White River Natural Resources Conservation District

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2023 Conservation District Natural Resources Assessment

Orange and Windsor County

Finding Local Solutions to Natural Resource Concerns

District Overview
Natural Resource Conservation Districts (NRCDs) are non-regulatory sub-divisions of state government, governed by a publicly elected board of residents, that work with private landowners, farms, local, state, and federal agencies, and other partner organizations to promote and implement conservation of natural resources. Conservation districts work on a local level to protect natural resources, provide solutions and resources to address environmental concerns, and coordinate resources to support conservation land use practices. Vermont's NRCDs work to improve water quality, protect the natural landscape, and support agricultural best practices. Through technical, financial, and educational assistance, Vermont's 14 NRCDs act as local facilitators linking landowners and producers with the appropriate federal, state, local, and private programs to meet their management objectives.

Vermont Conservation Districts

In the late 1930s, the Vermont legislature passed the Soil Conservation Act, declaring it to be the policy of the state to provide for the conservation, development, and use of the natural resources of Vermont, and that the lands, water, forests, and wildlife of the State of Vermont are among the basic assets of the State, and that the preservation of these lands, water, forests, and wildlife by conservation, development, and use is necessary to protect and promote the health, safety, and general welfare of its people. The VT Soil Conservation Act allowed for the creation of Natural Resources Conservation Districts, née Soil Conservation Districts, as democratically organized corporate bodies and governmental subdivisions, to lead conservation decision-making at the local level.

Two of the duties of the local Conservation District include but are not limited to:

- Conducting surveys, investigations and research relating to the character of soil erosion and its prevention and control measures and natural resources conservation; and,
- Developing comprehensive plans for the conservation of soil resources and for the control and prevention of soil erosion and the protection and conservation of natural resources within the district, which plans shall specify in such detail as may be possible, the acts, procedures, performances, and avoidances that are necessary or desirable, and to publish such plans and information and bring them to the attention of occupiers of lands within the district.

This document, drafted by the White River Natural Resources Conservation District (WRNRCD) and the Ottauquechee Natural Resources Conservation District (ONRCD), is intended to guide the understanding of natural resources in our

Districts. These two Districts have a long history of working cooperatively to help meet jointly-held conservation priorities. WRNRCD serves most of Orange County as well as Hancock and Granville in Addison County, Pittsfield in Rutland County, and Rochester, Bethel, Royalton, Sharon, Stockbridge and Barnard in Windsor County. Ottauquechee Natural Resources Conservation District (ONRCD) serves much of Windsor County as well as portions of Killington, Shrewsbury, and Mount Holly in Rutland County.

General Description of the Area Served

The two Districts serve approximately 29,541 people in Orange County and 58,196 in Windsor County (2020 census). The population is rural and has a wide geographic spread. In Orange County there are approximately 43 people per square mile, while Windsor County is slightly denser with around 60 people per square mile. The largest town in Orange County is Randolph with a population of 4,774, followed by Bradford (pop. 2,790) and Thetford (pop. 2,775). Williamstown is the second largest town in Orange County (pop. 3,515), but is serviced by the Winooski NRCD. Windsor County's largest municipality is Hartford (pop. 10,686), followed by Springfield (pop. 9,062) and Norwich (pop. 3,612).

The five largest ethnic groups in Orange County are White (Non-Hispanic) 95.2%, more than one ethnic group (Non-Hispanic) 2.05%, Hispanic 0.977%, Black or African American 0.419%, and Asian 0.353%. The five largest ethnic groups in Windsor County are White (Non-Hispanic) 94.5%, more than one ethnic group (Non-Hispanic) 1.77%, Hispanic 1.11%, Asian 0.977%, and Black or African American 0.665%. None of the households in Orange or Windsor County reported speaking a non-English language at home as their primary shared language and according to the 2020 Census, almost all of the residents in both Counties are US Citizens (Orange County 99.4% and Windsor County 98.1%).

The largest universities in the two counties are Vermont Technical College (600 degrees awarded in 2020) and Vermont Law School (267 degrees awarded in 2020).

While forests and small farming communities are a huge part of the White River and Ottauquechee Districts' identity, according to the 2020 census, only 5% of residents in Orange County and 2.41% of residents in Windsor County report primary income from agriculture, forestry, hunting, and/or fishing.

According to the United States Department of Agriculture (USDA) 2017 Agricultural Census (most recent available), Orange and Windsor County have similar agricultural profiles. Orange and Windsor Counties have a total of 1,246 farms (569 in Orange and 677 in Windsor) covering approximately 199,513 acres of land in farm use. Based on 2017 data, in Orange County, there were 137 beef operations, 82 dairy operations, and 32,583 acres of cropland. In Windsor County, there were 135 beef operations, 41 dairy operations, and 22,635 acres of cropland. By 2021, the number of dairy operations had dropped to 55 in Orange County and 25 in Windsor County, according to the Vermont Dairy Data statistics collected by the State of Vermont. The majority of the farming community falls into the "small farm" category with the average size of farms around 150 acres. These statistics reflect the small, family operated livestock farms dotting the landscape throughout the valleys in both of the Districts. According to the 1978 NRCS Soil Survey of Orange County, farmers in Orange County had the lowest number of cows per farm in Vermont, but produced more milk per cow than any other county in the State!

Timber is also a major resource in the Districts. Since 1945, the VT ANR Department of Forest, Parks and Recreation has produced annual Harvest Reports. Based on the most recent harvest report from 2021, 2,057 thousand board feet (MBF) of hardwood (4.45% of the total state production) and 4,027 MBF of softwood (5.55% of the State total) were harvested from Orange County as high-value sawlog and veneer. Windsor County produced 2,905 MBF hardwood (6.2% of the total state production) and 7,910 MBF (11% of the State total) of softwood sawlog and veneer. For pulpwood, 17,174 green tons (GT) of pulp (5.3% of the State total) came out of Orange Country and 48,133 GT of pulp were harvested in Windsor County (15% of the total state production). In the wood fuel category (including residential firewood), Orange County produced 44,026 cords and Windsor Country generated 60,217 cords. The majority of the sawlogs and veneer were exported to Quebec while much of the pulpwood and firewood were consumed locally for heat or to supply the Ryegate Power Station, a 20.5-megawatt wood biomass plant constructed in 1992.

References for this section:

US Census data 2020

USDA Census of Agriculture- www.agcensus.usda.gov

Natural Resources in the White River & Ottauquechee Conservation Districts

	Orange County		***Windsor County***	
Land Cover Type	***Acres***	***Percent***	***Acres***	***Percent***
Open Water	*2,020*	*0.5%*	*3,466*	*0.6%*
Developed, Open Space	*16,911*	*4.0%*	*23,700*	*4.0%*
Developed, Low Intensity	*5,894*	*1.4%*	*10,436*	*1.8%*
Developed, Medium Intensity	*1,648*	*0.4%*	*4,269*	*0.7%*
Developed, High Intensity	*232*	*0.1%*	*618*	*0.1%*
Barren Land	*347*	*0.1%*	*1,132*	*0.2%*
Deciduous Forest	*153,000*	*36.2%*	*223,280*	*37.9%*
Evergreen Forest	*66,451*	*15.7%*	*113,678*	*19.3%*
Mixed Forest	*113,338*	*26.8%*	*133,503*	*22.7%*
Shrub/Scrub	*4,518*	*1.1%*	*9,195*	*1.6%*
Herbaceous	*3,122*	*0.7%*	*6,613*	*1.1%*
Hay/Pasture	*42,017*	*9.9%*	*47,651*	*8.1%*
Cultivated Crops	*1,609*	*0.4%*	*1,372*	*0.2%*
Woody Wetlands	*10,423*	*2.5%*	*8,562*	*1.5%*
Emergent Herbaceous Wetlands	*1,249*	*0.3%*	*1,040*	*0.2%*

ANR Atlas data

Geology and Soil

The topography of Orange County is generally subdued with low, north-south ridges and valleys that make up most of the county. The terrain on the western side of the county is somewhat steeper as it nears the foothills of the Green Mountains, compared to the more rolling topography closer to the Connecticut River. The highest elevation is Butterfield

Mountain in the Town of Orange at 3,166 ft, down to the lowest elevation along the Connecticut River at 400 ft. The bedrock underlying the western part of the county is mainly quartz mica schist, interbedded phyllites (metamorphic slate), slates, quartzites, and limestone. The eastern part of the county is underlain by somewhat lower metamorphic grade rocks consisting of phyllites, slates and some schist and quartzite. When the last glacier retreated 13,000 years ago the river valleys were deepened and widened and received glacial fluvial and glaciolacustrine deposits. Glacial till makes up approximately 92% of the county.

