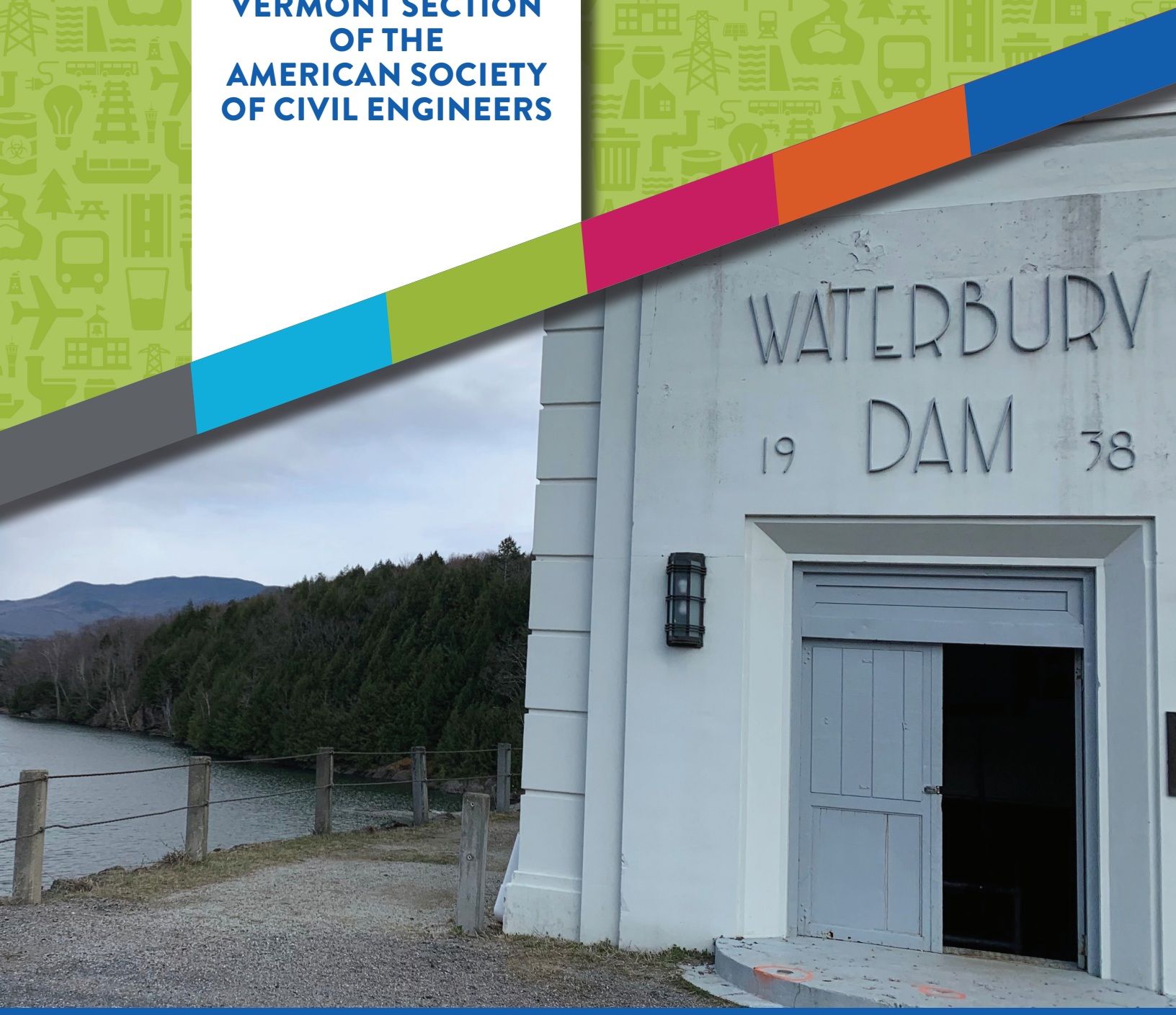
2023

REPORT CARD FOR VERMONT'S INFRASTRUCTURE

VERMONT SECTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS



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EXECUTIVE SUMMARY

Members of the Vermont section of the American Society of Civil Engineers volunteered to produce the *2023 Report Card for Vermont's Infrastructure.* This report serves to educate the public on the status of the infrastructure in the state of Vermont. Residents, in conjunction with elected officials, can therefore better prioritize limited funding among competing, connected needs to improve the condition, capacity, operations, maintenance, safety, innovation, and resilience of infrastructure.

Overall, Vermont's infrastructure gets a 'C', the same as the 2019 report card. Progress is real, but challenges remain. Vermont has some of the oldest infrastructure in the country. Substantial maintenance backlogs have accrued in several areas as recent investment runs into new challenges such as inflation, shortage of a trained workforce, and a deficit of resiliency to withstand climate change.

Since the previous report card, legislative support for infrastructure, public agency planning, and influx of COVID-19 pandemic relief funds deployed amid historic challenges. Vermont allocated federal pandemic funds to the water, sewer, and wastewater sectors in addition to other economic development and climate change mitigation measures. Congressional support was also used to expand Vermont's broadband infrastructure, a critical need in a rural state, the lack of which impacted people forced to learn and work from home during the public health emergency.

Dollars brought in through the 2021 Bipartisan Infrastructure Law provide ways to create tangible improvements in the status of several categories of infrastructure assets. However, maintenance and related slowdowns during the pandemic also set some sectors back. Aviation raised to a 'C': recent upgrades have been focused on airport capacity, including the expansion of the Burlington International Airport (BTV) apron and the construction of a 37,000-sf addition to the terminal building. Safety upgrades included BTV terminal and airfield access control system rehabilitation, perimeter fence installation at various state airports, and removal of obstructions at all airports. Bridges climbed to 'B-.' In the last few years, the number of poor condition bridges in Vermont has decreased to 2.4% of the inventory – down from 5% in 2017 and well below the national average. Roads stayed at 'C+,' but Vermont experienced a surge in traffic deaths, which increased every year since the 2019 report card – doubling from 0.64 to 1.2 fatalities per 100 million vehicle miles traveled.

COVID-19 also transformed how people use infrastructure, and how it is managed, along with what funding was available. The temporary influx of funding provided a boost, but the state's infrastructure needs continue to pose a challenge as is reflected in lowered grades across multiple sectors as compared to the 2019 levels. Aging infrastructure has led to failed wastewater treatment systems, and combined sewer overflows. Global supply chain issues have impacted the progress of project implementation across multiple sectors and shortages in a trained workforce are especially challenging the resilience of a small rural state like Vermont to meet the needs of its residents.

ABOUT THE INFRASTRUCTURE REPORT CARD

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GRADING CRITERIA

The Report Card Sections are based on the following eight criteria:

CAPACITY: Does the infrastructure's capacity meet current and future demands?

CONDITION: What is the infrastructure's existing and near-future physical condition?

FUNDING: What is the current level of funding from all levels of government for the infrastructure category as compared to the estimated funding need?

FUTURE NEED: What is the cost to improve the infrastructure? Will future funding prospects address the need?

OPERATION AND MAINTENANCE: What is the owners' ability to operate and maintain the infrastructure properly? Is the infrastructure in compliance with government regulations?

PUBLIC SAFETY: To what extent is the public's safety jeopardized by the condition of the infrastructure and what could be the consequences of failure?

RESILIENCE: What is the infrastructure system's capability to prevent or protect against significant multi- hazard threats and incidents? How able is it to quickly recover and reconstitute critical services with minimum consequences for public safety and health, the economy, and national security?

INNOVATION: What new and innovative techniques, materials, technologies, and delivery methods are being implemented to improve the infrastructure?

SOLUTIONS TO RAISE THE GRADE

As Vermont residents learn about infrastructure needs and decision-makers work to address them, ASCE members in Vermont offer the following suggestions to start raising the grade:

IMPROVE RESILIENCE TO POTENTIAL CATASTROPHIC EVENTS

Roads, bridges, transit systems, and other civil infrastructure need to offer high-quality service all-day and all-week. A global pandemic, weather-related disaster, or cybersecurity threats can wreak havoc on supply chains carrying goods for purchase and manufacturing. Our infrastructure requires improved conditions, redundancy, and resilience so demand or supply shocks do not devastate the whole network.

ADDRESS WORKFORCE CHALLENGES

A surge of retirements at state and local government agencies is draining institutional knowledge when project development and implementation are crucial to the best use of an historic funding surge. Agencies are struggling to retain younger engineers and other technical experts as they advance, especially women. The workforce crisis hitting construction and skilled labor further hampers implementation. This need ranges from adding more permanent FTEs to ensure enhanced dam safety and to expanding energy transmission capabilities as Vermont charges onward to meet its ambitious renewable energy goals.

