



What is Land Erosion?

Land erosion is the process by which material on the surface of the land is dislodged and moved. Land erosion becomes a water quality stressor when the transported materials reach surface waters. When this occurs, the sediment itself is a pollutant.. Land erosion is a natural process caused by both wind and precipitation; however, precipitation-driven erosion is the primary water-quality stressor in Vermont. Various human activities such as development of unmanaged impervious surfaces, or poorly managed agricultural or forestry activities can significantly increase the natural rate of land erosion.

In the precipitation-driven erosion process, soil or other materials are first dislodged from the ground by either the impact of rain hitting the ground, or by being “swept up” by the flow of “sheet runoff water” across the ground surface. Land erosion increases rapidly when vegetation and the intact “duff” or organic outer layer of soil are removed. Erosion rates vary significantly depending on a site’s slope, the inherent erodibility or prior compaction of the soil, as well as the extent and condition of vegetation and antecedent moisture conditions. The pollutant load associated with land erosion is dependent on the amount of pollutants that exist on or in the eroding material. The extent to which eroded material is delivered to a receiving water depends on proximity and the existence of constructed or natural conveyances, such as swales, channels and ditches, pipes, or culverts. Barriers to sheet-flow based erosion, such as riparian buffers, filter strips, stone-lined roadside ditches, and other green infrastructure practices can significantly reduce or even preclude the impacts of land erosion.

How important is Land Erosion?

Available data indicate that the effects of land erosion are widespread throughout the state. The delivery of sediments and associated nutrients has multiple effects on receiving waters, with the intensity of the impacts dependent on the type of sediment involved, the nutrient content of the sediments, and the capacity of the receiving water.

Empirical data are not available to describe the quantity of sediments and nutrients delivered from land erosion separately from those delivered by channel erosion. However, the 2010 statewide water quality assessment suggests that for rivers and streams, 211 miles are impaired due to sediment, with an additional 800 miles stressed. For nutrients, there are 136 river miles impaired, and 498 miles stressed. Among Vermont’s lakes, 100 acres are impaired due to sediment, and an additional ~8,900 acres are stressed (~5,400 of which are in Lake Champlain). As for nutrients, there are 139,800 acres impaired (132,000 acres of which are in Lake Champlain), and ~3,900 acres stressed ([hyperlink 305b report](#)).

What objectives are achieved by managing Land Erosion?

Addressing and preventing land erosion promotes several surface water goals and objectives, including:

Objective A. *Minimize Anthropogenic Nutrient and Organic Pollution*

Sediments from eroded lands contribute significantly to nutrient pollutant loading. Reducing land erosion can decrease the nutrient load delivered to receiving waters. Minimizing activities that contribute to erosion and implementing best management practices that prevent and control the rate of erosion are the focus of a substantive multi-agency effort to reduce this form of pollution.

Objective B. *Protect and Restore Aquatic, and Riparian Habitat*

Excess sediment resulting from land erosion degrades aquatic and riparian habitat. Cover, feeding, and reproductive habitats of aquatic organisms are dependent upon the sorting, distribution and variety of



sediment types in lakes, wetlands, and streams. By minimizing land erosion, complex physical habitats that support a diverse assemblage of aquatic and riparian species are maintained. Excessive land erosion will yield uniform, sediment-embedded habitats of considerably lesser quality.

Objective D. *Minimize Toxic and Pathogenic Pollution, and Chemicals of Emerging Concern*

Land erosion from excessively applied or poorly incorporated manure results in pathogen releases to surface waters, resulting in potential impacts to recreational uses. However, land erosion is not considered a major delivery mechanism for most toxic compounds, nor for Chemicals of Emerging Concern.

What are the causes and sources of Land Erosion?

The causes and sources of land erosion generally include activities that either eliminate the vegetation that protects soil from erosion, or result in increased runoff volume and velocity. The causes and sources of land erosion include runoff from developed lands; construction activities; agriculture; and forest management. Each of these categories is described in more detail below.

Land erosion from developed lands. Developed land generates more runoff than undeveloped land. Impervious surfaces, including roads (both paved and gravel), parking areas, and buildings prevent precipitation from infiltrating into the ground, and instead produce runoff of sufficient velocity to erode soil and other materials in the flow path. Additionally, developed land often includes a stormwater collection system, or storm sewer system, that effectively routes large areas of impervious system to single points, thus exacerbating the potential for erosion. Erosion is most pronounced where runoff is collected, or concentrated, such as in road ditches, or at outfalls of storm sewer systems. Land erosion due to stormwater runoff from developed land can be mitigated using traditional stormwater management practices, as well as Low Impact Development (LID) and Green Infrastructure (GI) practices. These include infiltration trenches, cisterns, rain gardens, porous pavements, and sustainable site design/redesign. These practices attempt to mimic natural hydrology by infiltrating, evapotranspiring, treating, and storing stormwater as close to the source as possible. Providing appropriate riparian buffers from surface waters can also mitigate the impacts of land erosion from developed land sources.