The 1978 Soil Survey of Orange County produced by the USDA-NRCS provided a graphic illustration of the general location of major soil types found in the area:

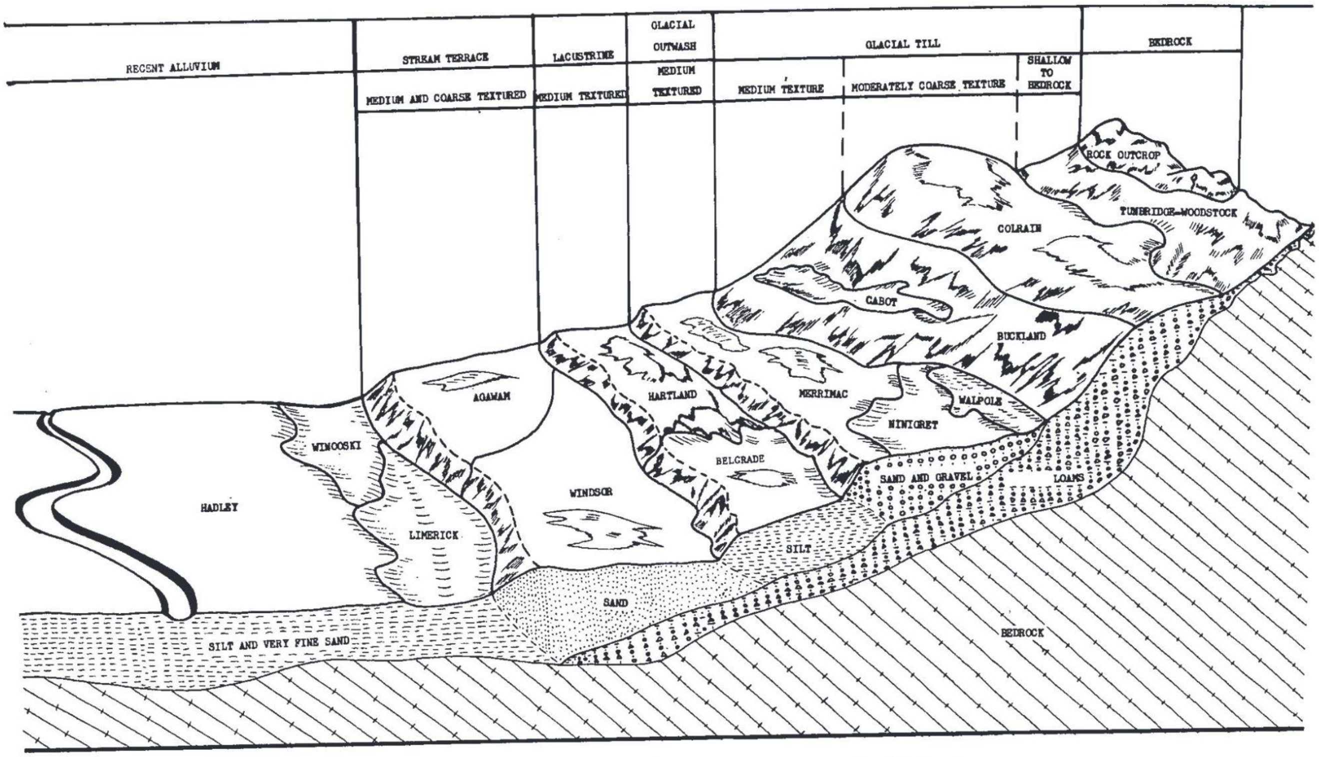


***Figure 2.*—Relation of several soil associations on the landscape.**

The rich sediments deposited after glaciation and alluvial sedimentation have created river valleys with rich soil better suited for agriculture than the steep hillsides. Because most of the river valleys throughout the basin are narrow, much development and agriculture are located along the rivers where soil is rich and deep, and the topography is flatter. Typical prime agricultural soils found on lower slopes include: Agawam, Belgrade, Buckland, Cabot, Charles silt loam, Colrain, Hadley, Hartland, Merrimac, Ninigret, Pomfret, Stowe, Tunbridge-Woodstock, Vershire-Glover, Walpole, Windsor, and Winooski.

In general, Windsor County consists of high ridges running north south and cut at intervals by the major rivers. The Connecticut River is about 350 ft above sea level, the adjacent hills range from 900-1200 ft, increasing on the western side of the county to 2500-3000 feet. Mount Ascutney is an isolated peak of igneous rock in the east central part of the county with an elevation of 3165 ft. Most of the soils in the county are of glacial origin. Glacial till is found in the uplands, is relatively thin, and typified by the Hollis series. Deeper deposits occur at the base of the slopes. Where granite, gneiss, or other crystalline rock occur, the surface is rough and the land is generally most suitable for forestry or pasture. The soils formed in schist tend to be smoother but hilly and suitable for pasture with some gentle slopes suitable for cultivated crops. The terrace materials are alluvial deposits typical of the Hinckley and Merrimac series. Podunk is found in the low lying areas along the waterways.

Typical prime agricultural soils in Windsor County include: Adams, Agawam, Belgrade, Buckland,Cabot, Colton, Croghan, Dummerston, Eldridge, Fullam, Grange, Hadley, Hinckley, Hitchcock, Limerick, Marlow, Monadnock, Nicholville-Adams, Ninigret, Ondawa, Peru, Skerry, and Colonel, Podunk, Raynham, Rumney, Shelburne, Teago-Pomfret, Tunbridge- Lyman, Vershire Buckland complex, Vershire Dummerston complex, Windsor, and Winooski.

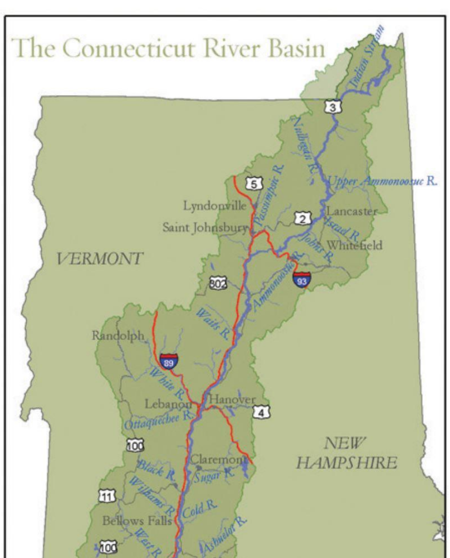
Soil carbon is the foundation of soil health, which can enhance climate resilience, water quality, and farm productivity. The promise of these co-benefits may balance some of the uncertainty in long term carbon sequestration. These are important environmental priorities that align reducing agricultural vulnerability with meeting environmental targets. In 2022, UVM reported that Northeastern soils and climate are naturally conducive to high levels of soil carbon. When compared regionally and nationally, Vermont's agricultural soil carbon levels are high. An average of 86 MT carbon per hectare and 4.3% organic matter was observed. Finely textured soils of glacial origin have a high affinity for holding carbon, and the cold temperate climate of the northeast prevents losses. Together, these conditions contribute to our region having higher soil carbon stocks than the national average. It may be possible to increase soil carbon on Vermont farms which can complement other strategies to reduce concentrations of atmospheric greenhouse gasses.

Soil carbon stocks are improved through changes in soil organic matter. Organic matter is the living or formerly living portion of the soil. It is a reservoir of organic carbon, biological activity, and nutrients; and is foundational to many ecosystem services and soil functions. This pool of organic carbon is influenced by soil texture but can be improved by management strategies that limit soil disturbance and increase inputs of biological carbon such as cover crops, crop residues, manure or other forms of organic carbon. Soil carbon sequestration in agricultural soils is a long-term endeavor that can take 5 to 7 years to show up in a routine soil test and can easily be lost to increases in tillage or changes in management. Evidence that recommended practices lead to additional soil carbon in this climate on Vermont soils is an important underpinning for conservation programs and policy. There is evidence that additional soil carbon sequestration may be achieved through the adoption of recommended practices that reduce tillage and increase organic matter inputs through residues, compost, and manures.

From
Soil Survey of Orange County Vermont USDA, SCS 1978
Soil Survey of Windsor County Vermont, USDA, SCS 1918
Soil carbon storage and sequestration in Vermont agriculture Alissa White, Heather Darby & Donald Ross. Research Brief, April 2022. University of Vermont Extension, Gund Institute for Environment, and Department of Plant & Soil Science

Water

Both the WRNRCD and the ONRCD are bound to the east by the Connecticut River making both Districts part of the Connecticut River Watershed. The Connecticut River Watershed is the largest river ecosystem in New England, encompassing approximately 11,000 square miles and spanning four New England states. The Connecticut River was designated as a National Heritage River in 1998, and it is now a national blueway and priority landscape of national significance for the America's Great Outdoors Initiative. This is one of the most at-risk areas of New England for forest fragmentation. This is an area with multiple federal and state interests, with public land acquisition, access to recreation, and economic interests leading the way. (ctriver.org)



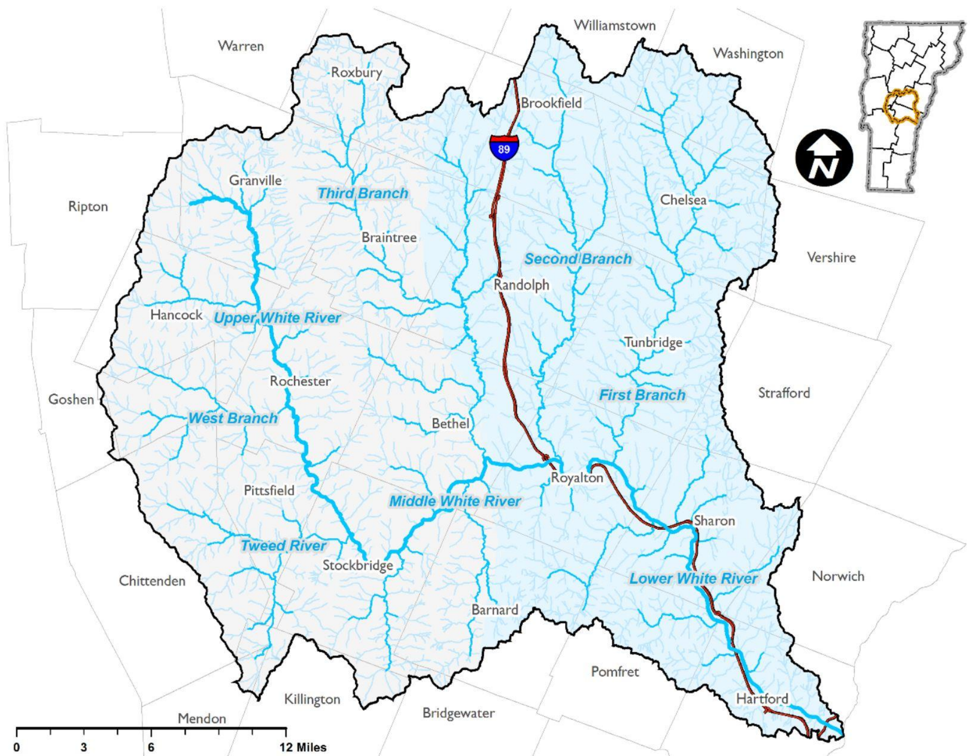
Every watershed can be subdivided into smaller and smaller watersheds down to an individual stream. The watersheds within Vermont are covered by a Tactical Basin Plan (TBP). For WRNRCD and ORNRCD the relevant Tactical Basin Plans include: Basin 9 White River, Basin 14 Stevens, Wells, Waits, and Ompompanoosuc Rivers, and five Connecticut River tributaries, and Basin 10 Ottauquechee River & Black River and six Connecticut River tributaries.   All of these waters drain into the Connecticut River.

