vehicles/day)

	Gravel Surface	Paved Surface (asphalt or concrete)
Travel Lane Width	7-14 ft.	11 ft.
Shoulder Width	Variable (blend w/travel lane)	Variable (3 ft. minimum)
Crown	1/4-inch per foot (minimum) (1/2-inch per foot preferred)	1/4-inch per foot
Shoulder Slope	1/4-inch per foot	3/4-inch per foot
Super Elevation (maximum)	3/4-inch per foot	3/4-inch per foot



Ditches

Planning Ditches

Open ditches provide a drainage network much like a piped system with catch basins. In a closed pipe system, you would avoid draining a 24 inch pipe into an 8 inch pipe. You must use the same logic in an open ditch system. Be sure the downstream ditches can adequately handle the flow from upstream.

• Record erosion problems that occur along the ditch network and be sure that any ditching maintenance and construction plan is geared toward resolving those problems.

• Whenever you clean ditches upstream that will increase flow in a restricted downstream ditch line, you run the risk of creating a highway erosion event.

Constructing Ditches

• When ditch construction/maintenance takes place, it is important to control erosion and sediment flow during operations. Always refer to the State's best practices for controlling erosion and re-establish ground vegetation as soon as possible.

• Use properly shaped ditches as circumstances allow. The best practice is to avoid deep v-shaped ditches. Creating a wider ditch with a parabolic or u-shape is preferred to provide safer roadsides and better treatment of run-off.

• The u-shaped, grass lined ditch, provides the best retention of sediment and a safer roadside in events where vehicles leave the travel lane.

• Try to establish an average minimum depth of approximately 2 feet. The depth may need to vary due to the width of the ditch and volume of run-off.

• Stone lining will be needed in ditches with a slope of 2.5% or more (see chart below).

• Paved ditches should not be used unless warranted by special circumstances. A paved ditch does not restrict the flow of sediment and will increase the rate of flow leading to a greater potential for downstream erosion. Paved ditches will also contribute to higher water temperatures which harm many aquatic organisms. The following guidelines should be used on all ditch construction:

Channel Slope	Ditch Linings	
	Lining	Min. Thickness
0 – 1 %	Seed & Mulch	4"
1 – 2.5 %	Natural Fiber Erosion Control Matting & Seed	--
2.5 – 10 %	Type I (stone) size varying from 1' to 12", with 50% 4" or greater in size	12"
> 10 %	Type II (stone) size varying from 2" to 36", with 50% 12" or greater in size	24"

Note: Seed and mulch should be completed in the summer growing season. Additional measures such as erosion matting should be added in late fall.