Land erosion from construction activities. Because construction activities typically result in the loss of vegetative cover, they can produce extremely high rates of soil loss. In addition, altering a site's topography can result in a concentration of runoff and stockpiling of erodible materials can cause significant erosion. Land erosion due to runoff from construction activities can be mitigated through: practices that reduce the amount of cleared land at a given time as well as reduce the period during which it is exposed or left without permanent cover or vegetation; practices that protect the soil during construction, such as mulching; and practices that slow runoff and filter or otherwise reduce the pollutants from the runoff. Providing appropriate riparian buffers from surface waters can also mitigate the impacts of land erosion from construction sources.

Land erosion from agricultural activities. Agricultural activities including: runoff from impervious surfaces in agricultural production areas, such as barn roofs and concrete barn yards; land disturbance associated with the planting and harvesting of annual crops, such as corn and soy; and unmanaged or poorly managed pasturing, allowing livestock direct access to surface water and wetlands and/or overgrazing and denuded vegetation, can all contribute to land erosion through alteration or removal of vegetation. This leaves soils exposed and alters natural drainage patterns, concentrating flows through ditching or tiling. Similar to runoff from developed lands, land erosion rates are highest where runoff is concentrated into a ditch or similar conveyance. Land erosion due to agricultural activities can be mitigated by following practices to reduce the potential for erosion, such as: expanding "clean water management" to include hydrologic considerations, planting only perennial crops in sensitive areas such



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as along rivers, ditches, lakeshores and steep slopes, using conservation tillage, planting cover crops, installing “WASCoB’s (water and sediment control basins), excluding animals from surface waters, and implementing rotational grazing systems. Providing appropriate riparian buffers from surface waters also mitigates the impacts of land erosion from agricultural sources.

Land erosion from logging activities. The construction of logging roads, skidder trails, log landings, inadequate protection of stream and wetland crossings, and log transport activities that expose the soil to precipitation, as well as a lack of site maintenance and close-out, can result in land erosion similar to that of construction activities and runoff from developed lands. On a statewide basis, logging activities result in less land erosion than results from runoff from developed lands and construction activities, however, when erosion from logging operations is allowed unchecked, intense localized impacts occur. Land erosion due to logging activities can be mitigated by following practices that properly locate and construct logging roads, skidder trails, stream crossings, and log landings, as well as restrict the use of mechanized equipment to times when there are sufficiently dry or frozen conditions. Providing appropriate buffers from surface waters can also mitigate the impacts of land erosion from logging sources.



Monitoring and assessment activities to assess effects of Land Erosion

Existing monitoring and assessment activities that consider the causes and effects of excessive land erosion are listed below. Full descriptions of the programs that carry out these activities may be found in the State Monitoring and Assessment Strategy and in Appendix D.

[VTDEC's Monitoring and Assessment Program](#) carries out a comprehensive surface water monitoring strategy aimed at understanding the relative importance of sedimentation and nutrient pollution in Vermont surface waters.

[VTDEC's Lake Assessment Program and Citizen Lake and Watershed Surveys](#) particularly note erosion occurring along lakeshores.

[VTDEC River Management Program](#)

Stream Geomorphic Assessments
Bridge and Culvert Assessments

[VTDEC Clean Water Initiative Program](#)

Stormwater Infrastructure Mapping
Illicit Discharge Detection and Elimination Surveys

[The LaRosa Partnership Program](#) of VTDEC supports citizen scientists who are interested in monitoring the condition of waters in their watersheds.

The [Natural Resources Conservation Service](#) has developed a metric of soil loss called "T," or tolerable soil loss. This is tracked within NRCS databases, and is assessed on a farm-by-farm basis. As a precondition for enrolling in many of the cost-share programs offered by NRCS, agricultural producers are required to have a plan in place that reduces soil loss to T by applying best management practices. The T-factor was initially developed out of concern for preserving agricultural productivity, and represents the maximum annual soil loss expressed in tons per acre per year that can occur on a particular soil while sustaining long-term agricultural productivity. It is important to remember that T is based on agricultural productivity and does not directly consider water quality impacts that such soil loss would have on a receiving water.