To help protect Vermont's clean water, every five years the Vermont Department of Environmental Conservation's (VTDEC) initiates the tactical basin planning process. Tactical Basin planning is designed to identify and prioritize state and local water quality issues and implement on-the-ground watershed protection and restoration projects. The following sections highlight some of the key findings from each TBP and the projects that often guide much of the District's work plan. Please refer to the Vermont DEC page linked at the heading of each plan for more information on each of the Basins.

White River Basin 9 (2018)

The White River Basin encompasses 710 square miles in Vermont, draining portions of Addison, Orange, Rutland, Washington and Windsor Counties. The basin covers significant portions of 20 individual towns. The White River mainstem is approximately 56 miles long and is the longest free flowing large river in Vermont and the longest undammed tributary to the Connecticut River. An emerging network of designated recreational access sites, the White River Water Trail, showcases the basin's overall good water quality and provides opportunities for water-based recreation such as fishing, swimming, boating, and related recreational uses. The mainstem of the White River is recommended as an Outstanding Resource Water for recreation. 42 waters have been identified for protection. In 2016, five waters were protected at the highest classification level.

Basin 9: White RIver



Geologically, the watershed is sliced in half by the geological formation known as the Richardson Memorial Contact, which runs north to south, roughly from the eastern edge of Roxbury to central Barnard. This contact point separates the post-Taconian carbonate rich rocks to the east from the older quartz-rich rocks to the west. This split in bedrock is relevant as it represents an underlying structure that affects the chemistry of ground and surface waters. The younger rocks to the east are less tightly formed and more porous than those of the west, therefore allowing water to penetrate more quickly, which recharges groundwater at higher rates than the west. Waters east of the split also have a greater buffering capacity, mitigating impacts from acid rain. Geologic resources along the contact in Basin 9 include chromium, iron, arsenic, copper, zinc, and lead. To the east, quarried resources include white granite in Bethel, and talc, soapstone, serpentinite, and verde antique.

The rich sediments deposited by Lake Hitchcock after glaciation and alluvial sedimentation from historic flooding have created river valleys with rich soil better suited for agriculture than the steep hillsides. Because most of the river valleys throughout the basin are narrow, much development and agriculture are located along the rivers where soil is rich and deep, and the topography is flat. Unfortunately, this land use pattern also leads to surface water pollution from stormwater runoff and inherently higher flood damage risks from encroachment into the river corridors and floodplains. The basin can be divided into five major sub-basins – the First Branch, Second Branch, Third Branch, Upper White, and Lower White.

Overall, land use in the White River basin is 1.3% open water and wetlands, 4.6% developed (including the interstate and roads), 8.4% agriculture, and 82.7% forests. The forested landscape is largely responsible for the good water quality in the basin. Many of the areas in the White River basin that are experiencing degraded water quality trends are adjacent to dense road and residential development (Jericho Brook, Third Branch, Ayers Brook, Sunset Lake, and Silver Lake) and agricultural lands (Kingsbury Brook, Second Branch, and First Branch). Managing land use to reduce discharge of polluted runoff and allowing adequate space for treatment can both improve and protect water quality.

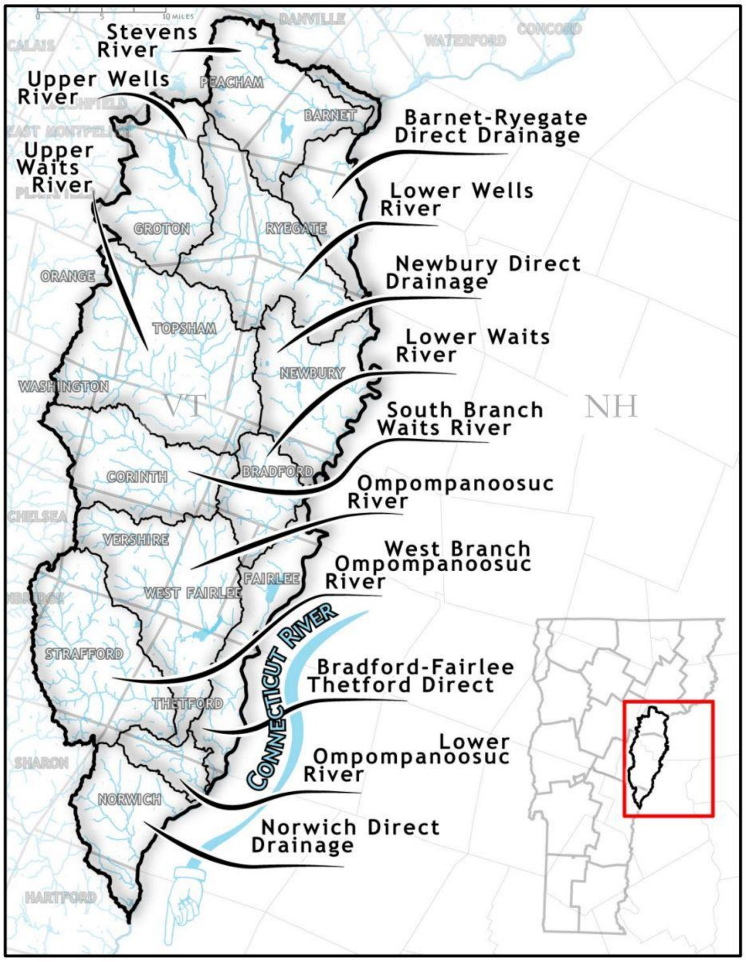
A Total Maximum Daily Load or TMDL is the calculated maximum amount of a pollutant that a waterbody can receive and still meet Vermont Water Quality Standards. In a broader sense, a TMDL is a plan that identifies the pollutant reductions a waterbody needs to meet Vermont's Water Quality Standards and develops a means to implement those reductions. TMDLs can be calculated for reducing water pollution from specific point source discharges or for an entire watershed to determine the location and amount of needed pollution reductions.

TMDLs for Basin 9 include:

- 2004 TMDL for 7 Acid Impaired Lakes in Vermont
- Vermont Statewide Total Maximum Daily Load (TMDL) for Bacteria-Impaired Waters
- Long Island Sound (LIS) Dissolved Oxygen TMDL
- Northeast Regional Mercury Total Maximum Daily Load

Basin 14 (2020)

Basin 14 Watershed Boundary and Towns



Basin 14 comprises multiple sub-basins including the Stevens, Wells, Waits, and Ompompanoosuc Rivers, and five Connecticut River tributaries. The basin stretches south, from Peacham to Hartford, draining portions of Caledonia, Orange, and Windsor Counties and covers significant areas of 17 individual towns. The Basin 14 Tactical Basin Plan was updated in 2020. Overwhelmingly, the waters in Basin 14 meet or exceed water quality standards. Yet, there are still 69 river segments, lakes, ponds, and wetlands that were identified for protection or additional monitoring. Thirteen stressed lake and river segments, 6 impaired lakes and river segments, 3 impaired lakes and river segments with a TMDL, 2 lakes altered by aquatic invasive species.

The surface and ground waters of Basin 14 run through the copper belt within a calcareous sandy marble bedrock. This bedrock is more susceptible to karst – a special type of landscape eroded by the dissolution of soluble rocks – which can result in sinkholes and caves. While Basin 14 is not known for its sinkholes or underground caves, micro-karst features allow water to readily move underground and form springs. Closer to the Connecticut River, quartz schist and quartzite dominate along with black graphitic phyllite and Ammonoosuc volcanics which are less calcareous.

The geology of a basin relates to water quality through physical processes such as groundwater seepage and surficial infiltration of precipitation that control baseflows and low-flow conditions. Chemical processes cause water and minerals in bedrock to interact (e.g. weathering of minerals by precipitation, leaching of chemicals into water after mining activities) and water and sediments in surficial geology to interact (e.g. erosion of soils during rain events, erosion of streambanks after gravel extraction). Sometimes this interaction is natural and sometimes it is human caused (e.g. Elizabeth Mine copper pollution).

The rich sediments deposited by glacial Lake Hitchcock after glaciation and alluvial sedimentation from historic flooding have created river valleys with rich soil utilized by agriculture in the Connecticut River Valley. Because most of the headwaters throughout the basin are heavily forested or narrow, much development and agriculture are located along the rivers where soil is rich and deep, and the topography is flat. This land use pattern can lead to surface water pollution from stormwater runoff close to surface waters and inherently higher flood damage risks from encroachment into the river corridors and floodplains. However, Basin 14 is less susceptible to landslides, the movement downslope of a mass of rock, debris, earth, or soil, and gullies - trenches cut into land by the erosion of an accelerated stream of water, in comparison to the White River or Champlain Valley waterways.

TMDLs for Basin 14 include:

- 2004 TMDL for 7 Acid Impaired Lakes in Vermont
- Vermont Statewide Total Maximum Daily Load (TMDL) for Bacteria-Impaired Waters
- Bacteria TMDL Ompompanoosuc River
- Long Island Sound (LIS) Dissolved Oxygen TMDL
- Northeast Regional Mercury Total Maximum Daily Load
- Ticklenaked Pond TMDL

Of the thirty-one lakes monitored in Basin 14, poor conditions are reported on only seven lakes. Six poor condition ratings are for invasive species (Martins Pond, Ticklenaked Pond, Round Pond, Halls Lake, Lake Morey, and Lake Fairlee). Two poor conditions ratings are for shoreland and lake habitat (Harveys Lake and Lake Fairlee). One poor condition rating is for nutrient trend (Lake Fairlee). Seven lakes show good conditions for all parameters except for mercury pollution which is reported in fair condition statewide.