ADAPT FUNDING OPPORTUNITES TO MEET FUTURE NEEDS

It is critical to implement federal funds while reconsidering methods of state and local funding. Strong revenue mechanisms aligned with planning goals can close investment gaps and provide long-term revenue certainty. Large-scale federal investments provide great opportunity: remaining balances of the 2021 American Rescue Plan Act, the 2021 Bipartisan Infrastructure Law, and the 2022 Inflation Reduction Act. Continuing to pursue competitive grants from Congress is critical while re-evaluating the ways Vermont generates revenue. Dedicated state and local funding streams are often insufficient and sometimes contradictory to long-term targets. Currently, funds are generated in proportion to the amount of trash disposed, while Vermont aims to aggressively increase diversion and reduce rates of household waste. Vermont's gas tax has lost power to support road infrastructure due to inflation and the uptake of more efficient vehicles and fleet electrification, a trend the state is actively encouraging.

BALANCE THE NEEDS OF URBAN AND RURAL COMMUNITIES

Vermont's communities are diverse in structure and density, with equally diverse infrastructure needs and investments required to meet them. Urban infrastructure projects may benefit a larger number of people, but funding for rural infrastructure ensures that all Vermonters have equitable access to jobs and a strong quality of life. Rural communities have limited resources to leverage available grant sources and may need continued technical assistance.

PROMOTE PEOPLE-FOCUSED, SUSTAINABLE INFRASTRUCTURE

Infrastructure is for people: efforts must be resilient, sustainable, and equitable. Engineers should plan and implement the "right" projects according to economic, environmental, and social effects. Decision-makers must engage residents and community groups with an aim to include the needs of all users of systems. Project planning should include life-cycle cost assessments to account for tomorrow's maintenance and resilience expense – in addition to today's construction cost – and the social benefits or costs of disruptive changes to the built environment. Vermont has great models of collaborative design and implementation. These should be fostered and enhanced to meet long term resilient and sustainable infrastructure goals.

INVEST IN WATER INFRASTRUCTURE

Vermont's water infrastructure is among the lowest scoring infrastructure categories. Strategic planning and investment of time, innovative minds, and fiscal resources in these areas is important to ensure a healthy and prosperous environment and population for decades to come.

ADVOCATE AND PARTICIPATE

Vermont has a proud tradition of advocacy and public involvement. We need to channel that energy toward improving the infrastructure that Vermonters rely upon. Talk to your legislators, reach out to decision-makers, and let them know about the importance of maintaining the public assets that protect our health, safety, and welfare.

GRADING SCALE

EXCEPTIONAL: FIT FOR THE FUTURE

The infrastructure in the system or network is generally in excellent condition, typically new or recently rehabilitated, and meets capacity needs for the future. A few elements show signs of general deterioration that require attention. Facilities meet modern standards for functionality and resilient to withstand most disasters and severe weather events.

GOOD: ADEQUATE FOR NOW

The infrastructure in the system or network is in good to excellent condition; some elements show signs of general deterioration that require attention. A few elements exhibit significant deficiencies. Safe and reliable with minimal capacity issues and minimal risk.

MEDIOCRE: REQUIRES ATTENTION

The infrastructure in the system or network is in fair to good condition; it shows general signs of deterioration and requires attention. Some elements exhibit significant deficiencies in conditions and functionality, with increasing vulnerability to risk.

POOR: AT RISK

The infrastructure is in poor to fair condition and mostly below standard, with many elements approaching the end of their service life. A large portion of the system exhibits significant deterioration. Condition and capacity are of significant concern with strong risk of failure.

FAILING/CRITICAL: UNFIT FOR PURPOSE

The infrastructure in the system is in unacceptable condition with widespread advanced signs of deterioration. Many of the components of the system exhibit signs of imminent failure.

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SPECIAL THANKS TO

VT-ASCE Board of Directors
ASCE Infrastructure Initiative Staff & Committee on America's Infrastructure
VT Agency of Natural Resources (VTANR)
Vermont Agency of Transportation (VTrans)

AVIATION

2023 Grade: C | 2019 VT: C- | 2021 Nat'l Grade: D+

SUMMARY

Vermont is home to 16 public-use airports, 12 of which are included in the National Plan of Integrated Airport Systems (NPIAS). A 69% year-over-year reduction in passengers served and 33% drop of scheduled flights in 2020 temporarily alleviated Burlington International Airport's (BTV) terminal capacity challenges before the COVID-19 pandemic. Federal funds secured in 2021 allow BTV to increase its terminal apron and construct a 37,000-sf addition to the building for flight and passenger growth. All of Vermont's NPIAS facilities have "fair" or better pavement condition with most runways "good" or "excellent." Increased FAA funding and fee increases would close a projected funding gap for 2023 through 27. BTV's estimated investment need in those years is $73 million, plus $66 million for the other state airports – compared to a projected $61 million and $25 million funding availability, respectively.

CONDITION & CAPACITY

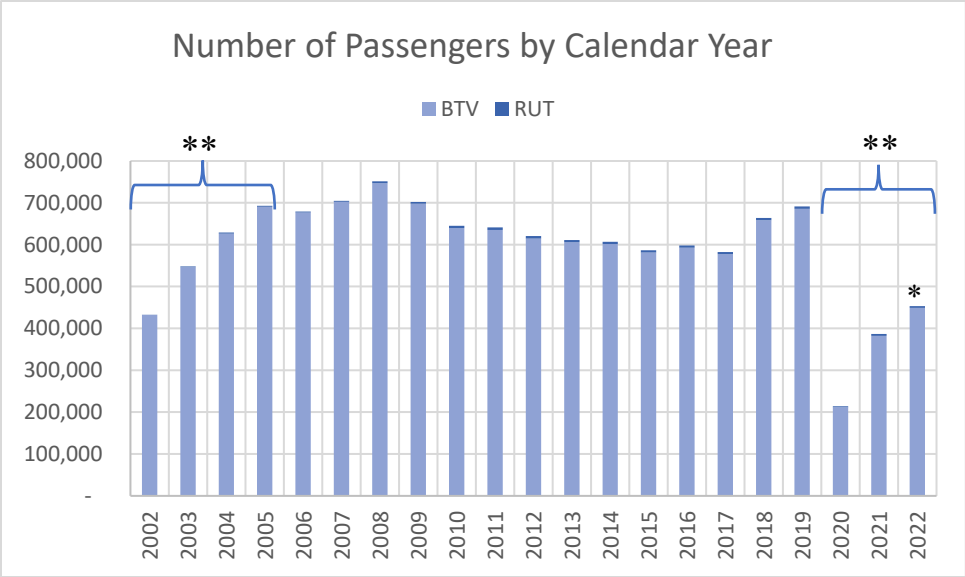
Vermont's aviation infrastructure is comprised of 16 public-use airports serving both commercial and general aviation needs. The network consists of:

- 10 state-owned airports
- 1 municipally-owned airport
- 5 privately-owned airports

Of these 16 public-use airports, only 12 are included in the National Plan of Integrated Airport Systems (NPIAS): airports determined to be of significance to the national air transportation network. These airports are eligible for grants through the FAA's Airport Improvement Program (AIP). The NPIAS network in Vermont consists of two Commercial Service Airports and 10 General Aviation Airports. Over 99% of all airline passengers in Vermont fly through Burlington International Airport (BTV), so much of the data and statistics for Commercial Service Airports is focused on BTV.

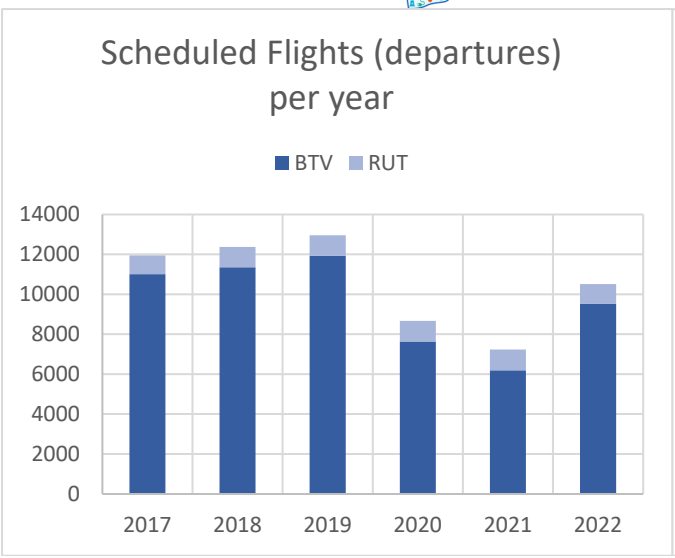
Leading up to the Covid-19 pandemic, Vermont Commercial Service Airports were experiencing growth in number of annual passengers, total freight, and scheduled flights. Although the growth in total freight continued to climb in 2020 following the onset of the Covid-19 (22% growth over prior year), the number of annual passengers and scheduled flights experienced a steep decline (69% and 33% decrease from prior year, respectively). Since 2021, the number of annual passengers and scheduled flights are rebounding, while the total freight/mail appears to be returning to pre-Covid-19 conditions. If the rate of rebounding which occurred between 2020 and 2022 continues, we could see the number of annual passengers and scheduled flights restored to pre-Covid-19 levels as soon as 2023.