Ditches

Maintaining Ditches

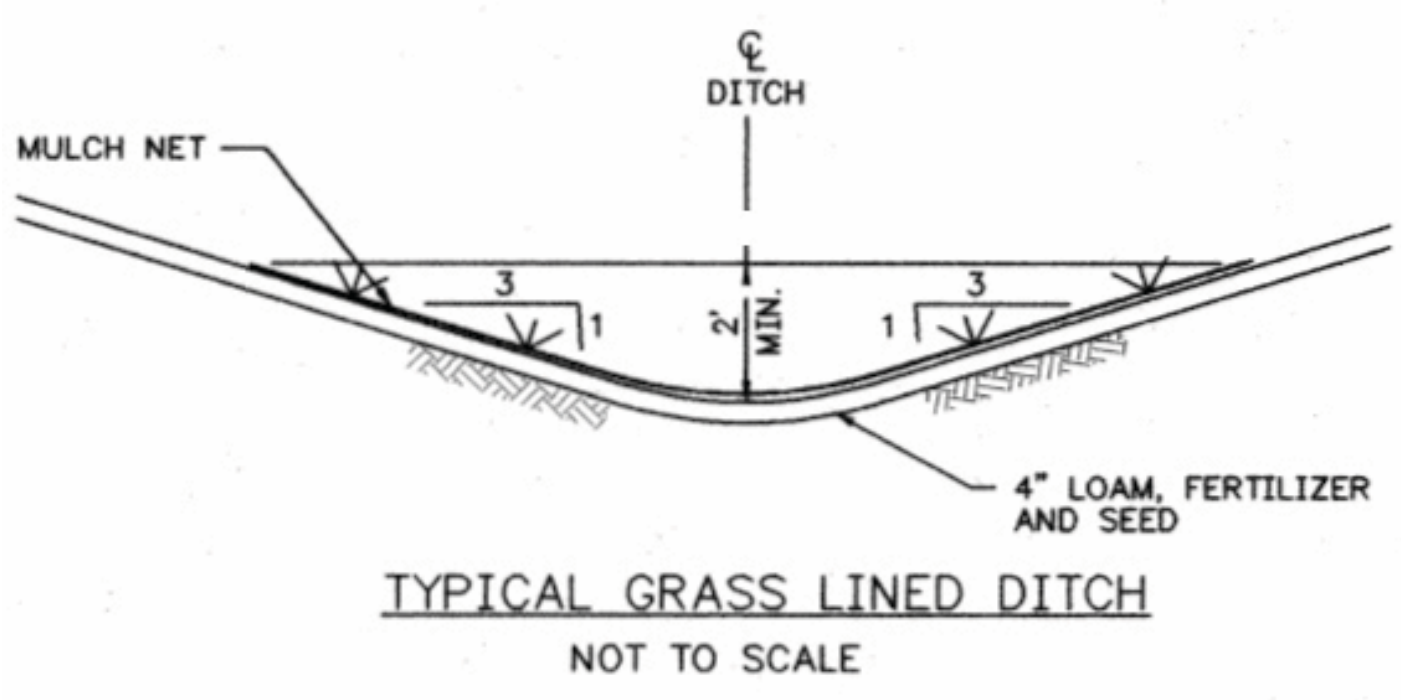
• As mentioned, maintenance should be part of an overall plan that takes into account how work in one area will affect other portions of the network, particularly the areas that are downstream of work being performed.

•Therefore, maintenance of steep inclines should occur in an uphill fashion. This would always be advised when clearing debris or cleaning sediment from the ditch line. In routine mowing operations, this would not be as critical.

• When making erosion repairs, look both upstream and downstream to find solutions that will correct future problems. Can water be released to a flood plain upstream? Can flow capacity be greater downstream without transferring the issue to a downstream location?

• Manage vegetation in the ditch line during the summer months. Mow the ditch to control unwanted vegetation from overtaking the ditch area but also repair and reseed areas that are in need of vegetative cover.