[Lake Champlain Basin Program](#) – supports the Long-Term Water Quality and Biological Monitoring Program on Lake Champlain, which is operated jointly by the States of Vermont and New York. The program measures TSS, phosphorus, nitrogen and many other parameters in the lake and its tributary rivers. All chemical analyses are conducted by the Vermont DEC Laboratory. The tributary monitoring results are analyzed with data from the network of stream flow gauges in the basin operated by the U.S. Geological Survey. The monitoring results are updated annually on the [Lake Champlain Long-Term Monitoring Program website](#) where the data and graphical summaries are freely available. The Basin Program also supports individualized watershed-specific sampling efforts as needed.



Key Monitoring and Assessment Strategies to Address Excessive Land Erosion

- Conduct integrated analysis of biomonitoring and land use data to identify trends in and extent of land erosion.
- LiDAR, or “Light Detection and Ranging” is a method of very high-resolution elevation and contour mapping. Obtain statewide “LiDAR” data and use this to identify areas of localized erosion.
- Complete critical source area analysis, evaluating the relative erosion potential from different areas across the state.
- A major concept promoted through agricultural management programs is that soil loss should be maintained within a tolerable level, known by the farming community as “T.” “T” is presently based on soil protection, and not water quality protection. Alternatives for a water quality-based “T” value would benefit both soil protection and surface water quality.



Technical assistance programs to address Land Erosion

Existing programs that provide technical assistance in various aspects of managing the causes and sources of excessive land erosion are listed below. Full descriptions of these programs may be found in Appendix D.

AAFM ARS Program
AOT Environmental Services
Better Roads Program
Local Roads Program
VTFPR Watershed Forestry and Urban and Community Forestry Programs
VTDEC Lake Shoreland Management Program
USDA NRCS Highly Erodible Land Conservation
USDA Conservation Technical Assistance
Vermont League of Cities and Towns (model ordinance development)

Key Technical Assistance Strategies to Address Land Erosion

- Develop and maintain the capacity to technically assist landowners, municipalities, land developers, engineers, agencies, and organizations in the implementation of sound land use practices, including shoreland management and green infrastructure.
- Continue to provide technical assistance to town road maintenance programs through the Better Back Roads Program to encourage proper ditch design and maintenance, and dirt road design specifications that minimize land erosion.
- Provide access to trainings on green infrastructure practices.
- The FPR Division of Forests staff provides technical assistance to forest landowners and loggers to help them comply with Vermont's Water Quality and the Heavy Cutting Laws.
- The Vermont Agency of Agriculture, Food and Markets - Division of Agricultural Resource Management and Environmental Stewardship offers a host of programs to protect water resources. These programs are both regulatory and voluntary in nature and are designed to be an efficient approach for Vermont farmers to protect their environment.



Regulatory programs to address Land Erosion

Existing programs that regulate activities causing land erosion are listed below. Full descriptions of these programs may be found in Appendix D.

AAFM Required Agricultural Practices RAPs
AAFM Large Farm and Medium Farm Operation Permitting Programs
AOT Access Management Permit Program
VTDEC Stormwater Management Program
 Construction General Permit and Individual Permits
 Stormwater Operational General Permit and Individual Permits
 Municipally-separated Storm Sewer System Permit
 State of Vermont Transportation-separated Storm Sewer System Permit
 Municipal Roads General Permit
 Three-acre Developed Lands Permit
VTFPR Accepted Management Practices for Logging AMPs

Key Regulatory Strategies to Address Land Erosion

- Continue to implement the State's stormwater regulatory programs. The 2009 Lake Champlain TMDL implementation plan also identified addressing stormwater runoff from developed lands as one of the top ten steps for reducing phosphorus pollution in Lake Champlain. The State's stormwater program is the primary mechanism for regulating discharges from impervious surfaces and construction sites. Regulatory oversight of new development is necessary to ensure that stormwater discharges do not contribute to excess land erosion.
- Conduct an analysis of existing jurisdictional thresholds (e.g. 1 acre of disturbed land) to determine if existing programs are sufficiently protective, particularly in sensitive areas such as within river corridors, or lakeshores.
- Further coordinate Agency of Agriculture, Food and Markets regarding implementation of Accepted Agricultural Practices (AAPs), which, are intended to reduce pollutants associated with common agricultural activities. The AAPs require, among other things, setbacks along surface waters. The AAPs are the State's primary regulatory for any agricultural operation that does not trigger the regulatory thresholds of the medium- or large-farm operation permitting program; the AAPs apply to all farm operations, regardless of type or size.
- Continue development of a Consolidated Animal Feeding Operation permit to supplement existing Medium (MFO) and Large Farm Operation (LFO) permitting programs as administered by the Agency of Agriculture.
- Coordinate with the Department of Forests and Parks to evaluate opportunities for enhanced surface water protection under the Accepted Management Practices (AMPs) for Maintaining Water Quality on Logging Jobs in Vermont. AMP's define allowable activities within river corridors and prescribe baseline practices to reduce land erosion.