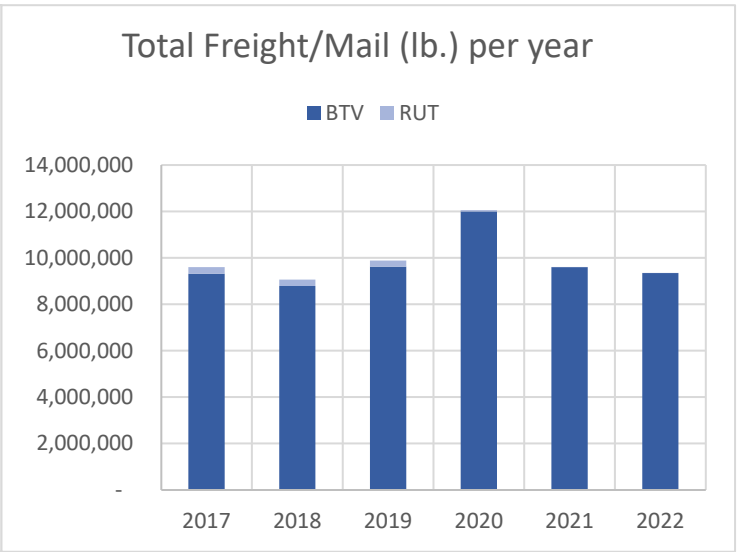
Prior to the onset of the Covid-19 pandemic, BTV had been experiencing some capacity issues associated with terminal operations. Holding rooms had been constructed to accommodate the number of passengers associated with regional jets (approx. 75 seats), whereas operations at BTV were trending towards more mainline aircraft (approx. 150 seats). This trend towards a larger aircraft was also creating issues with terminal apron capacity for parking the larger aircraft. The reduction in number of passengers and flights since the onset of Covid-19 provided temporary relief. Meanwhile, in 2021 BTV was able to secure AIP funding to expand the terminal apron as well as continue constructing a 37,000-sf addition to the terminal building.



** Data only available through September 2022. Year-end totals expected to be as much as 25% higher.*

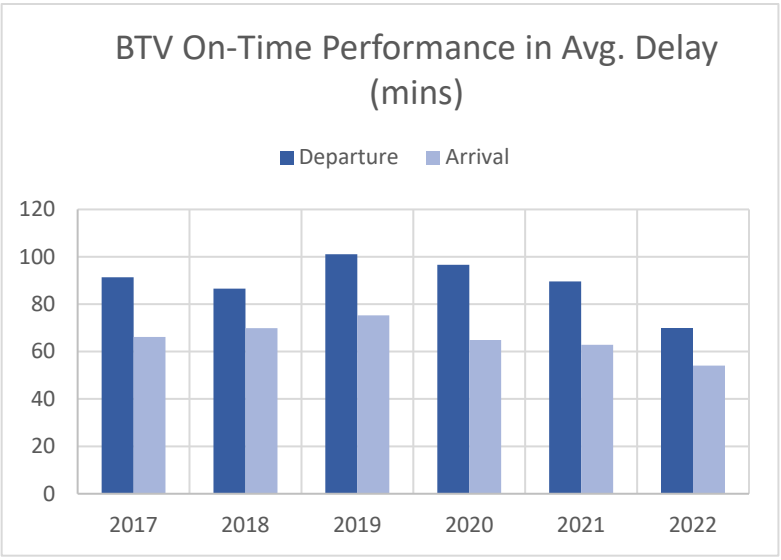
*** From 2002 to 2005 the airline industry experienced rebounding from the impacts of September 11, 2001. We see a similar rebounding trend from 2020 to 2022 following the onset of the Covid-19 pandemic in 2020.*



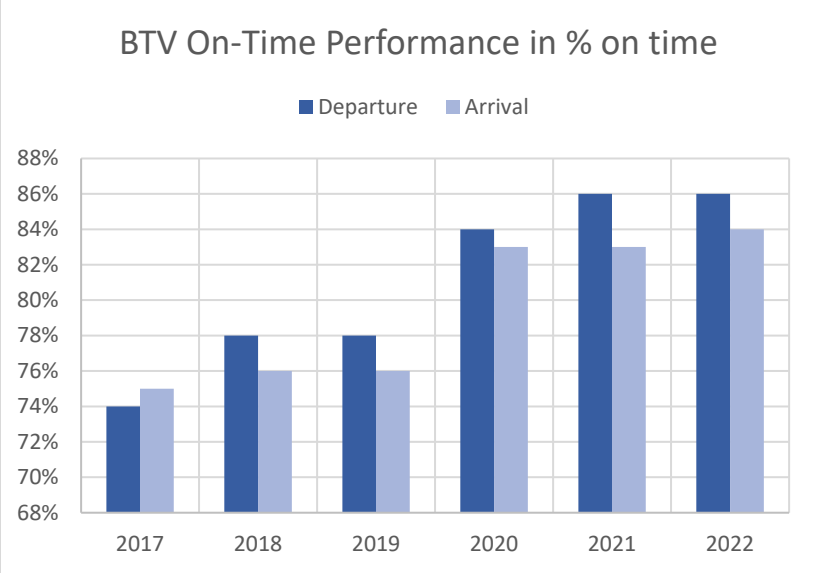


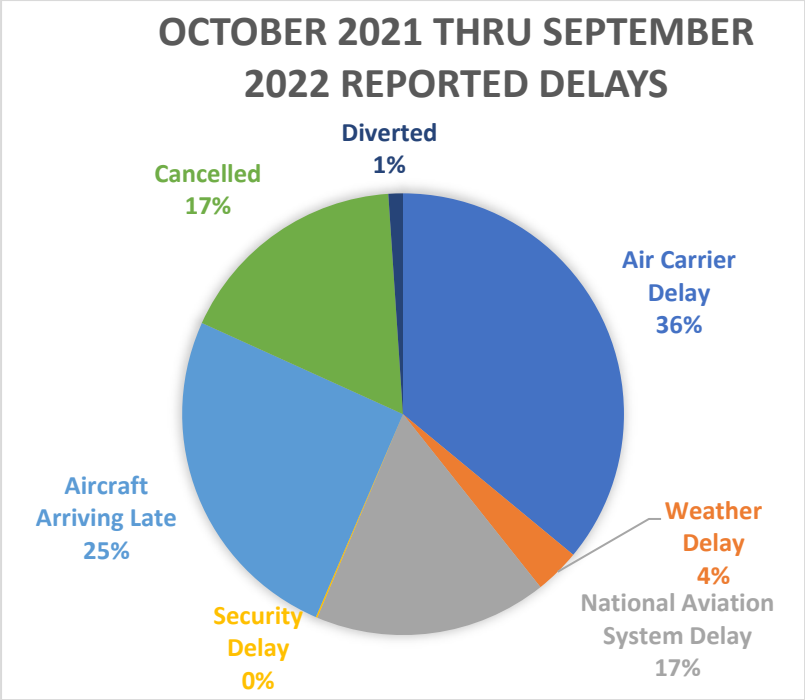
Note: the number of flights is reported by airlines and does not include general aviation flights or military flights (BTV is both a commercial and military airport).

Another key indicator of capacity in the Aviation Industry is flight delays. From 2019 to 2022, the percent of on-time flights at BTV increased over 10%, while the average flight delay, reported in minutes, decreased 30%. The challenges facing BTV moving forward will be maintaining these improvements in delayed flights while the number of flights continues to rebound. For the other 10 Vermont airports in the NPIAS Network, specifically the general aviation airports with far fewer operations than the commercial service airports, the number of operations has less of an impact on capacity than the availability of facilities and services provided at each of those airports. In August 2021, the Vermont Agency of Transportation issued a Vermont Airport System Plan (VASP), which is a long-term strategic plan for the development and maintenance of the State's public-use airports. The VASP focuses on the system performance of the network of public-use airports in Vermont as a means to ensure capacity is maintained and added where it is needed throughout the State. The Top Priority Improvements listed in the VASP include adding precision and non-precision approach capabilities, building basic terminal shelters, and extending runways for various public-use airports throughout the State as a means to improve the capacity of the overall system.



Fortunately, the condition of runways at the Vermont NPIAS network airports continues to exceed the FAA's minimum system performance goal that 93% of paved runways are reported to be in fair, good, or excellent condition. The *2021 ASCE Report Card on America's Infrastructure* reports that 97.9% of runways at NPIAS airports nationwide were rated as fair or better condition in fiscal year 2019. In Vermont, that metric is 100%. The VASP, issued in 2021, reports that most airports have runways in good or excellent condition. One airport is reported to be in fair condition.