The Ompompanoosuc River, in Fairlee and Thetford, is listed as impaired by pathogenic bacteria, indicated by the presence of E. coli, which is an indicator of difficult to detect disease causing microbes. Human produced communities of E. coli are introduced into surface waters from substandard septic systems, runoff from incorrectly applied manure, and runoff from neglected pet waste. VDEC, watershed partners, and local stakeholders continue to implement the Ompompanoosuc bacteria TMDL by identifying and remediating potential agricultural and septic sources through nutrient management planning and septic surveys, and intercepting runoff before it enters the river by expanding and conserving riparian buffers and floodplains.

Basin 10: Ottauquechee River & Black River (2012)

Basin 10 consists of two major watersheds in southeastern Vermont - the Ottauquechee River watershed and the Black River watershed. The Ottauquechee River has a mainstem length of 38 miles and drains an area of 223 square miles and the Black River, with a mainstem length of 40 miles, drains an area of 202 square miles. There are 19 lakes and ponds in the Basin that are 20 acres or larger covering approximately 1,610 acres. The North Springfield Reservoir, North Hartland Reservoir, Echo Lake, Lake Rescue, Lake Ninevah, and Woodward Reservoir are the largest bodies of water in Basin 10, each being at least 100 acres in size. The Basin is currently 93.8% undeveloped land while only 6.2% is built. One of the most difficult challenges is due to historical settlement patterns where a large amount of the developed land is in the valleys and along the waterways. The land most impacted by development is the same land most critical to water quality and aquatic habitat condition.

Tropical Storm Irene concentrated six to ten inches of rain on the narrow river valleys of Basin 10. With soils already saturated from a wet August, the rivers quickly filled to capacity and rose into and beyond their recognized floodplains. With so much standing in their paths, the massive energy ripped out roads, bridges, culverts, and buildings. While all areas of Vermont experienced the storm, Basin 10 is one of the hardest hit areas in the state. The Ottauquechee River discharged over 4000 cubic feet per second (cfs) of water at North Hartland, over ten times its normal flow rate. Similarly, the Black River at North Springfield reached 4000 cfs, thirteen times greater than normal. We can expect to see the intensity and extensiveness of these storms repeated in the future with greater frequency as Vermont's climate warms.

The most pressing need identified in the TBP was the need for riparian buffers. It is clearly understood that the lack of buffers is a major cause of water quality and habitat problems in the Basin, and that the simplest, most efficient and most cost effective way to improve and protect surface water quality is to implement coordinated buffer improvements throughout the Basin.

Of the nine waters known to be in need of further assessment, seven have sediment as the suspected pollutant. Silt and sediment are by far the most visible causes of water quality problems noted and impact over thirty miles of river and 132 lake acres. Six impacts from flow alteration at the eighty-nine dams cause stress to rivers and streams. Forty-two dams are in use for hydroelectric power generation, flood control, recreational lake impoundments, water supply reservoirs, and other purposes. Many of the remaining dams, however, are obsolete and serve no current purpose. Their presence in rivers and streams blocks aquatic organism passage, prevents sediment from passing downstream, increases water temperature, and causes disequilibrium in the ecological function of the river system. These pollutants - along with pathogens and excess nutrients - are entering rivers from land development, road runoff, removal of riparian vegetation, and a number of other sources. Basin lakes face contamination and threats from atmospheric deposition of mercury, metals, and acid rain, as well as habitat alterations from varying flow levels. Fortunately there are few impaired waters. These include waters impacted by stormwater runoff from resort development, municipal combined sewer overflows and wastewater treatment facilities, and landfill runoff. There is even one successful removal of a stream from the impaired waters list. Soapstone Brook in Ludlow was recently delisted following diligent stormwater management practice implementation in the watershed.

Emerging Threats

PFAS

PFAS is the acronym for Perfluoroalkyl and polyfluoroalkyl substances. PFAS are a large group of human-made chemicals that have been used in industry and consumer products worldwide since the 1950s. These chemicals are used to make household and commercial products that resist heat and chemical reactions and repel oil, stains, grease, and water. PFAS chemicals include PFOA (perfluorooctanoic acid) and PFOS (perfluorooctane sulfonic acid).

PFAS chemicals from household and commercial products may find their way into water, soil, and biosolids. As a result, PFAS have been found in people, fish, and wildlife all over the world. Some PFAS do not break down easily and therefore stay in the environment for a very long time, especially in water. Some PFAS can also stay in people's bodies for a long time.

In response to the contamination of private wells in Bennington and North Bennington discovered in 2016, the Vermont Department of Health (VDH) issued health-based standards for two PFAS compounds, PFOA and PFOS, to guide drinking water remediation efforts. Since that time, the VDH has updated those standards to include three additional PFAS compounds. In 2019, the Vermont General Assembly passed and the Governor signed into law Act 21 that directs DEC to use the health advisory level as an interim drinking water standard and to develop a final standard, known as a Maximum Contaminant Level (MCL). DEC adopted rules in February 2020 to regulate 5 PFAS compounds in all public drinking water systems. As part of Act 21, public water systems around the state began testing for the presence of PFAS. The following systems tested above standards and the locations in bold are located in the WRNRCD and ONRCD Districts:

- **Killington Mountain School (Killington)**
- **Thetford Academy (Thetford)**
- **Mount Holly School (Mt Holly)**
- **Killington Village Inn (Killington)**
- Fiddlehead Condominiums (Waitsfield)

In 2019, DEC continued with a broader PFAS investigation, including testing of all biosolids (i.e., sludge meeting pollutant limits and treated for pathogens prior to recycling to the land) produced in Vermont. PFAS was detected in all influent, effluent, and solids samples from these facilities with PFAS in sludges and biosolids averaging 83 ppb (sum of 24 PFAS compounds analyzed) across the facilities tested. With the observation of PFAS contamination in biosolids from Vermont wastewater treatment facilities, DEC then conducted soil and groundwater testing at four agricultural sites permitted for the land application of biosolids and stabilized septage during the late summer/early fall of 2019. In addition, any water supplies within ¼ mile of these sites were tested for PFAS. Based on results from initial testing at land application sites, Vermont DEC directed all land application permittees (18 permittees at the time) to conduct soil and groundwater testing at all permitted sites. Testing began in late 2019 and continued through 2020. Average concentrations of total PFAS in soil across 23 unique land application sites was 16 ppb. Groundwater testing results varied, with approximately 20% of all (downgradient) monitoring wells tested indicating PFAS exceeding the Vermont groundwater enforcement standard. Permittees with sites associated with PFAS above the groundwater enforcement standard were directed to halt land application, retest groundwater to confirm results, and identify and test any water supplies within a quarter mile of the site. PFAS testing of drinking water supplies adjacent to these sites confirmed no detections at or above the groundwater enforcement standard to date from land application.

In February 2020, ANR released the report, Deriving Ambient Water Quality Standards for the Emerging Chemicals of Concern: Per- and Polyfluoroalkyl Substances (PFAS). The report describes the framework ANR uses to establish surface water quality standards, and how this framework may apply to the development of state-specific water quality standards to protect both human health and aquatic life from PFAS. Developing water quality standards for PFAS would represent ANR's first undertaking to establish water quality standards for a group of chemical contaminants that currently are not included in the Environmental Protection Agency's (EPA) Clean Water Act Section 304(a) National Recommended Water Quality Criteria.

PFAS Roadmap (ANR) 2021

Wetlands

The term wetland refers to those areas of the state that are inundated by surface or ground water with a frequency sufficient to support plants and animals that depend on saturated or seasonally saturated soil conditions for growth and reproduction. These areas are commonly known as ponds, bogs, fens, marshes, wet meadows, shrub swamps, and forested wetlands. In Vermont, over 230,000 acres, or 4% of the land area in the state, have been identified as wetlands on the Vermont Significant Wetlands Inventory (VSWI) Map. Studies have shown that up to 39% of Vermont wetlands may not be mapped. In addition, more than 35% of the original wetlands in Vermont have been lost. In recent years, residential, commercial, and industrial development have been the primary causes of wetland loss.

While conservation and protection of wetlands are critical for preventing continued loss of our remaining intact wetlands, wetland restoration is essential for rehabilitating those that have already been degraded or lost. Wetland restoration goals include assessing areas of prior converted wetland and hydric soils for restoration projects. As sites and opportunities are identified, implementing those restoration projects is an important step to help reverse past damage. Implementing wetland restoration and conservation projects also need to be prioritized where water pollution reduction and flood protection projects are identified. Recommendations for wetland protection and restoration can be found in the Stream Geomorphic Assessments and River Corridor Plans that have been developed for most of the rivers and streams in Vermont.

2014 VT Wetlands 101 publication
VT ANR Wetlands Restoration Webpage

Climate

Vermont must prepare for a changing climate and cut its climate pollution. To meet the target in Vermont's Global Warming Solutions Act, carbon and methane emissions need to be reduced by half by 2030. To do this, Vermont will need to prioritize helping the people who will be most affected by climate change.

The Legislature established the Vermont Climate Council to draft a Climate Action Plan. As they drafted the plan, the Climate Council incorporated ideas and feedback from a wide range of Vermonters. In addition, the Climate Council developed this plan in coordination with the State of Vermont's Comprehensive Energy Plan (released November 2021), which details energy opportunities and challenges for the State. Five subcommittees shaped the plan: Rural Resilience and Adaptation, Agriculture and Ecosystems, Cross Sector Mitigation, Just Transitions, and Science and Data.

Based on current trends and modeling, it is expected that Vermont will be faced with:

- More rain and flooding: Extreme precipitation events, such as those with 2" or greater precipitation in a 24-hour period, will likely increase in frequency. These events could cause flooding that threatens homes, businesses, infrastructure, communication, and transportation systems.
- Changes to agriculture: Shifts in growing season lengths and more rain will complicate growing conditions for many crops, including apples and maple syrup, increasing the likelihood of crop damage or crop failure. Rising temperatures can also lead to heat-stress for livestock.
- Forest composition: Ecosystems will be increasingly threatened by invasive pests and plants that move north, shifts in the growing season and changes in the natural range of plants.