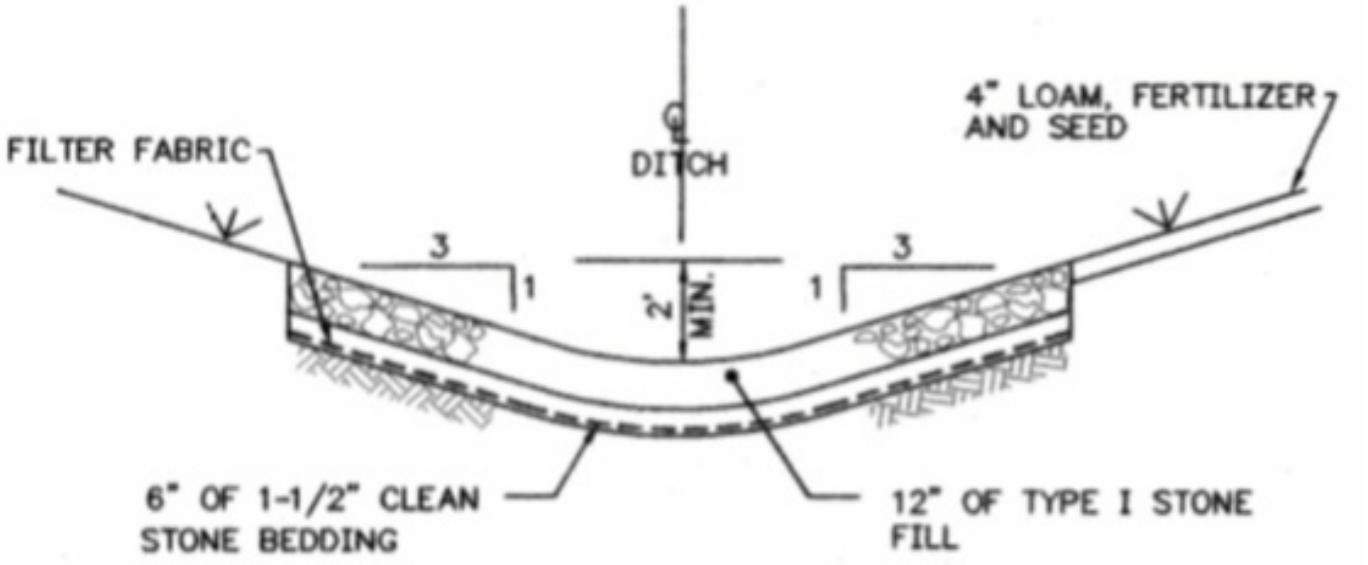
• Remove debris from ditch lines on an ongoing basis and monitor the ditches during high water seasons to assure obstructions are not present.



TYPICAL GRASS LINED DITCH

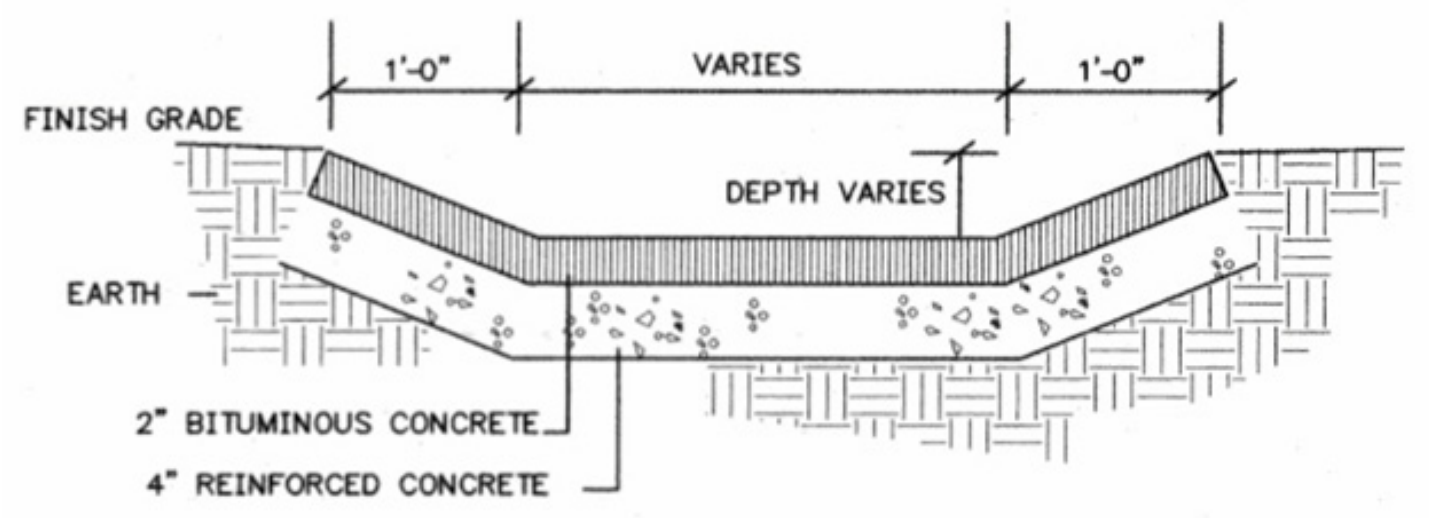
NOT TO SCALE

Ditches



TYPICAL STONE LINED DITCH

NOT TO SCALE



PAVED DITCH (FLAT BOTTOM)

NOT TO SCALE

Note: The asphalt ditch is least preferred method. This diagram shows a combination of reinforced concrete and bituminous concrete (asphalt). The ditch can be constructed with one layer of either material. Ditches constructed using thinner layers of asphalt or concrete will not endure the erosive forces of heavy water flows. Less than a six inch thickness is not recommended.