FUNDING & FUTURE NEED

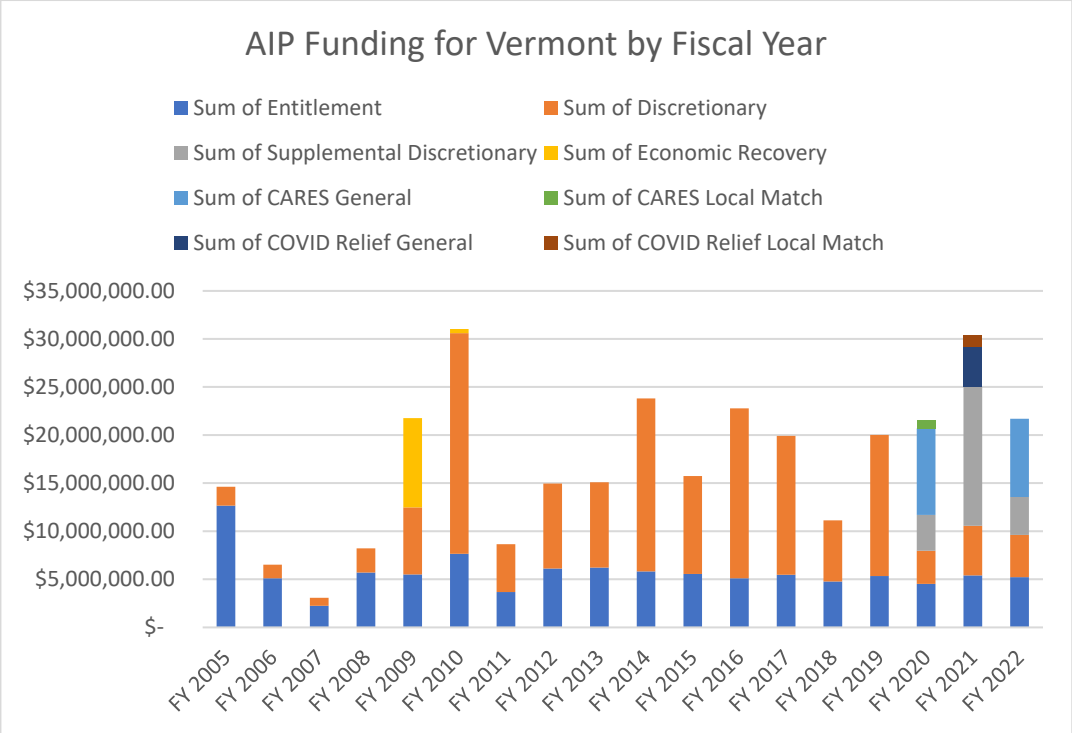
Airports within the NPIAS system are eligible for funding through the FAA Airport Improvement Program (AIP), which funds up to 95% of the cost of a project. AIP Funding is generally distributed via entitlement funding and discretionary funding. The entitlement funding for the State of Vermont is estimated at ±$1,910,000 in AIP funding each year, whereas BTV is estimated at ±$3,500,000.

Although discretionary funding is not guaranteed, Vermont has been very successful at leveraging these additional funds. The NPIAS Report to Congress for 2015-2019 estimated the funding needs for Vermont NPIAS airports at $64,554,072. During that same period, Vermont actually received over $89M in entitlement and discretionary funds for projects.

Unfortunately, discretionary funding is never guaranteed and fluctuates from year to year. Meanwhile, the amount of entitlement funding provided has remained stagnant for the last 10 years, and is not sufficient alone to cover the needs of Vermont airports.

Since the onset of Covid-19, over $40M of additional funding came to Vermont through supplemental discretionary, Covid Relief, CARES, and Economic Recovery funding programs. This funding went towards capital projects, as well as general administration, operations, and maintenance costs. This funding allowed for airports to continue operating even when the number of flights and passengers has been drastically reduced.

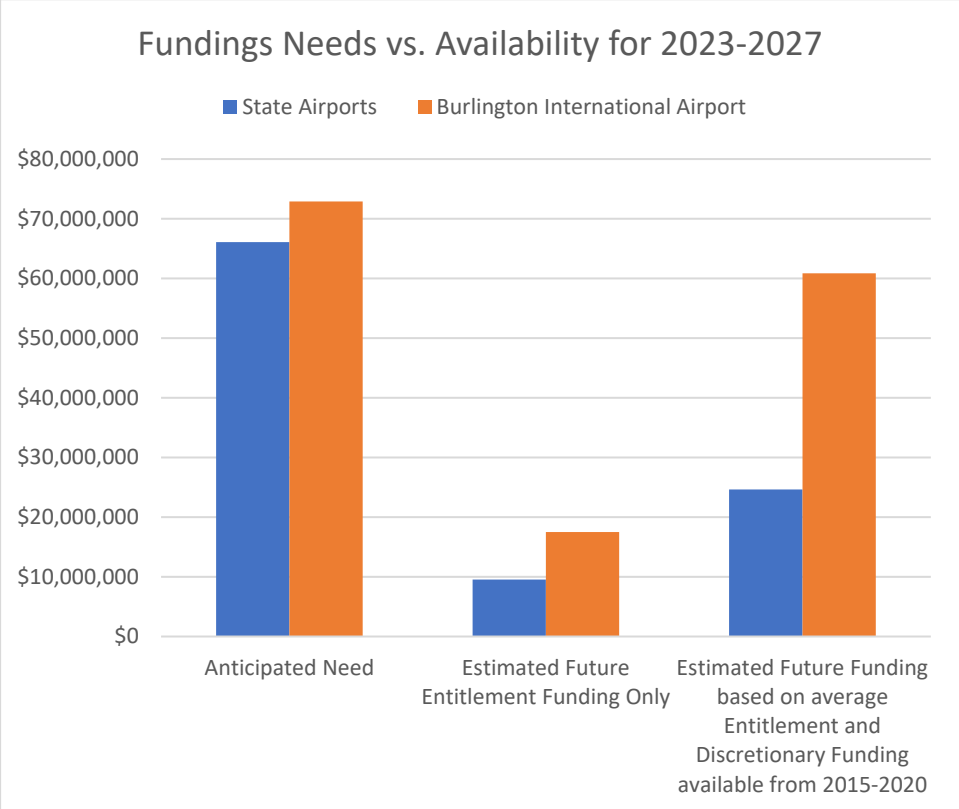
Commercial Airports can use additional funding through the FAA's Passenger Facility Charge (PFC) program. Since 2000, the PFCs have been capped at $4.50 per flight segment. Increasing the PFC cap has been discussed on a national level but has not been implemented. Given inflation and the airport industry growth over the last 22 years, this crucial funding source for commercial airports is becoming less and less effective.



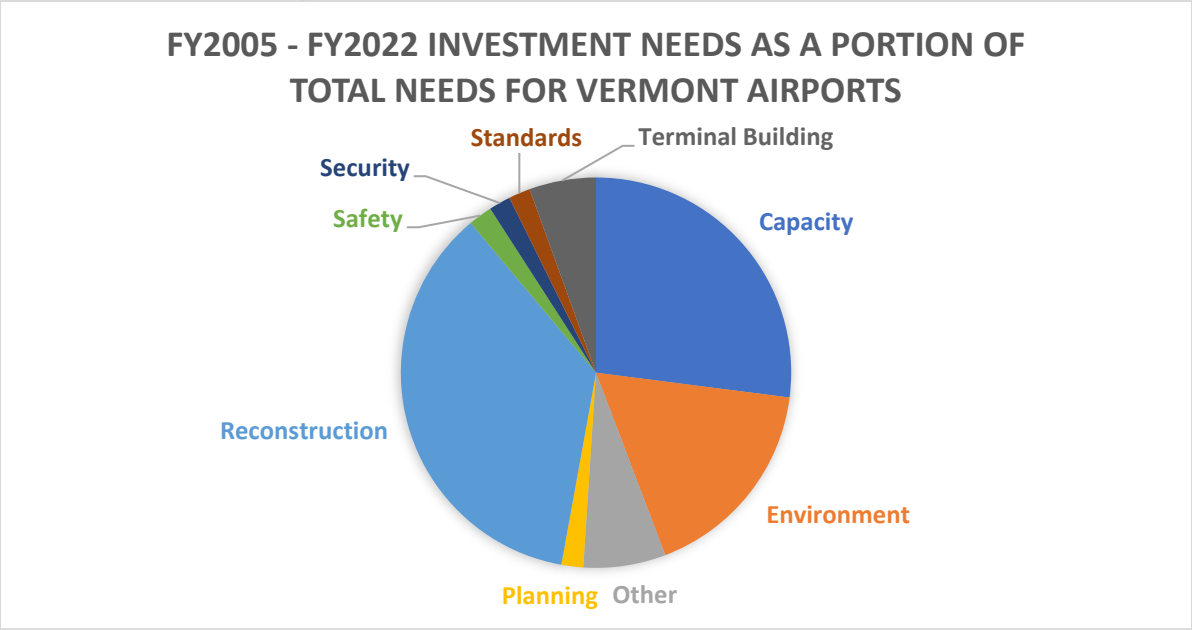
To provide a sense of the current and future infrastructure needs in Vermont, we look to the NPIAS Report to Congress for 2023 to 2027. The report estimates that Vermont state airports need approximately $66 million over this five-year period. Given their entitlement funding is only ±$1,910,000 per year, approximately 86% of the needs would go unmet without discretionary funds and other sources of supplemental funding. The BTV funding need is approximately $73 million during this same time period. Given their entitlement funding is only ±$3,500,000 per year, over 76% of the needs could go unmet. Even if we assume that discretionary funding is available for 2023 to 2027 at the same average annual rate as from 2015 to 2020, 63% of the Vermont state airport needs would go unmet and 16% of BTV's needs would go unmet.