Climate Change Vermont

Air

Vermont's air quality is often considered to be among the best in the nation. However, the air we breathe is not pollutant-free. Motor vehicles, building heating systems, and manufacturing all generate air pollution. Our air quality is also affected by emissions that occur outside of the state, from sources such as electricity generating facilities and wildfires. The weather also plays an important role. Brisk winds and fast-moving weather fronts move pollutants out of our area, while stagnant weather systems can cause pollutants to linger and accumulate, particularly in mountain valley areas.

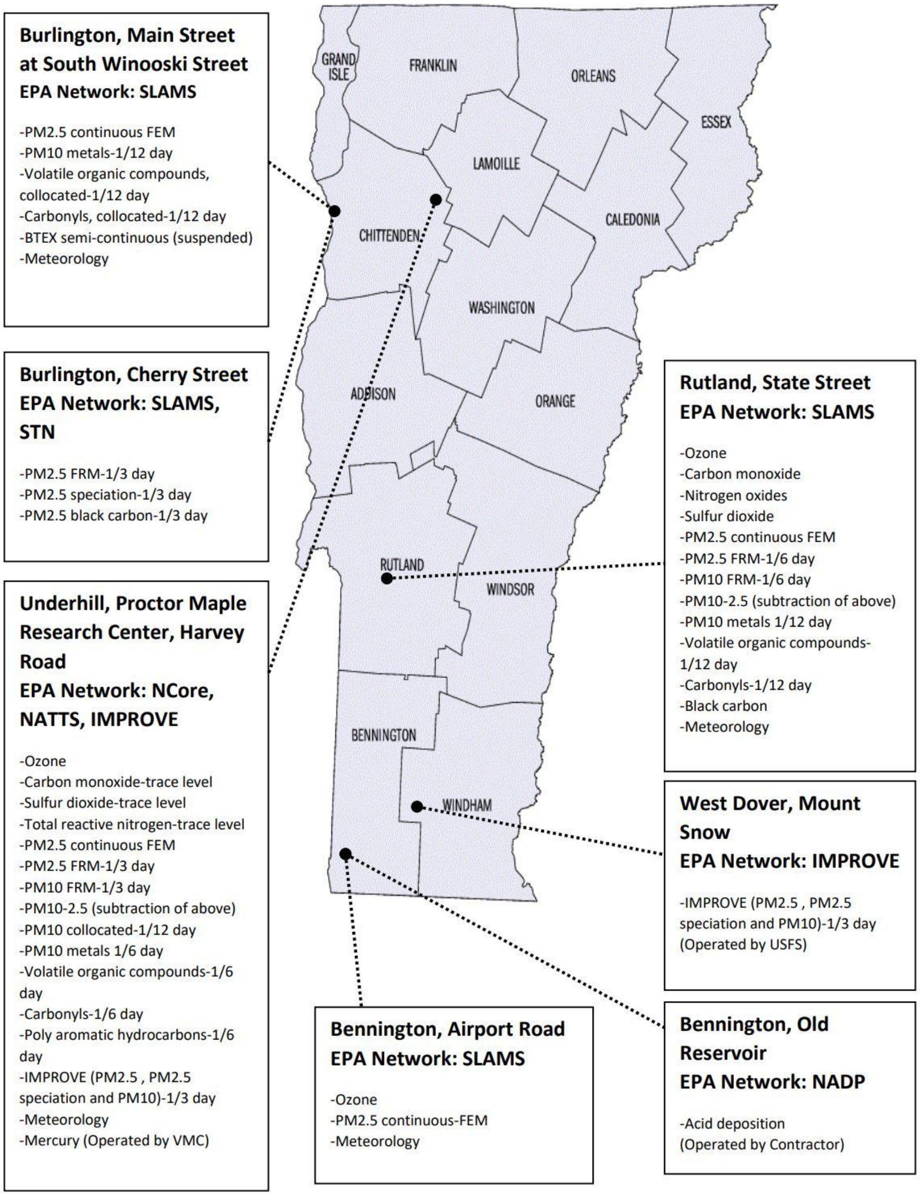
As the seasons change, so do the sources and causes of decreased air quality. Hazy, hot summer days, combined with increased motor vehicle emissions during "driving season", can result in increased concentrations of ground level ozone and volatile organic compounds contained in fossil fuel. As winter and "heating season" arrives, emissions from furnaces and boilers, in particular those using wood for fuel, increase and can be trapped in valley areas during temperature inversion events. Throughout the year, fuel burning, agriculture, and industry release heat-trapping greenhouse gasses such as carbon dioxide, methane, nitrous oxide, and sulfur hexaflouride into the atmosphere.

The federal Clean Air Act identifies six common air pollutants:

- Ground Level Ozone
- Sulfur Dioxide
- Nitrogen Dioxide
- Particulate Matter
- Lead
- Carbon monoxide

Ambient air monitoring is essential for state and federal environmental planning, enforcement efforts, air pollutant trends analysis, and providing timely air quality health advisories. Vermont began air monitoring in the 1960s with a focus on total suspended particulate (TSP). Vermont established an air monitoring network for criteria pollutants in the 1970s and a network for monitoring toxic air pollutants in 1985. The Vermont AQCD currently operates and maintains five permanent air monitoring stations to measure the six EPA criteria air pollutants and 96 air toxic pollutants .

Ambient Air Monitoring Network Vermont – 2022



Real time air quality data from each of the monitoring stations listed above can be found at https://dec.vermont.gov/air-quality/Air-Quality-Data

From
Air Pollutants and Health | Department of Environmental Conservation
Vermont Annual Air Monitoring Network Plan 2022 Vermont Department of Environmental Conservation Air Quality & Climate Division July 1, 2022

Plants

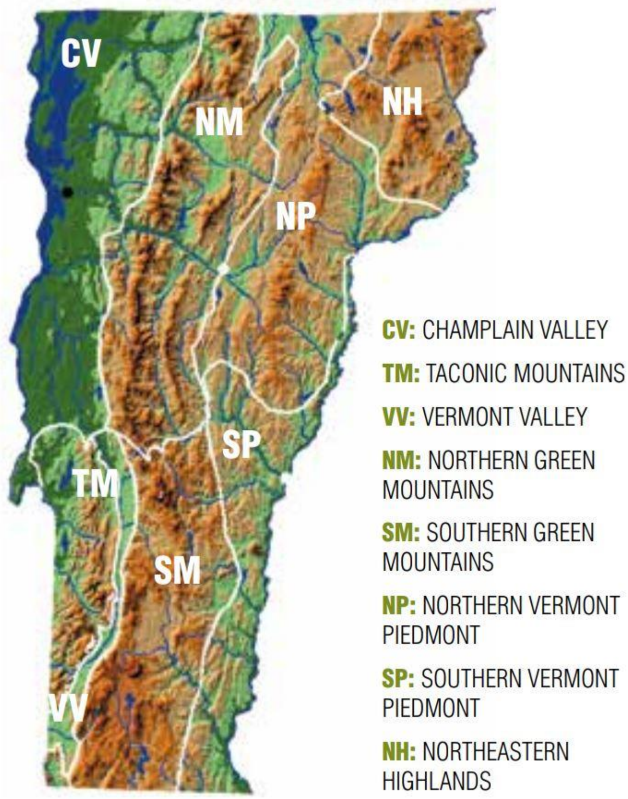


Figure 2.1 Biophysical Regions of Vermont

Most of WRNRCD and ONRCD are part of the Southern Vermont Piedmont, although portions of the northern WRNRCD fall in the northern Vermont Piedmont and portions of the western ONRCD include the southern Green Mountains.

The Southern Vermont Piedmont is a variable region, with a cool climate in the northern hills, and some of the warmest temperatures in Vermont being recorded in Vernon. The topography comprises gentle, rolling hills that rise from the Connecticut River Valley to meet the Green Mountains. Northern hardwood forest dominates throughout, but oak and pine forests occupy warm southern and western slopes in the hills of the central and southern portions of the region. Hemlock forests are also common. The Connecticut River and its tributaries provide important aquatic habitat. These river valleys also have abundant deposits of sand and gravel resulting from the last glacial period in Vermont. Although many of these well-drained soils have been developed or processed for gravel, temperate climate oak and pine forests are common on those that remain. Floodplain forests are also common along many of the region's rivers. The dense network of roads in this region has resulted in smaller blocks of forest and more fragmented wildlife habitat than in the less developed regions. Turkey, gray squirrel, and white-tailed deer are some of the species that benefit from the abundance of acorns.

Moderate in both its climate and topography, the Northern Vermont Piedmont is a hilly region bisected by many rivers. With rich soils derived from the underlying calcium-rich bedrock and gentle topography, this landscape is dominated by a dense network of roads connecting farms and small villages. Consequently, it contains fewer large forest blocks and has more fragmented wildlife habitat than in the Green Mountains and northeastern highlands. The calcium-rich bedrock is responsible for the abundance of rich northern hardwood forests, northern white cedar swamps, and rich fens—all characteristic communities of this region. In contrast, the acidic granite hills of Derby, Glover, and Groton State Forest support northern hardwoods with abundant spruce and fir. The granite quarried in Barre is world famous for its high quality. The Northern Vermont Piedmont has many lakes and ponds, including the larger Memphremagog, Seymour, and Caspian, as well as numerous smaller ponds in the vicinity of Woodbury and Groton State Forest. These lakes and ponds provide successful nesting habitat for the greatest concentration of common loons in Vermont.