Culverts

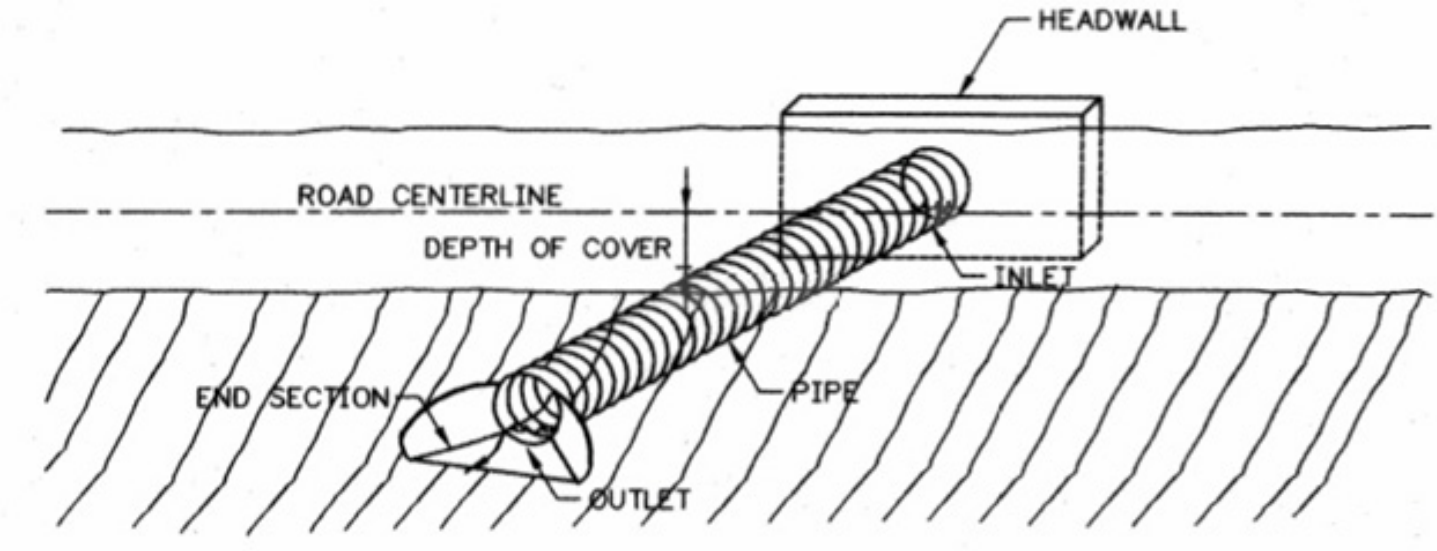
Make Sure Your Culverts Are:

• Adequately sized for water flow and meet minimum State specifications. The State of Vermont specifies a minimum of 15 inch diameter for driveways and 18 inch diameter for road crossings. Do the proper study to determine if a larger than minimum size is required. Take into account what size culverts exist upstream and downstream.

• Properly installed by insuring good alignment, proper grades, and meticulous compaction during construction. Compaction is very important to assure culverts do not sag or pull apart as non-compacted soil settles around them.

• Placed in stabilized earth at the inlet by use of proper erosion resistant backfill, proper alignment to water flow, use of headwall or inlet attachment as needed, and protective measures as needed to prevent scouring.

• Regularly monitored to identify needed maintenance or repair.