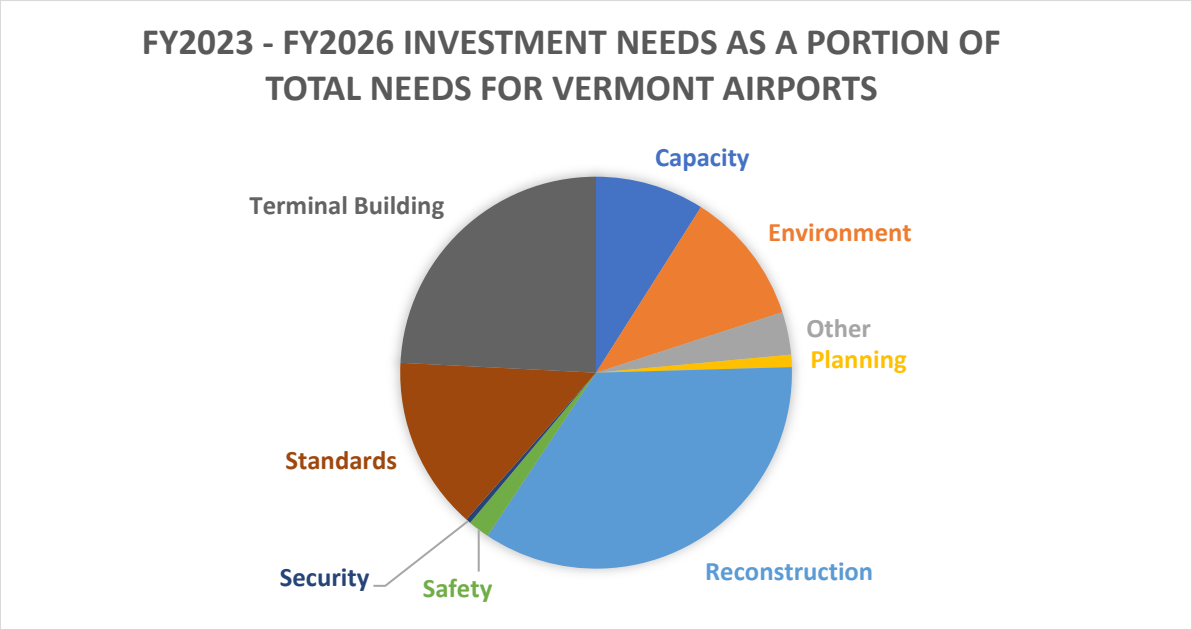
The Infrastructure Investment and Jobs Act (IIJA) includes $25B for airport infrastructure projects from 2022 to 2026, which is above and beyond the current $3.35B per year that is currently authorized for AIP funding. An estimated $28M of the IIJA funds are anticipated to be available for Vermont airports over the five year period, but given the variability of discretionary funding from year to year it is unclear whether this funding will bridge the gap between infrastructure needs and available funding. The IIJA airport infrastructure funds

are derived from the Treasury general fund and can be used for any airport-related project as defined under the existing AIP and PFC criteria. In the short term, this addresses two issues: 1. AIP and PFC programs are largely funded from airport user taxes and fees, which are not resilient to catastrophic events such as the Covid-19 pandemic, and 2. It takes some pressure off the need to increase the PFC cap. The IIJA reflects the type of resiliency and flexibility that needs to be incorporated into the AIP and PFC programs for future years beyond 2026.



From 2005 to 2022, 80% of all airport projects in Vermont were focused on reconstruction/repair of existing infrastructure, building capacity associated with the airfield, and environmental projects including the implementation of noise compatibility programs. Those types of projects continue to be dominant for the future needs outlined from 2023 to 2026 at 55% of overall needs, but there are two other categories of projects which are targeted for significant needs: terminal buildings and projects aimed at supporting airports in their attainment of recommended airport design standards. It is estimated that from 2023 to 2026, the needs related to terminal buildings is 24% of the overall need. This follows national trends for small hub airports, which are seeing 36% of all needs in the terminal building category. The other project category which has significantly increased needs in the future is the standards category. For Vermont this translates largely to meeting the standards with respect to snow removal. The majority of the funding needs in the standards category, which in total is estimated at over $24M, are proposed for snow removal equipment and snow removal buildings.





Given the significant economic benefit provided by both civil aviation and commercial airports in Vermont, it is imperative to maintain and improve upon this critical infrastructure. The Economic Impact of Civil Aviation on the U.S. Economy publication, dated November 2020, estimates that in 2016 Vermont civil aviation accounted for $1.195 million in output, $304 million in earnings, $644 million value added, and 8,917 jobs. Similarly, The Economic Impact of U.S. Commercial Airports in 2017 publication, estimates that Vermont commercial

airports, which includes Rutland Southern Vermont Regional and Burlington International Airport, accounted for $264 million in payroll, $688 million in output, and 8,000 jobs. It is important to consider the value aviation provides when discussing future investments in infrastructure.

OPERATIONS & MAINTENANCE

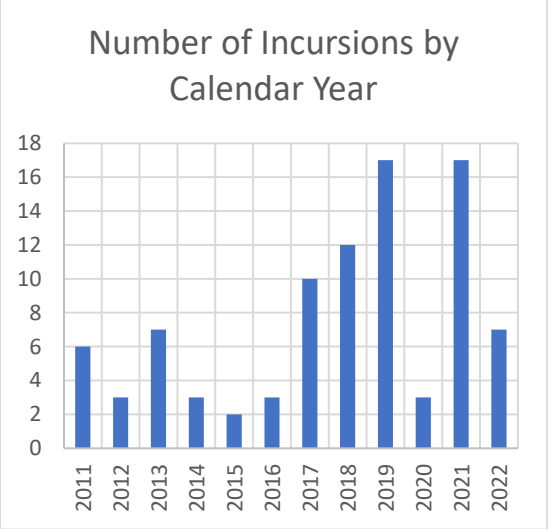
Vermont airports are in need of significant investment for projects aimed at repairing and reconstructing existing infrastructure, with an estimated average annual need of $15.1M for 2023 to 2026. This is more than double the annual average need for reconstruction type projects over the last five-years of $7.3M from 2018 to 2022.

Operations and maintenance are managed very differently between State-owned airports and BTV. The State has a small team of full-time employees and will bid out operations and maintenance services to contractors, or rely on internal resources for support. Only 10 of the 16 public-use airports provide snow removal services, with 9 of the 10 State-owned airports undertaking timely snow removal resulting in 90% of the State-owned network being available, compared to the general lack of availability during snow events at privately owned airports. The ongoing need to upgrade snow removal equipment is driving the increased need for funding snow removal projects identified in the capital improvement programs for 2023 to 2026.

Adding airport operations and management staff is included in the VASP as both top and mid-term priorities for a variety of public-use airports across the State. An additional $4.6M is estimated for needs related to operations and maintenance at airports statewide from 2023 to 2026.

INNOVATION, PUBLIC SAFETY & RESILIENCE

Public safety is a top priority for FAA and all of the Vermont airports. Information is provided on an airport diagram with respect to hot spots which alert airport operators to a location on the airfield with a history or potential risk of collision or runway incursion. Data related to the number of incursions reported in Vermont (all logged at BTV) show that the annual average from 2011 to 2016 of 4 incursions per year increased to 12 incursions per year from 2017 to 2021. In 2021, BTV implemented a $1M+ project to install runway incursion lighting and pavement markings. This project appears to have a significant positive impact on safety as the number of incursions dropped by 60% from 2021 to 2022.



Note: None of the incursions were categorized as a serious incident

The average annual need for safety projects from 2023 to 2026 is $770K per year. This is a 57% increase over the annual average need for safety projects over the last five-years from 2018 to 2022 of $492K.

Significant progress has been made in recent years with respect to safety, innovation, and resiliency. Some examples include terminal and airfield access control system rehabilitation at BTV, perimeter fence installation at various state airports, removal of obstructions at all airports, installation of state-of-the-art computed tomography (CT) scanners in the new BTV TSA checkpoint, and power upgrades at BTV to ensure airport operations continue during power outages. BTV is also home to the headquarters of BETA Technologies, an aerospace company specializing in the development, test and certification of electric vertical takeoff and landing vehicle (eVTOL) aircraft, propulsion systems and charging pads. The company is on the forefront of innovation with their developments in the electric aircraft, and have brought hundreds of jobs to Vermont. They are currently building a new manufacturing facility which will drive even more advancement and employment.