This Southern Green Mountain region has high mountains (Killington Peak is 4,235 feet), acid bedrock composed of the same material as the Northern Green Mountains, cold temperatures, heavy precipitation, and dominated by the same forest types that are largely determined by elevation. One distinct feature of the Southern Green Mountains is the relatively level plateau on the southern and western sides of the region. Here, northern hardwood forest and spruce-fir forest intermix with spruce swamps, poor fens, and small ponds. Beaver are abundant and have had a significant influence on the wetlands of the plateau. Another distinct and dramatic feature of the Southern Green Mountains is the escarpment along the western boundary. The cliffs and steep slopes of the escarpment drop more than 1,000 feet in some areas to the valleys to the west. The escarpment's acidic rock and warm western slopes support northern hardwoods, hemlock, and in many locations, oak and pine.

Thompson, E.H. and E.R. Sorenson. 2005. Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont. Lebanon, NH: The Nature Conservancy and the Vermont Department of Fish and Wildlife. A second edition was released in 2019.

In 2017, the Vermont Forestry Division released a Forest Action Plan to address the forest resources concerns for the State. The overarching goal of the 2017 Plan was to minimize the loss of forest cover to conversion to other uses. The following list highlights other emerging issues, threats, and new strategies needed to ensure sustainable forests in Vermont.

VERMONT FORESTS TODAY: FOREST FACTS

FOREST FACTS	2010	2017	COMMENTS
Forest Area	4,580,000 acres	4,508,000 acres	Agricultural land is no longer being abandoned and forest land development is occurring at a slow but steady pace.
Forest Land Area	75%	74%	
Ownership	80.4% Private 19.6% Public	79.5% Private 20.5% Public	
Conserved Land	1.3 million acres	1.4 million acres	Includes 84,000 acres on which the State has public access that may not have been included in the 2010 Plan figures.
Enrollment in Use Value Appraisal program	1,521,566 acres	1,846,743 acres	
Live trees	3,523,000,0000	3,403,000,000	Trees of 1-inch diameter and larger
Hardwood / Softwood	72% Hardwood 28% Softwood	73% Hardwood 27% Softwood	
Sugar Maple	19%	18.5 %	Trees of 5-inch diameter and larger
Dieback of sugar maples	7.5%	7.1%	
Healthy Sugar maples	95.2%	95.9%	
Annual net growth of live trees	193,866 thousand ft^3/yr	175,550 thousand ft^3/yr.	Vermont's forests are still growing, but the rate of growth has decreased
Growth-to-harvest removal for all species across the State	2.1/1	2.1/1	Both growth and harvests have declined since 2009, but this ratio has remained steady
Forestry Division Budget	$5.4 million: 67% general funds 21% federal funds 9% special fund 3% inter-departmental transfers	$6.4 million: 60% general funds 20% federal funds 18% special funds 2% inter-departmental transfers	Accounting for inflation and recovery from the 2009 recession, the Divisions' budget has essentially been flat. 93% of the Division's budget is personnel costs.
Carbon storage in above ground forests	397 short tons	402 short tons	
Emissions from gallons of gasoline offset by growth in forests	n/a	619 million gallons annually	

Data sources: USDA Forest Service, Forest Inventory, and Analysis; Department of Forests, Park and Recreation; University of Vermont Transportation Research Center; and US Energy Information Administration. More forest facts can be found at fpr.vermont.gov/forest/forest_business/forest_statistics

Chart 1: Vermont Forests Today: Forest Facts

- Continue to place priority on maintaining highly functioning forest lands for their ecological values, habitat and wildlife connectivity, and adaptive capacity during climate change. Strategies include encouraging working with partners in assessments and enhancing ecosystem integrity.
- Non-native invasive plants threaten to impact native regeneration, particularly in uninvaded forests. Strategies that track the spread of these species, support partnerships, and encourage efforts across property lines will promote integrated management.
- Climate change threatens our native tree species and the many valuable goods and services they provide. Implementation of strategies outlined in our 2015 document "Creating and Maintaining Resilient Forests in Vermont - Adapting to Climate Change" will be key to maintaining forests that can adapt to changing environmental conditions and stressors.
- Urban canopy enhancements can provide myriad social, economic, and ecological benefits. Continue to focus on communities that have less than average urban tree canopy, higher than average population, and high impervious surface area.
- The economic viability of Vermont's working lands is challenged by changing land use, development pressure, and macroeconomic trends in the forest product economy. Maintaining focus and investment in Vermont's working lands will grow forest businesses, improve our economy, and keep forests as forests.
- In Vermont, forest-based recreation has outpaced forest products in economic value. The demands on public land stretch staffing and raise resource concerns. Private lands represent an opportunity to provide forest-based recreation but will require support and guidance.
- Intergenerational transfer of forest land is a critical issue as Vermont's population is aging. Working with partners to encourage estate planning is a key strategy.

The State of Vermont releases a Forest Condition Report to help track forest pests and their impacts. Highlight from the report, especially for pests localized in Orange and Windsor Counties, are listed here:
Maple leafcutter (MLC) *Paraclemensia acerifoliella*, damage is predominately found on sugar maples, although this insect also feeds on other hardwoods such as red maple, beech, and birch species. This insect caused observable damage to hardwoods during late summer and early autumn in 2021, causing our northern hardwood forests to appear brown and discolored before the onset of typical fall colors. Most reports of MLC came from Orange and Washington counties in 2021 (ANR).
Saddled prominent (SP), *Heterocampa guttivitta*, are hardwood defoliators native to the northeastern United States. Although a native insect, heavy and repeated defoliation can lead to dieback and mortality of infested hosts. Increased

reports of defoliation during the growing season of 2020 led to reestablishing trapping efforts in 2021. In 2021, reports of defoliation were received from Franklin, Orange, Washington, Windsor, and Windham counties ANR.

Hemlock Woolly Adelgid (HWA), *Adelges tsugae*, continues to threaten hemlock trees in southern Vermont, especially in combination with drought and elongate hemlock scale. Traditionally infested sites are still infested, with no observed spread despite low winter mortality and higher population counts. Only 16 acres of hemlock decline related to HWA was mapped during aerial surveys. In the past, drought was observed to be the primary cause of symptoms on unhealthy hemlock trees in 2019 aerial surveys, a trend that would have likely been observed in 2020 if aerial surveys were conducted. As of 2021, known infested counties that were surveyed included Windham, Windsor, and Bennington counties. High-risk counties adjoining known infested counties were also surveyed including Rutland and Orange counties. High-risk areas, and plant hardiness zones 5a and 5b, in Windsor County, were also surveyed since Windsor County is only known to be infested at its southernmost edge.

Emerald Ash Borer (EAB), *Agrilus planipennis*, was first discovered in Vermont in February 2018, and new detections continued in 2021. As a result, EAB has now been confirmed in thirteen counties in the state. Emerald ash borer was detected in many significant new locations in 2021, including 15 new towns and two new counties. New towns include Belvidere, Berlin, Brookfield, Colchester, East Montpelier, Grand Isle, Hartford, Highgate, Middlebury, North Hero, Rupert, Saint Albans Town, Shaftsbury, Vernon, and Wilmington. New counties with EAB this year include Lamoille and Windsor counties.

Beech bark disease dieback, caused by *Cryptococcus fagisuga* and *Nectria coccinea var. faginata*, was mapped on 21,093 acres in 2021, an increase from the 15,073 acres mapped in 2019. Due to COVID restrictions, aerial surveys were not conducted in 2020. Bark symptoms remain common and crown symptoms are increasingly noticeable in mid-summer. This may be due to drought conditions that increased the survival of beech scale crawlers, the success of bark infections, and tree vulnerability. In addition, the 2019-20 winter had no prolonged cold snaps, and deep snow in some locations protected scales at the base of trees. Mapped acres of beech bark disease in 2021: Orange 506 ac Windsor 3097ac.

Forest Condition Report

Animals

Vermont is rich with wildlife, largely because we have an abundance and diversity of habitat that supports the needs of many species. These habitats include extensive areas of interconnected forests of many types, swamps and lakeside marshes, fens and bogs, cliffs and caves, seeps and vernal pools, fields and grasslands, and streams, rivers, and ponds. An important conservation goal is to maintain this diverse array of habitats to continue to support Vermont's wildlife resources and all the values they provide.

Wildlife is very important to the people of Vermont. This love of wildlife is more than anecdotal. The 2011 National Survey of Fishing, Hunting, and Wildlife Associated Recreation conducted by the U.S. Fish and Wildlife Service documented that 62 percent of Vermonters went fishing, hunting, or wildlife watching. Vermont ranked second, only two points behind Alaska in participation (U.S. Dept of Interior 2011). When it comes to wildlife watching, however, Vermont was first in the nation with an impressive 53 percent of residents enjoying this activity. This same survey estimates more than $704 million was spent on fish-and wildlife-based recreation in Vermont.

Fifty-eight species of mammals are found in Vermont. While a handful of Vermont's mammals are important to our hunting and trapping tradition, (more than 150,000 deer with 48 days of hunting opportunity, annually and more than 40,000 turkey and both fall and spring hunting opportunities) most are small, nocturnal animals we may go a lifetime without seeing. Three are non-native species – house mouse, brown rat, and Eastern cottontail. Thirty five are small mammals – weighing less than 1.1 lbs. There are 17 species that are believed to be rare or uncommon and are tracked in the Natural Heritage Database. Five hibernating bat species are state-listed as endangered following a recent frightening decline due to White-nose Syndrome. Two are very rare, recently-returned carnivore species – Canadian lynx and American marten. Other rare species include the Long-tailed Shrew, Rock Vole, and Southern Bog Lemming.