Culvert Maintenance

• Spring run-off, summer storms, or any time when water is flowing rapidly, are the best times to check for problems in culverts and ditches. Many problems that would go unnoticed during dry weather will quickly surface. It is a good practice to send all available staff to check ditches and culverts in any rain event whether flooding is anticipated or not.

• Problems identified during spring run-off should be placed immediately into the summer maintenance schedule for repair as soon as the schedule allows. Delays can lead to serious erosion problems.

• Changes in the road surface (cracks/depressions) at culvert locations should be checked immediately to assure a serious issue does not exist.

• There should be an established culvert repair and maintenance program that provides for annual cleaning and replacement of selected culverts.

• Culverts prone to freezing should be well marked before winter so that thawing is easier to accomplish. Culvert replacement should be considered if there is a likelihood that freezing issues would be resolved.

• Culverts along gravel roads and mowing routes should be well marked if they will be prone to damage by maintenance operations.

• Locate and place in inventory all culverts with data that states condition, material, and size.

• Upsize culverts that have caused recurring flooding of roadway.

• Record all inspection information to be used for planning maintenance.

Culvert Problems

Avoid Problems

• Good compaction during installation is one of the most critical components to assure longevity of a culvert and this is especially true with HDPE culverts. Compaction insures structural integrity and a lack of compaction will insure premature failure. A large plate compactor with a foot or more compaction capacity per lift works well. Anything smaller is not practical and compacting with a vehicle such as a backhoe or dump truck is simply not acceptable at any time. Make sure the trench is wide enough to accommodate compaction procedures.

• Use a good base material under the culvert and properly control water during construction.

• Try to reuse excavated sub-soil in road crossings, but backfill around a culvert with material that is free of large stones or other debris.

• Be sure the grade places the invert low enough to keep water from scouring under the culvert, but keep it elevated enough for pitch to occur without having the outflow substantially buried. Establish proper grades ahead of time.

• Properly aligning the culvert to reduce the angle at which water enters is always best. This is not always possible with ditches that run parallel with the road but it is useful for larger flows such as rivers and streams.

• Make sure that rivers and streams are done in cooperation with the proper state regulatory agencies. The Agency of Natural Resources is always a good starting point. Stream crossings should not occur without consultation and required permits.

• Headwalls are not necessary at every culvert, but should be installed where obvious problems will occur. Repetitive maintenance resulting from the absence of a needed headwall will outweigh headwall cost. Risking expensive road damage is not worth forgoing headwall installation when needed in a problem location.

• Culverts that don't require headwalls should have other good practices employed such as heavy erosion resistant soil, geo-fabric below the topsoil, or stone armoring when applicable. Any variation or combination of these practices can be useful.

• Assure that a culvert has adequate backfill thickness above. A minimum of ¾ of the diameter will be adequate cover in proper road base construction. Poor soils will require more cover. Squash culverts, metal culverts and combination culverts (side by side) are possible solutions in areas where backfill limits are present. To assure minimum cover is achieved, follow manufacturer's specifications for backfilling.