The Covid-19 pandemic has brought much needed emphasis on the topic of resiliency. Supplemental discretionary funds have been available to airports over the last couple of years to replace lost revenues, but that might not always be the case in the future. At BTV, the Airport's agreement with the Airlines allows the airport to increase rates on the airlines if needed to maintain a minimum debt ratio of 1.5x. This was built into the contract to ensure resiliency against unexpected changes in operations. As we move forward, this type of resiliency should be explored across all Vermont airports and related operations.

SOLUTIONS TO RAISE THE GRADE

- Accelerate and increase investment in Airport Improvement Programs, and other projects which increase both airfield and terminal building capacity.
- Increase entitlement funding through AIP grants to provide for more stabilized funding forecasts.
- Evaluate existing airport revenues, contracts, and operations for opportunities to increase resiliency against future interruptions to the aviation industry.
- Encourage state leaders to advocate in Congress for increased funding for the AIP program and removal of the PFC cap.

AUTHORS/CONTRIBUTORS

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Amanda has a Bachelor of Science in Civil Engineering from the University of Vermont, Master of Business Administration from the University of Rhode Island, and is licensed as a Professional Engineer in the State of Vermont. She is also Vermont's 2011 Young Engineer of the Year. Amanda has filled several positions including an assistant traffic engineer for the Rhode Island Department of Transportation, transportation staff engineer for Stantec Consulting Services, research program manager for University of Vermont Transportation Research Center, and Director of Engineering and Environmental Compliance at the Burlington International Airport. Amanda also served as the 2009-2010 President for the Vermont section of the American Society of Civil Engineers.

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BRIDGES

2023 Grade: B- | 2019: C+ | 2021 Nat'l: C

SUMMARY

In the last few years, the number of poor condition bridges in Vermont has decreased to 2.4% of the inventory – down from 5% in 2017 and well below the national average. Thanks to the federal 2021 Bipartisan Infrastructure Law, Vermont's FY 2023 transportation program shows an increase in federal funding for bridge projects of approximately 27% compared to the average federal contributions over the previous four fiscal years. Although the number of poor condition structures decreased, their age is increasing. In comparison to the national average bridge age of 44 years, Vermont's bridges average 59 years. Despite the progress made on bridges in the National Bridge Inventory, the older age and worse condition of shorter span bridges in and culverts in Vermont requires greater attention in the coming years. Increased funding for replacements, development of efficient designs, and innovative construction methods will be needed to improve the condition of these structures.

CONDITION & CAPACITY

Bridges are a vital component to the transportation network, creating links between communities allowing the movement of people, goods, and services. Vermont has 2,809 bridges (greater than 20 feet) on interstate, state, and town highways. Vermont inspects these bridges at least every two years in accordance with the National Bridge Inspection Standards (NBIS). There are an additional 1,260 short structures (less than 20 feet) in Vermont's transportation network.

According to the National Bridge Inventory (NBI), approximately 2.4% of Vermont's bridges were in poor condition in 2022, down from 5% in 2017. It should be noted that the rating system has changed from classifying structures as structurally deficient to classifying them as being in poor condition since the 2019 report. The total bridge area that was in poor condition in 2022 was 3.9%. Nationally, just under 7% of all bridges are in poor condition, or 5% by bridge area. While not necessarily unsafe, bridges in poor condition may have imposed limitations for speed and weight, thereby affecting performance of the transportation system. These bridges must also be inspected on a more frequent basis to ensure safety which increases maintenance and operation costs. FHWA classifies a bridge as spanning an opening of more than 20 feet. It is very common that bridges crossing small streams or river headwaters are less than this span. There are many locations across the state where culverts under 20 ft in width exist to handle hydraulics as well. For the purposes of this report, structures with greater than 20 ft spans will be referred to as NBI structures, and those with less than 20 ft spans will be referred to as short structures. The breakdown of Vermont bridges listed as long (NBI) and short structures is shown below in Table 1.

TABLE 1 Vermont "Highway" Structural Population

	Interstate	State Highway	Town Highway	Other	Totals
Long Structures	314	815	1673	7	2809
Short Structures	204	1056	*	*	1260
Totals	518	1871	1673	7	4069

* VTrans does not maintain an inventory of or inspect town highway or other short structures

Due to the Federal Highway Administration's (FHWA) definition of bridges, many of Vermont's short span bridges and culverts beneath roadways are not counted in the FHWA conditions report.

The percentage of Vermont's bridges in poor condition is at historically low levels and is well below the national average. Vermont has many accomplishments it can be proud of that have led to the low level of poor condition bridges. However, significant challenges remain in the near future.

Many of the state's bridges were constructed in the post-1927 flood-era and during the construction of the Interstate Highway System (1958-1978). Bridges of these eras were designed for a life of 50 years and because of this, Vermont is now finding many of them to be beyond their useful design life. For NBI bridges, 60% are 50 years or older, and 31% are 80 years or older. Similarly for short span bridges, 80% are 50 years or older, and 30% are 80 years or older, according to the 2022 VTrans Factbook.

This trend is similar nationally that while the number of structurally deficient bridges is decreasing, the average age of the bridges continues to go up. Aging bridges typically require increased funding for repairs, operations, and maintenance. Vermont's average bridge age is 59 years, compared with the national average of 44 years. Figure 1 provides a structure count by age.

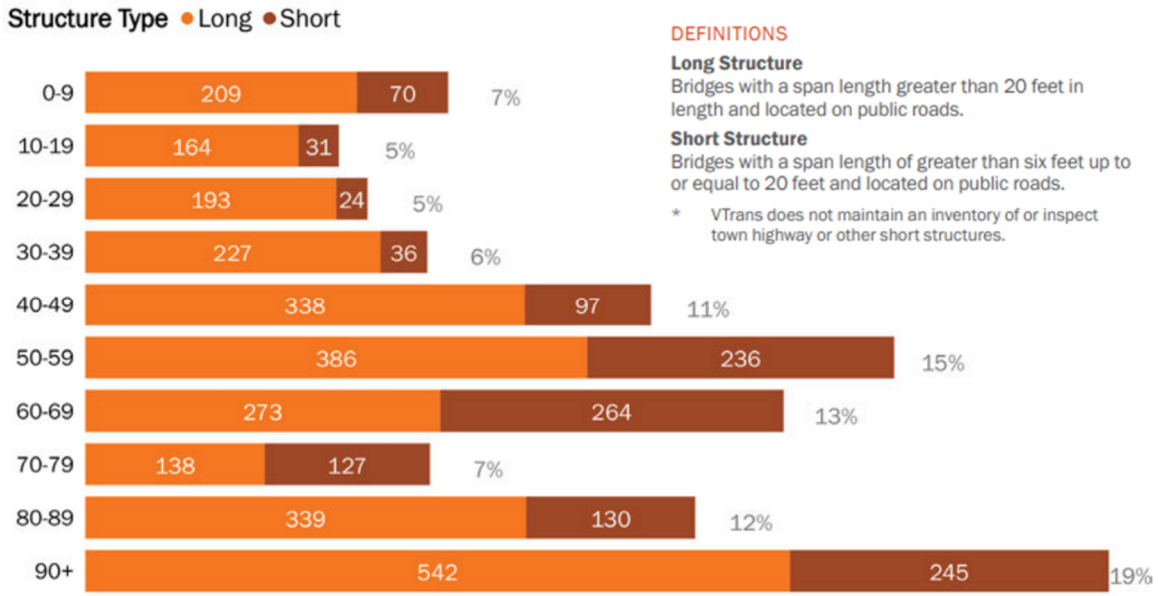

FIGURE 1 Structure Count by Age (in years)

O&M, FUNDING & FUTURE NEED

Bridge funding comes from federal, state, and local sources. Vermont does not have any tolls to generate transportation revenue. The federal government passed the bipartisan Infrastructure Investment and Jobs Act in 2022, authorizing $110 billion to roads and bridges nationwide. Vermont's FY 2023 transportation program shows an increase in federal funding for bridge projects of approximately 27% when compared to the average federal contributions over the previous four fiscal years.

In general, the federal government's share of a capital project is 80%, or up to 90% if the project is located on the Interstate System. Similar to many states, federal funds are an important source of funding for Vermont. Bridge projects can often be funded by federal grants. This recent legislation will open more opportunities for funding from federal discretionary grants in Vermont.

State funding for bridges comes from a combination of sources, including a 31 cent-per-gallon gas tax, proceeds of which are directed to the transportation network. Table 2 provides a summary of the Vermont Agency of Transportation's (VTrans) bridge budget and funding sources.