Every 10-years, Vermont's Fish & Wildlife Department updates the Wildlife Action Plan to help guide the Fish & Wildlife

Department, partners, stakeholders and others in the conservation of our Species of Greatest Conservation Need (SGCN) and efforts to keep common species common. Notable, in the most recent 2015 revision, is the growing specters of climate change and diseases, the role pollinators play in the environment, and the reminder that habitat loss and degradation remain the primary threats to most wildlife. The problems most frequently identified have not changed much from the first plan. They include:

- Loss of habitat (from conversion, degradation, fragmentation)
- Impacts of roads and transportation systems
- Pollution and sedimentation
- Invasive species
- Information needs and data gaps critical to conservation success
- Climate change

Species of Greatest Concern included in the Wildlife Action Plan

Table 1.1 Summary of Changes to SGCN Lists 2005:2015

Taxon	2005 SGCN	2015 SGCN	Change Notes
Amphibians & Reptiles	19	19	No changes
Birds	57	50	Removed: Long-eared Owl, Henslow's Sparrow, Osprey, Cooper's Hawk, Barn Owl, Veery, Blue-winged Teal Added: None
Fishes	33	29	Removed: Arctic Char, Atlantic Salmon (anadromous), Brassy Minnow, Muskellunge and Quillback Added: Northern Pearl Dace
Invertebrates	191	198	Removed: 19 species Added: 26 including 9 bumble bee species
Mammals	33	33	Removed: Black Bear and Mink Added: Moose and Snowshoe Hare
Plants	577	673	Added 96 species

Amphibians: The threats identified most frequently for Vermont's reptile and amphibian populations are all closely related to habitat degradation: trampling and direct impacts, road and transportation system impacts, habitat fragmentation, habitat alteration, and habitat conversion.

Birds: Vermont serves as host to 268 bird species for some, if not all, of their annual life cycle. Perhaps the single most significant emerging issue impacting birds in Vermont during the last 10 years has been the conversion of forest and grassland habitat to utility-scale wind and solar energy generation. Although descriptors such as 'renewable', 'sustainable', and 'environmentally friendly' create an image of energy development that is less harmful than fossil fuel, wind and solar energy development still involve habitat loss and impairment.

Fish: The 80 native fishes face many conservation challenges. The threats of habitat alteration, loss, and fragmentation are pervasive in Vermont's rapidly changing landscape. The introduction of nonindigenous fishes, including associated aquatic pathogens and parasites, also pose risks to aquatic ecosystem health and native species conservation. Just within the past 20 years, seven non-native fishes have shown up in state and interstate waters.

Invertebrates: Of the thousands of species that occur in Vermont, several are rare or threatened enough to be at risk of disappearing from the state in the future. The causes that lead to their predicament vary among species. One of the greatest obstacles to acting to help conserve these "at risk" invertebrates has been the scarcity of information that exists on their distribution, abundance, habitat requirements, life history characteristics, population trends, and threats.

Mammals: In total, sixty-one mammal species presently exist in Vermont or were here just prior to European settlement. Vermont is at a crossroad. Due primarily to conscious choices made by her citizens in the last 100 years (restoration of white-tailed deer, beaver, wild turkey, fisher populations, enactment of Act 250 legislation, and wetland regulations, etc.), as well as economic forces that essentially allowed the state to bypass the Industrial Revolution, Vermont has remained predominantly rural throughout the 20th century. Many mammal species, therefore, are at population levels that are likely higher than they were prior to European settlement (fisher, red fox, white-tailed deer, raccoon, bobcat). Today, however, with Vermont's population growing, development pressures, and increased roads and traffic, the potential for significant habitat destruction in the next ten years is high. In addition, global climate change is already influencing the potential residency of some native mammal populations in Vermont.

Plants: Vermont is home to approximately 2,000 species of native plants. This includes 1,200 native vascular plants (seed and flowering plants, ferns and fern allies) and 800 non-vascular plants also known as bryophytes (mosses, liverworts, and hornworts). Many species are quite common (sugar maple, jewelweed) while others are exceedingly rare (green mountain quillwort is found only in Vermont). Vermont's plant diversity is driven, in part, by the different biomes that inhabit the state. While most of the state is dominated by Northern Hardwood Forest, there are also extensive areas of boreal forest in the higher elevations and the northern part of the state, and oak-hickory forests in the Champlain and Connecticut River Valleys. There are even remnant alpine tundra and coastal beach species.
Plant distribution and diversity is also determined by the following factors: type of the bedrock; surficial deposits (gravels, sands, silts, and clays) that were laid down during and after the last glaciation; soil chemistry; climate, elevation, topography; and past land use history. Vermont has extensive areas of calcareous (limy) bedrock that is conducive to high plant diversity. While acidic soils or bedrock areas have distinctly less plant species diversity, they still contribute to the overall diversity in the state in that certain species are adapted to these conditions.

The most significant near-term threats to plant SGCN across the state is conversion, alteration, and fragmentation of natural habitats, and invasive plants and animals. Other less obvious threats include pollinator declines; plant diseases; suppression of natural processes; an overabundance of certain animals; air pollution, including acid deposition; and how natural and anthropogenic plant habitats are managed.

Long-term threats are from increasing human population and footprint; and the many issues related to climate change. We can expect that there will be dramatic shifts in plant communities and diversity in the coming decades and centuries from a warming climate. This inevitability is one that we should start planning for, as there is no turning back from much of the carbon dioxide we have put into the atmosphere.

Vermont's Wildlife Action Plan 2015

Humans

Vermont's economic history has deep roots in agriculture, logging, mining, and manufacturing. Yet, the modern Vermont economy is a diversified mix of industries. Vermont's economic output (gross domestic product) continued to increase in 2021 as the COVID-19 pandemic receded. The largest declines in output were in Agriculture, Forestry, Fishing & Hunting (-37.9%), Educational Services (-8.6%), and Utilities (-7.1%).

Between 2020 and 2021, Vermont's annual average labor force declined by 12,921 (-3.8%%) to 328,216, its lowest level since 1996. The average annual number of employed persons declined by 5,137 (-1.6%) to 316,941, also the lowest since 1996. The number of unemployed persons increased from 7,784 to 11,275. The post-pandemic unemployment rate fell from an annual average rate of 5.6% in 2020 to 3.4% in 2021.

Orange County is the tenth most populous county in the State of Vermont and the seventh largest in size. The 2020 Census per capita income in the county is 89.8% of the statewide average while average quarterly wages (2021) are 82.9% of the statewide wage, the eleventh highest quarterly wage in the state. Large industries in the county include healthcare and social services (18.7% of all covered employment) and retail trade (11.2%). Relative to the state as a whole, Orange County has a high concentration of the agriculture, forestry, fishing, and hunting industry (2.8 percentage points higher than the state share). In 2021, Orange County had the ninth largest labor force in the state with a labor force of 15,227. Since 2010, its labor force has decreased by 9.0%. The county's annual average unemployment rate for 2021 was 3.2%, lower than the statewide average of 3.4%. The poverty rate among all Orange County residents was 9.7% in 2020, while among children under 18 it was 11.1%, compared to the statewide averages of 10.8% and 12.3%, respectively. The major racial groups by percentage of the population were "White alone" (96.2%) and "two or more races" (2.4%). Of Orange County residents 25 years of age and older, 92.7% hold a high school diploma or higher,while 31.9% hold a bachelor's degree or higher. People 65 years of age and over constitute 21.1% of the population, a number that is expected to grow to 29.7% by 2030.

Agriculture, forestry, fishing, and hunting accounts for 42 businesses, 295 people are employed, and the average income in the field is $34,011.

Windsor County is the fourth most populous county in the State of Vermont and the largest in size. Its 2020 Census per capita income in the county is 107.8% of the statewide average, while average quarterly wages (2021) are 96.7% of the statewide wage, the third highest quarterly wage in the state. Large industries in the county include Healthcare and social services (13.5% of all covered employment) and accommodation and food services (12.8%). Relative to the state as a whole, Windsor County has a high concentration of the arts, entertainment, and recreation industry (1.1 percentage points higher than the state share). In 2021, Windsor County had the fourth largest labor force in the state, with a labor force of 28,071. Since 2010, its labor force has decreased by 12.0%. The county's annual average unemployment rate for 2021 was 3.3%, slightly lower than the statewide average of 3.4%. The poverty rate among all Windsor County residents was 9.4% in 2020, while among children under 18 it was 10.9%, compared to the statewide averages of 10.8% and 12.3%, respectively. The major racial groups by percentage of the population were "White alone" (95.6%) and "two or more races" (2.1%). Of Windsor County residents 25 years of age and older, 94.7% hold a high school diploma or higher, while 38.4% hold a bachelor's degree or higher. People 65 years of age and over constitute 23.4% of the population, a number that is expected to grow to 29.9% by 2030

Agriculture, forestry, fishing, and hunting include 50 businesses, 163 people are employed, and the average income in the field is $32,668.

ECONOMIC & DEMOGRAPHIC PROFILE SERIES Vermont 2022

The Vermont Social Vulnerability Index (SVI) is a planning tool to evaluate the relative vulnerability of populations in different parts of the state. It can be consulted in the event of an emergency, either natural or man-made, to identify populations that may need more assistance. This SVI draws together 16 different measures of vulnerability in three different themes: socioeconomic vulnerability, demographic vulnerability, and housing/transportation vulnerability. For each of the vulnerability measures, census tracts in the 90th percentile of vulnerability were assigned a flag. These flags were then summed for each theme. Towns are ranked based on flags from 0 to 5.

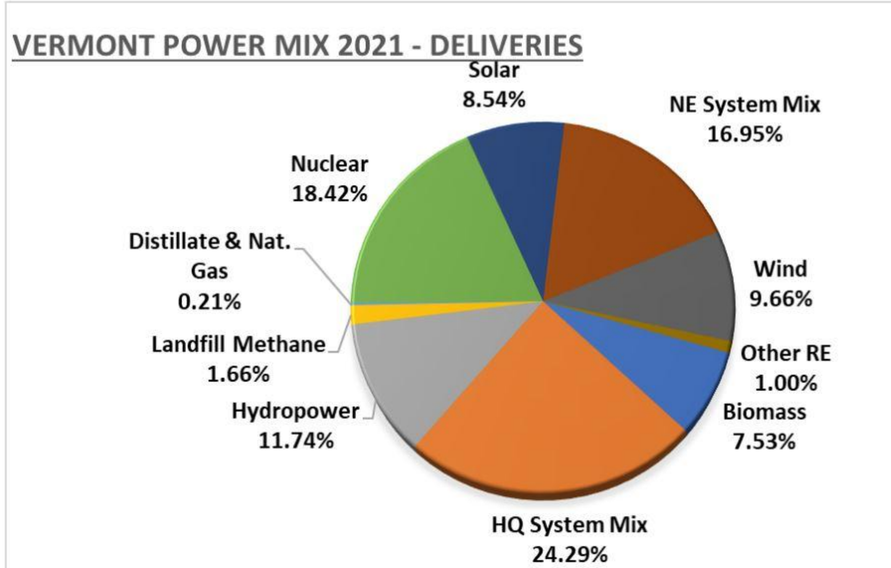
There are five socioeconomic measures: Poverty, Unemployment, Income per capita, Education, and Health Insurance. Based on that flag criteria described above, Bradford received 3 flags, White River Junction, Windsor and Ludlow received one flag.