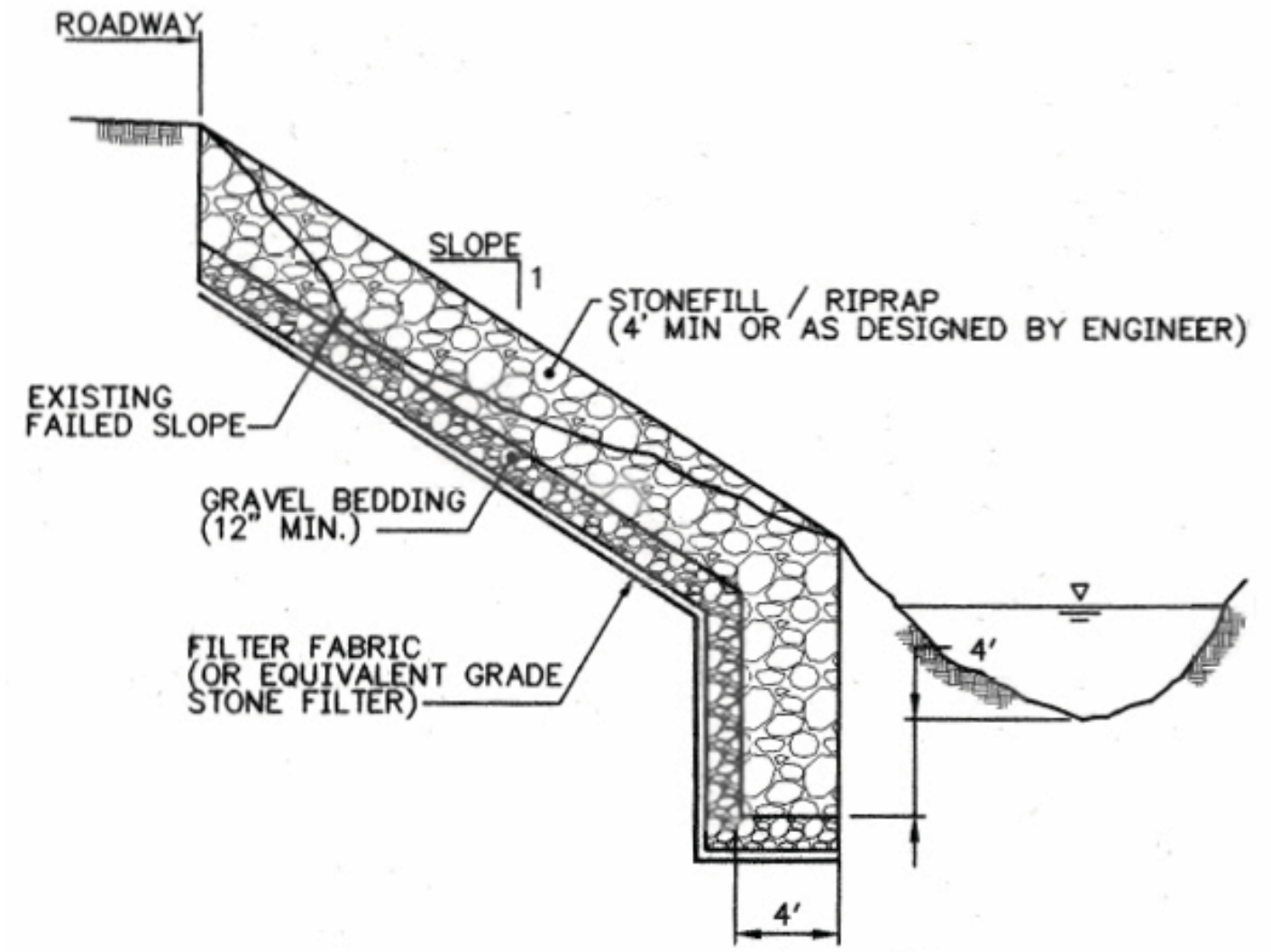
Note: Before deciding to replace a culvert, take into account all factors that may affect future water flow through the culvert or other factors such as correcting a steep shoulder embankment. Is there going to be flow increase in the near future because of development, land clearing, or other factors? Has there been a repetitive problem with freezing, beaver dams, or erosion? Does the road shoulder need to be extended? Think it completely through before moving forward. Is there a chance to save future expense? Too many times, the same size culvert is used in replacements when upsizing is warranted.