TABLE 2-VTrans Bridge Budget

	FY 2019 as passed	FY 2020 as passed	FY 2021 as passed	FY 2022 as passed	FY 2023 as passed
Interstae Bridges	$ 24,543,000	$ 30,831,313	$ 22,653,892	$ 22,595,374	$ 36,731,681
State Highway Bridges	$ 57,636,326	$ 54,100,006	$ 67,955,839	$ 49,252,858	$ 57,838,207
Town Highway Bridges	$ 13,324,994	$ 13,833,851	$ 13,073,351	$ 15,408,394	$ 30,314,187
T-Fund	$ 5,943,702	$ 6,510,446	$ 5,075,059	$ 9,143,572	$ 8,199,502
TIB	$ 5,375,346	$ 6,138,430	$ 2,822,132	$ 7,199,994	$ 10,223,250
Federal	$ 81,554,815	$ 85,176,627	$ 93,597,765	$ 70,381,623	$ 105,309,922
Local	$ 692,332	$ 939,667	$ 388,726	$ 531,437	$ 1,151,401

The Town Highway Bridge Program provides funding for local bridge projects. The Transportation Fund (TFund) is funded by a diverse set of gasoline and diesel taxes, purchase and use taxes, and motor vehicle fees. The Transportation Infrastructure Bonds (TIB) are issued by the state and are repaid by a flat $0.03 per gal of diesel fuel and 2% of the retail price of motor fuel. The existing funding model is not sufficient to address the state's need for bridges, as the state continues to find a shortfall in revenues.

Despite this recent shortfall in funding in previous years, Vermont has made significant progress in addressing bridge needs. Vermont passed the largest funding budget for FY 2023 then it has seen in the past 4 years. VTrans has set a goal for percentage of bridges that are structurally deficient at 6% for the interstate, 10% for state bridges, and 12% for town bridges. Between 2005 and 2022 the deficiency status of interstate, state, and town bridges has greatly improved as shown in Figure 2.

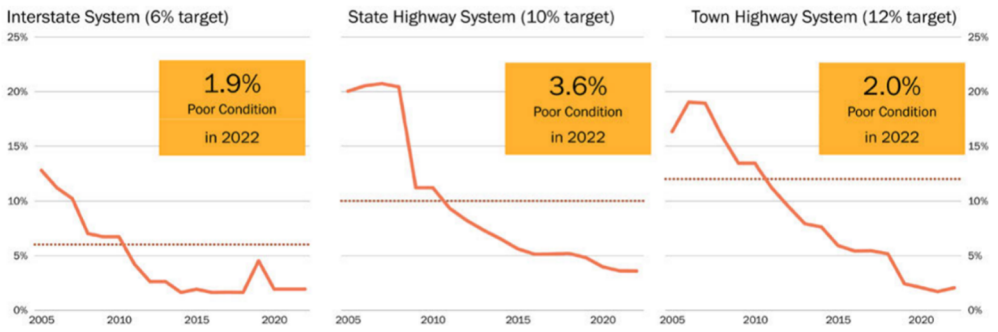

FIGURE 2 Percentage of Structurally Deficient NBI Structures

RESILIENCY

Over the past few years, VTrans has been revising its project selection and prioritization system. The system is used to identify, prioritize, and select state transportation capital improvement projects on the interstate, state and town highway system. The categories that influence this new system include safety, asset condition, mobility/ connectivity, community, economic access, environment, resiliency, and health access. This contrasts with a previous method of project prioritization, which mainly accounted for asset condition and safety above other measures.

Along with this system, the state uses the Statewide Highway Flood Vulnerability and Risk Map to define the risk of failure during significant storm events for structures and roadways, and can help determine which structures and roadways will impact travel the most around the state. This system can show which structures need to be considered most when scheduling replacements that help major roadways stay open during large storm events.

By using data to help aid decisions, the transportation value of projects in Vermont can be maximized and resilience of future projects to the effects of climate change can be increased. In addition, this project prioritization system will provide a defined, consistent, and transparent process for selecting and prioritizing the projects that ultimately make up VTrans' Capital Program.

This project is currently in a two-year pilot program that in 2021 began to be used for paving, roadway, traffic, and safety programs. In 2022 this system started to be used for bridge programs. This system of selecting and prioritizing projects allows VTrans to select bridge capital programs in a 5-7 year window based on anticipated funding capacity in the bridge programs. The ability to look further out in to the future allows for better planning of preservation and maintenance activities and for more accurate modelling of predictive network conditions.

INNOVATION

Recent software advancements have allowed bridge designers to change the way they bring projects from design to delivery in the form of model-based design. Model based design is actively transforming how bridges are designed by moving from 2D lines on paper to 3D digital models. Vermont has been at the cutting edge of this transformation and has completed multiple bridge projects that have been model-based.

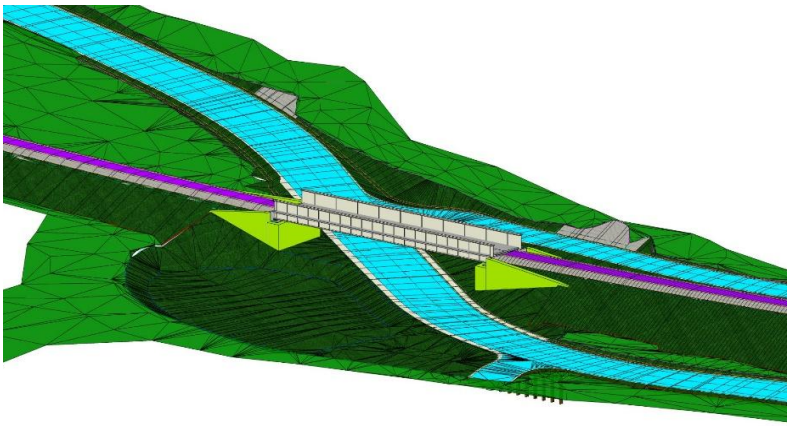

FIGURE 3 Railroad Bridge and Roadway Digital Model

The latest software allows engineers to develop bridge and roadway models for an entire project area and work through design challenges in 3D. Previous design software involved using a combination of views to see a project from different angles, and geometric data would typically come from other sources. With model-based design, engineers, contractors, and officials can all have geometric data combined with visual 3D bridge elements when reviewing a project.

This innovative technology is already changing methods for bridge design, but further honing of these systems will be necessary. As designs get more complex, standards for reviewing models will need to be developed. Within the software itself, resources will need to be needed to build databases of information and to program the software for Vermont's specific design criteria.

SOLUTIONS TO RAISE THE GRADE

Vermont has made strong progress in the past few years reducing the number of structurally deficient structures in its inventory. This being said, the number of aging structures continues to rise which has the potential to increase the number quickly unless these structures get replaced.

- Continued focus must be placed on bridges and culverts that are nearing the end of their useful life. While it may be easy to ignore problems that are out of sight, deep buried culverts can continue to cause problems when they fail. This is especially true with culverts on the interstate which are buried very deep and require months of design and development to replace.
- A long-term approach to funding that includes a shift from the standard fuel tax and addresses the reality of a future with more electric and fuel-efficient vehicles is needed. The funding needs to sustain continual investment in the state's bridges. Regular investment will ensure that the aging bridge and culvert inventory are addressed over time and not all at once.
- A continued emphasis on preservation of the bridge network, combined with necessary major bridge rehabilitation or reconstruction allows for a more proactive life cycle management of bridges on the network. By keeping up with fair condition bridges and not allowing them to slip into poor condition, the state can achieve a higher average condition ratings for a prolonged period of time.

AUTHORS/ CONTRIBUTORS

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Ryan is a licensed Professional Engineer in the state of Vermont. He graduated from the University of Vermont in 2017 with a BS in Civil Engineering. Ryan has been involved in bridge projects across Vermont, Connecticut, New York, and Massachusetts and has performed inspections for many of Vermont's railroad bridges on multiple state-owned rail lines. Ryan is a structural engineer at VHB and has previous experience in construction engineering.

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Mr. Wines earned a BS in Civil Engineering in 2019 and a BA in Engineering in 2019 from the University of Vermont and Saint Michael's College. Mr. Wines has worked with Stantec for 3 years as a structural engineer in its transportation department in Vermont. Mr. Wines is registered as a FRA bridge inspector and has worked on bridge inspections along the railroad in Vermont. Mr. Wines has also worked on bridge design in multiple states including Kentucky, New York, and Vermont. Mr. Wines is currently serving as the Younger Member Chair of the Vermont Section of ASCE.

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DAMS

2023 Grade: C | 2019 VT: C | 2021 Nat'l Grade: D

SUMMARY

Vermont's 1,115 dams serve a variety of purposes, including recreation, flood-control, and hydropower. 6% of Vermont dams are high hazard – if they fail loss of life is probable, as are damages to property and the environment. In the past four years, dam inspections went up 30% and the number of Vermont's dams known to be in poor condition dropped from 40% to 31%. Two dams experienced partial failure in the past four years. Higher sustained funding will improve the Vermont dam safety program such as by increasing permanent staff to six FTEs from today's two. Temporary funding has supported nineteen dam removals in the last four years. Additional federal money from the Bipartisan Infrastructure Law will help improve dam safety and removal of obsolete, decaying dams, but private and municipal dam owners report greater financial assistance is needed for maintenance and operations changes necessary to comply with recently improved dam safety regulations and needs identified in a 2022 State Auditor report.