There are six demographic vulnerability measures: Children, Elderly, Disability, Single Parent, Minority, and Limited English. Based on the flag system, with a range of zero to four, Royalton and Springfield received 3 flags, and Bradford, Wilder, Woodstock, Windsor, and Ludlow received one flag.

There are five housing/transportation measures: Large Apartment Buildings, Mobile Homes, Crowding, No Vehicle, and Group Quarters with a scale from zero to four. Bradford, Orange, Washington, Brookfield, Braintree, Randolph, Ludlow, Weathersfield, and Springfield received one flag, while Wilder received three flags with the caveat that there is a high probability of error.

Social Vulnerability Index

Energy



In 2011, the State of Vermont developed a Comprehensive Energy Plan (CEP) with the goal of obtaining "90% of our energy needs from renewable sources by 2050." In order to meet this goal, municipalities and residents need to find creative ways to reduce energy use, conserve energy (or use it more efficiently), and produce and utilize more renewable energy. As described in the CEP, many pathways for our energy future involve significant electrification of non-fossil resources. A modern electric grid allows for the integration of distributed energy resources (DERs) — e.g., electric vehicles, heat pumps, smart appliances, storage, and generation — while maintaining and improving safety and reliability. The grid needs to continue to perform — to reliably deliver the required energy to customers, every hour of the year, to and from resources that are exponentially more distributed, diverse, and variable, under increasing pressure from severe weather events and cyberattacks, while weaning off fossil resources and staying affordable. Where we don't electrify, ensuring that biofuels (solid, gas, or liquid) remain available and affordable is critical.

The CEP 2022 plan identifies the following set of goals:

- In the transportation sector, meet 10% of energy needs from renewable energy by 2025, and 45% by 2040.
- In the thermal sector, meet 30% of energy needs from renewable energy by 2025, and 70% by 2042.
- In the electric sector, meet 100% of energy needs from carbon-free resources by 2032, with at least 75% from renewable energy.

Currently, Vermont's electric generation mix is 94% carbon-free, and the statutory Renewable Energy Standard requires that all electric utilities meet at least 66% of electricity deliveries with renewable power. Overall, the electric sector contributed less than 6% of Vermont's GHG emissions in 2017, a number that is forecasted to decline even further.

Transportation fuels continue to account for the largest portion of Vermont's total energy consumption, and they include more fossil fuels than any other energy source. Transportation makes up 38% of the total energy consumed in Vermont, and produces more GHG emissions — around 40% — than any other sector.

The transportation sector is overwhelmingly fueled by gasoline and diesel, including small portions of ethanol and biodiesel, respectively. Electricity use for transportation is rapidly growing but remains less than 1% of total fuel use, in part because electric vehicles are more efficient per mile than vehicles with combustion engines.

Every year, Vermont produces an Annual Energy Report. The following highlights the progress and challenges facing the energy sector:

- Solar: Despite its small size, Vermont has experienced a high rate of growth in distributed energy resources, specifically in the deployment of solar installations. Having seen almost 50 megawatts (MW) of small-scale solar installations each year for the better part of the past decade, and with total capacity now about 400 MW, there are certain parts of the Vermont grid that are saturated with generation resources. Particularly in western Vermont, several distribution substations are no longer able to accommodate the connection of additional distributed generation resources above a certain size. Reverse power flow from these resources would exceed utility system equipment ratings.

- Biomass: Ryegate is a 20 MW biomass (wood-fired) generator plant located just north of Orange County. The fate of this facility is not yet known and contingent on improved heat utilization for beneficial purposes (also known as co-generation). As a wood-fired plant, the Ryegate facility relies upon a consistent supply of biomass from the forest economy. Likewise, many fuel suppliers rely on Ryegate to fill an essential role in the market for forest products, a market with significant impacts on businesses and livelihoods. Several fuel suppliers have recently expressed significant concerns about the state of operations at the Ryegate facility. The most prominent issues include (1) payment and contracting practices, with some commenters reporting that they are not being paid for deliveries or are owed substantial sums; (2) lack of a certified scale to weigh incoming deliveries; (3) lack of qualified forestry staff; and (4) the impacts of ongoing bankruptcy proceedings associated with Solar Enterprises, Series LLC ("Stored Solar"), Ryegate's owner. The Department has engaged with Ryegate since learning of these issues to express its concern and underline the importance of addressing the issues, fully and transparently, without delay. Ryegate has acknowledged that it had been behind on payments, and faced difficulties with its payment schedules, but reported that it was current on its outstanding obligations through November 13, 2022. The company also expressed a willingness to enter contracts with suppliers, which had been a standard practice in the past. As to equipment and staff, Ryegate stated that its broken truck scale was due to be repaired and recertified on November 29, and confirmed it has a Vermont-licensed forester with plans for a successor. Ryegate also represents that it is not directly involved in the bankruptcy case, although the proceeding has indirectly affected its operations. There is still significant progress to be made on several fronts, and Ryegate has affirmed its commitment to continuing the work. The Department will continue to closely monitor Ryegate's operations under the contract that has been directed by the General Assembly.

- Vermont Gas Systems has begun incorporating alternative fuel supplies into their portfolio and has set a corporate goal to increase their alternative supplies to 20% of retail sales by 2030, including from Renewable Natural Gas (RNG). RNG can come from many sources including landfills and farms; each source brings different carbon intensity levels. Recently, the Public Utility Commission adopted the Department's position that approval of RNG contracts should reflect the carbon intensity of the source, and keep the cost paid for avoided greenhouse gas emissions below the social cost of carbon.

- Heating and cooling have a large impact on energy consumption and greenhouse gas production. Over the last twenty years, the amount of Cooling Degree Days in New England has increased by 30% and the amount of Heating Degree Days has decreased by 6.5%.

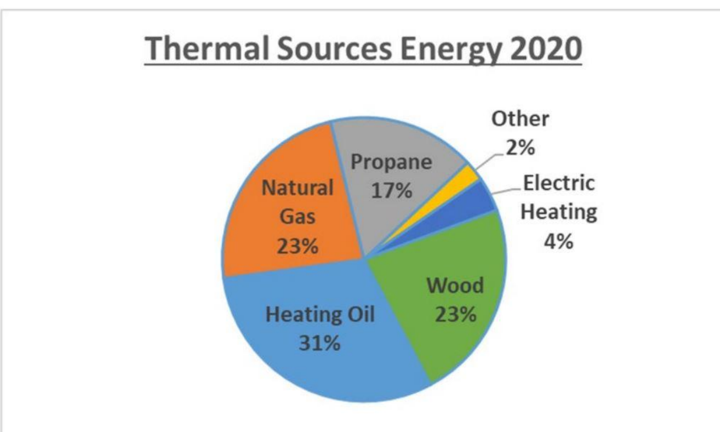


Figure 37: Vermont Thermal Energy Sources by Fuel[35]

Vermonters often use more than one fuel for their thermal needs. The primary source of residential fuel use in Vermont remains fuel oil, although it has had a slow and steady decline over the last decade. Wood as a primary fuel dropped surprisingly in 2019 and 2021 (no data was collected in 2020) and electricity as a primary fuel had a significant increase since 2019.

The State of Vermont has committed to meet 90% of the State's total energy demand from renewables by 2050. The CEP calls for an increase in the portion of renewable energy used to heat Vermont's buildings to 30% by 2025, through both efficiency and increased use of renewable fuels (including wood). More specifically, the CEP calls for doubling the use of wood heating in Vermont. Expanded use of advanced wood heat will help Vermont make measurable progress toward a number of key goals. Developing local demand for cordwood, wood chips, and pellets will help create vital markets for low-grade timber from managed forests. Heating with local wood fuels reduces the economic drain on Vermont's economy. Factoring that only 22 cents of every dollar spent on heating oil or propane are likely retained in the local economy, and 80 cents of every dollar spent on wood are likely retained in the local economy, an estimated net $70 million was retained in the Vermont economy in 2016 by Vermonters choosing to heat with wood rather than fossil fuels.

Wood heat lowers and stabilizes energy costs and keeps dollars circulating in the local economy. Wood heat also creates and supports jobs in the forestry, wood processing, and transportation sectors.

Wood heating comes in many forms. There are three main categories of wood fuels – cordwood, pellets, and woodchips. Cordwood is sold by volume and is used predominantly in the residential sector in stoves that provide point-source heat. Wood pellets sold in 40 pound bags are commonly used with pellet stoves that also provide point-source heat. Bulk pellets are now widely available to the residential and small commercial heating market and are most commonly used to fuel automated boilers that provide whole-building heating via hydronic (hot water) piping and emitters (radiators). Woodchips are used for larger commercial and institutional buildings or networks of buildings with central hydronic or steam heat distribution systems. Automated woodchip and pellet boilers are highly efficient with minimal emissions. Pellet stoves also feed fuel automatically and are thermostatically controlled. Traditional use of cordwood in stoves is a significant portion of the total wood heating sector today and will remain an important portion of the sector in the years to come.

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EXPANDED USE OF ADVANCED WOOD HEATING IN VERMONT: A Roadmap to Reach the Target of 35% of Vermont's Thermal Energy. Prepared byRenewable Energy Vermont and Biomass Energy Resource Center