Road/Stream Embankment and Lakeshore Stabilization

Slope Protection:

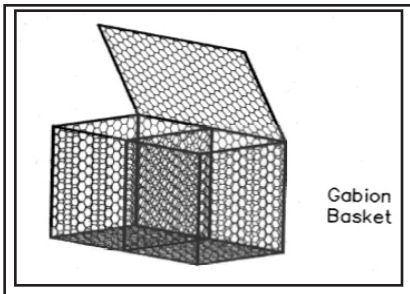
- Cover the slopes with a material too heavy for water to move (stone or rip-rap, gabions)
- Protect with a structure (sheet piling, retaining walls, gabions)
- Establish natural vegetation that can hold itself and the embankment in place (bio-engineering and/or erosion control matting and seeding)
- Use the proper sized stone based on stream velocity or wave height.
- Make the thickness of the outer layer of stone at least twice as thick as the average stone diameter.
- Use gravel bedding and filter fabric to ensure the outer stone layer does not settle into the embankment.
- Bury the toe at least 4’ below the river/lake bottom for scour protection.

Stone or Rip-Rap



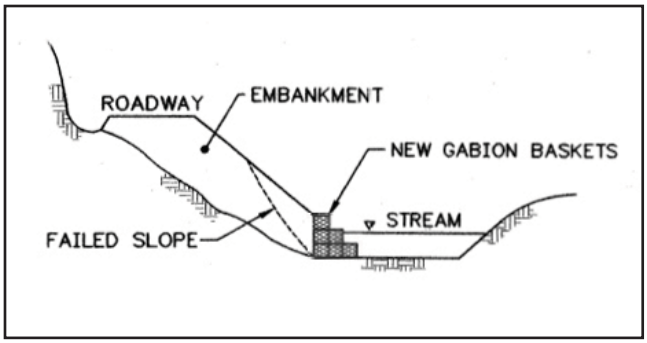
Note: Do a proper engineering study of the site and circumstances to properly size stone and establish plan details.

ROAD / STREAM EMBANKMENT AND LAKESHORE STABILIZATION

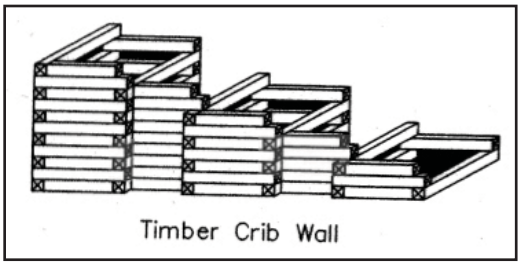


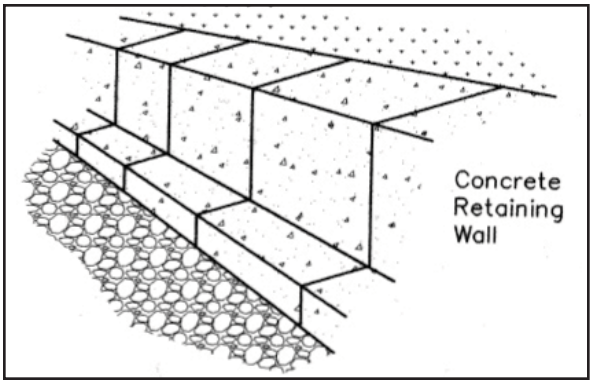
Stone Fill	Stone Diameter		
	Minimum	Average (D50)	Maximum
Type I	1"	4"	12"
Type II	2"	12"	36"
Type III	3"	16"	48"
Type IV	3"	20"	60"