Funding programs to address Land Erosion

Existing funding programs that support projects to address the causes and sources of land erosion are listed below. Full descriptions of these programs may be found in Appendix D.

AAFM Farm Agronomic Practices (FAP) and, Nutrient Management Plan Incentive Programs
Better Roads Grant Program
Clean Water State Revolving Fund
USDA-NRCS EQIP Program
USDA-NRCS/AAFM Conservation Reserve Enhancement Program
VTDEC Ecosystem Restoration / Clean Water Initiative Program Grants

Key Funding Strategies to Address Land Erosion

- The Clean Water Initiative Program (ERP) is the cornerstone of ANR's on-going efforts to reduce surface water pollution from phosphorus and sediment. ERP is specifically interested in proposals designed to improve water quality, including but not limited to projects that: improve stream stability, incorporate the science of fluvial geomorphology in river corridor management decisions, protect against flood hazards, and improve in-stream and riparian habitat; mitigate the effects of hydrologic modification (stormwater runoff) associated with urban development; protect and restore riparian wetlands; re-establish lake shoreline native vegetation and related shoreline erosion corrections; directly address in-lake (internal) phosphorus loading conditions; and enhance the environmental and economic sustainability of agricultural lands.
- The AAFM, Division of Agricultural Resource Management and Environmental Stewardship offers several funding programs to promote agricultural best practices that include very low cost-share requirements.
- The Vermont Better Back Roads Program provides direct funding to municipalities for road and culvert assessments and to promote improvements that are recommended by these assessments.

Information and Education programs to address Land Erosion

Existing programs that inform and educate the general public about the causes and effects of land erosion and BMP's to address them are listed below. Full descriptions of these programs may be found in Appendix D.

Chittenden County's Regional Stormwater Educational Program (RSEP)
Chittenden County Stream Team (CCST)
Ecosystem Restoration Program (ERP)
Lake Champlain Basin Program (LCBP)
Lake Champlain SeaGrant (LCSG)
Natural Resource Conservation Districts (NRCDs)
UVM Extension
VTDEC Lake Shoreland Management Program
VTFPR Watershed Forestry and Urban and Community Forestry Programs



Key Information and Education Strategies to Address Land Erosion

As described above there are a broad suite of technical and financial assistance programs, as well as regulatory measures that are designed to address land erosion. By in large these efforts target specific practices, activities or locations, and do not provide broad-based outreach to the general public about the causes and effects of land erosion. While it is unlikely that the typical Vermont homeowner will have substantial and uncontrolled erosion occurring in their backyard, each homestead contributes to the changes in hydrology and overland flow that can cause or contribute to land erosion.

In 2011, ANR completed a Green Infrastructure Strategic Plan that identified areas where green infrastructure efforts could be strengthened. Education and outreach was identified as a high priority for four target audiences: design professionals, municipalities, property owners, and agency staff. Working with local, regional, and state partners, ANR staff (specifically the Green Infrastructure Coordinator) will coordinate and assist in efforts aimed at increasing awareness and adoption of GI practices among these groups.

The Lake Shoreland Management Program works with lakeshore owners and municipalities to educate them about shoreland sources of erosion and to offer materials and technical assistance to correct and avoid problems.

Towns and other entities subject to MS4 stormwater permitting develop and distribute education about the source of stormwater and residential BMPs for protecting surface waters from stormwater and subsequent land erosion. To meet permit criteria, they provide information on websites, displays, commercials, and factsheets. The Smart Waterways program of the Regional Stormwater Education Program is one model for this collaborative educational approach.

In municipalities subject to mandatory stormwater pollution control efforts at the individual parcel level (e.g., where total maximum daily loads and residual designation authority has been imposed), considerable education and outreach effort is provided to residents on how to comply with the stormwater control requirements. Materials developed for that purpose are made available to residents and officials in other municipalities, coincident with a coordinated outreach effort through the Stormwater Management Program, via the Low Impact Development website (http://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/Resources/sw_LID%20Guide.pdf).