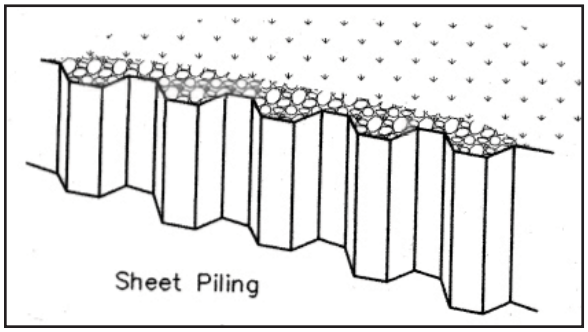
STONE FILLED GABIONS



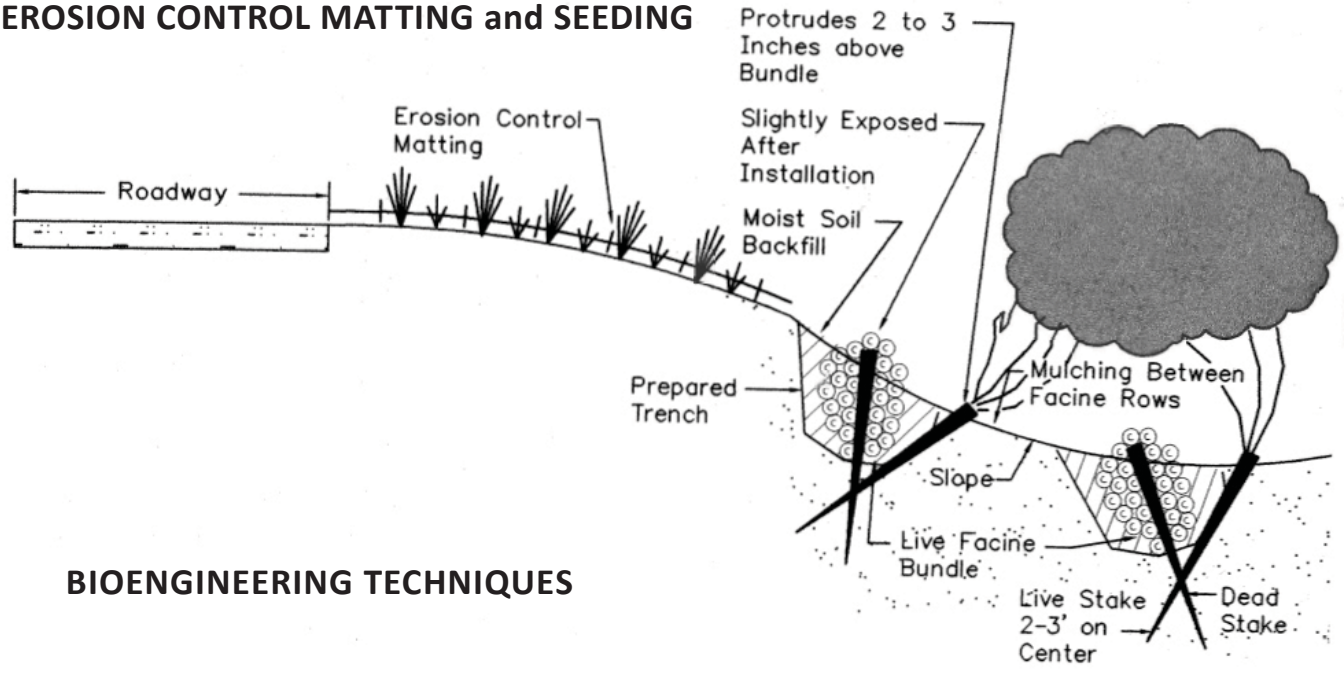
RETAINING WALLS AND SHEET PILING







EROSION CONTROL MATTING and SEEDING



BIOENGINEERING TECHNIQUES

Acknowledgements

Information from the following sources was used to create this document:

- The Vermont Agency of Transportation
- The Vermont Agency of Natural Resources
- The Vermont Department of Environmental Conservation
- The Northwest Regional Planning Organization
- The Northern Vermont Resource Conservation & Development Council
- The Vermont Local Roads Program

The Vermont Agencies listed in this book would serve as helpful resources when planning or performing operations listed in this manual. Be sure to contact the Agency of Natural Resources before performing work in or around a Vermont waterway, wetland, river, or stream.

The Vermont Local Roads program is always happy to assist with directing you to the proper resource to answer operation issues or we will often provide technical assistance in the field for Vermont municipalities.

This document was updated by Vermont Local Roads on 12/11

We work to foster a safe, efficient, and environmentally sound surface transportation system by improving the skills and knowledge of the municipal transportation workforce and leaders.

- Vermont Local Roads Mission Statement