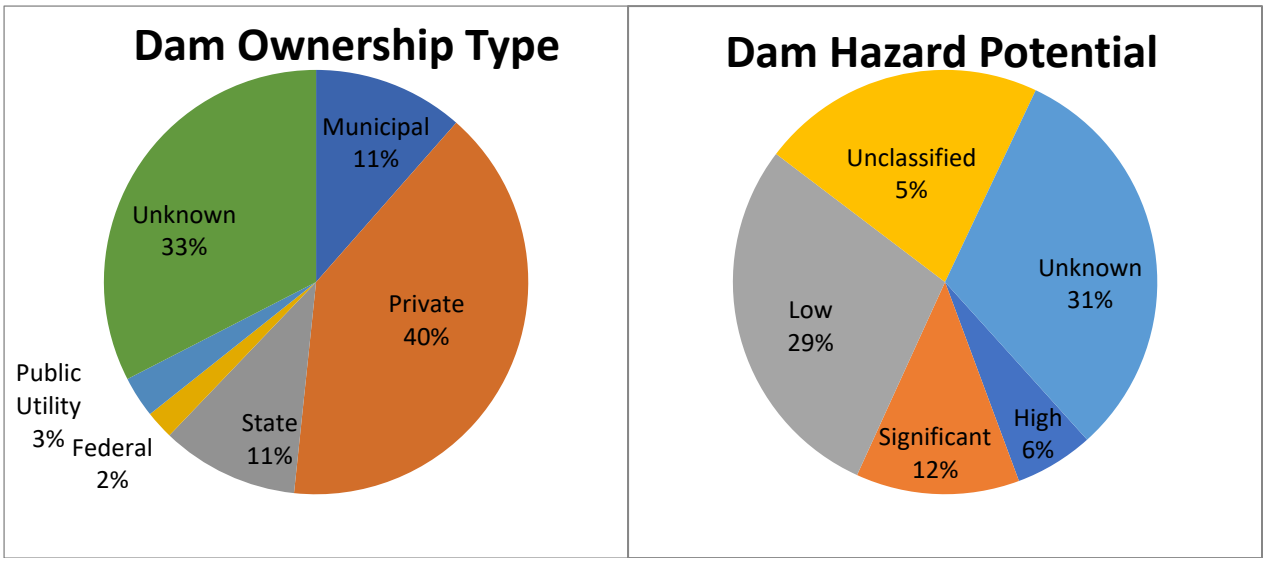
BACKGROUND

Vermont has 1,115 dams inventoried by Vermont Department of Environmental Conservation (VTDEC). 721 dams currently are in service, while the remainder have been breached, removed, or are obsolete. The functioning structures span a range of sizes and uses such as large flood control dams, medium hydropower dams, and small recreation dams. Vermont dams are aging with an average structure age of 80 years (range 7 to 232 years). The majority of dams are small and privately owned.

Some Vermont dams are owned and operated by federal, state, and local governments (Figure 1). VTDEC regulates 418 dams that are capable of impounding 500,000 cubic feet of water and sediment. HIGH and SIGNIFICANT hazard dams are visually inspected by two full-time VTDEC Dam Safety Engineers with assistance from two temporarily funded, limited-service engineers. The inspection frequency was recently set in the rule: 2 years for HIGH, 5 years for SIGNIFICANT, 10 years for LOW, and not required for MINIMAL.

The Federal Energy Regulatory Commission (FERC) regulates and inspects 79 dams in Vermont. The Vermont Public Utility Commission (PUC) regulates 20 non-federal power dams that are inspected by consulting engineers. The Federal Government owns, operates, and regulates about 24 dams in the State, including the U.S. Army Corps of Engineers, U.S. Forest Service, and U.S. Fish & Wildlife Service.

Of the dams in the Vermont Dam Inventory, 67 are HIGH hazard potential (6%) (Figure 2). A HIGH hazard classification is an indication that dam failure or mis-operation could lead to probable loss of life. An identified 139 dams are SIGNIFICANT hazard potential (12%) (Figure 2) meaning dam failure is not likely to lead to loss of life, but is expected to lead to economic loss, such as damages to downstream property and critical infrastructure, or environmental damage not expected to self-remediate within 5 years.



Figures 1 and 2: Summary of Vermont dam ownership and hazard potential.

The Vermont Dam Safety Statute, under which the VTDEC Dam Safety Program and the PUC are governed, was updated in 2018 with the passage of Act 161. The first part of the new rules that were adopted in 2020 include new hazard potential classifications (i.e., HIGH, SIGNIFICANT, LOW, MINIMAL); changing the definition for potential loss of life from "more than a few" to "Probable (one or more)"; and including environmental losses. Hazard potential classes, and now condition assessment rating definitions, were updated to align with definitions in the National Inventory of Dams. The second round of rulemaking that will provide guidance on design, construction, EAP, and operation and maintenance is anticipated to begin in the next year.

A 2022 State Auditor report on Vermont's Dam Safety program brought attention to areas needing improvement and provided recommendations. These program enhancements will require additional investment by the State.

CAPACITY

Most of the dams in Vermont (317 of 1,115) are used for recreation (Figure 3). Other common uses of dam include hydroelectric power, water supply, fish and wildlife, flood control. Many dams do not have a listed primary use, may be breached or obsolete, and are often ignored as they deteriorate.

One new regulated dam has been built in the last ten years and it supplies snow-making water to a ski area. No new dams have been constructed in the last four years. State Environmental rules prevent the construction of a new onstream dams.

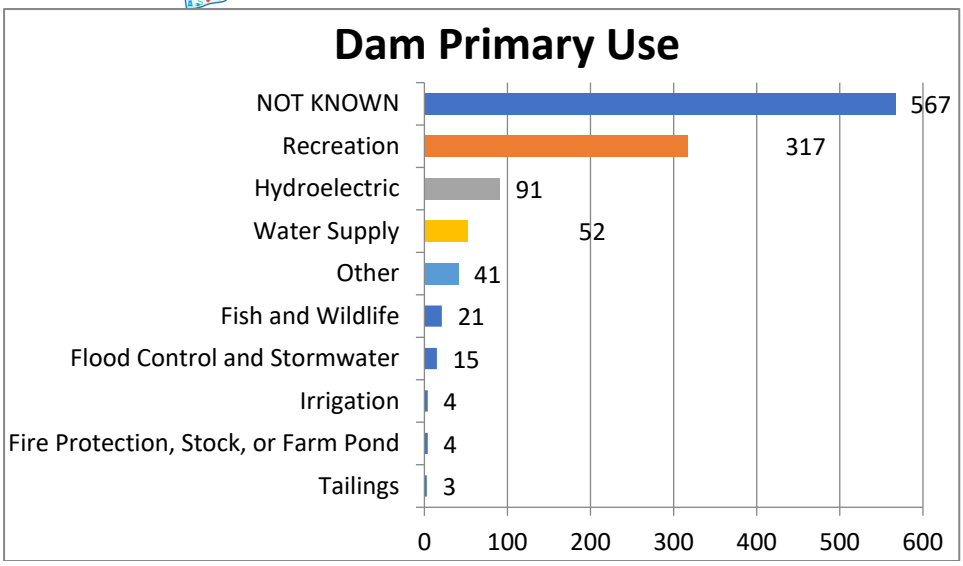


Figure 3: Summary of Vermont dam primary use.

CONDITION

There are 4 jurisdictional dams are in unsatisfactory condition, while 179 jurisdictional dams are in poor condition. 8 of these deteriorated structures are HIGH hazard potential dams. Poor condition dams make up 31% of the inspected dams – a decrease from 40% since 2018.

Small dams under partial jurisdiction of the State of Vermont are especially likely to be in poor condition. Many of these small structures are 50 to 100 years old and are not regularly inspected but are classified as MINIMAL hazard dams.

Enforcement to require dam owners to make repairs or needed improvements is difficult for VTDEC to carry out due to limited authority beyond the cumbersome unsafe dam proceedings. The state prefers to work with dam owners to collaboratively improve the condition of dams. A state revolving loan fund for dam safety improvements is needed to support costly repairs that promote public safety.

Once the new rules are complete and being put into action, a key challenge will be the funding necessary for owners to take action and bring their dams into compliance with the rules to protect public safety. A funding source that could be accessed by private and municipal owners would help to get dam safety projects completed and prioritize safety over enforcement proceedings.

The Act 161 rulemaking has started to update inspection and maintenance requirements. The PUC and FERC dams tend to be in good condition as they have uses that generate money, are regularly inspected and maintained, and have a process in place to implement repairs when deficiencies are identified.

OPERATION AND MAINTENANCE

The VTDEC Dam Safety Program does not have enough staff to keep up with the current inspection schedule, timely reporting, and other obligations. Some SIGNIFICANT and LOW hazard potential dams are not being inspected within an appropriate timeframe due to limited staff time. The State focuses on inspections of HIGH hazard dams to document the condition of the most high-risk or high-consequence dams first. The inspection rate has increased in 2022 with the addition of two temporary staff.

The PUC inspection frequency is lower than VTDEC recommendations and the need exists to synchronize inspection frequency. For example, HIGH hazard potential dams should be inspected by the PUC annually or every other year instead of every five years. The current PUC inspection schedule provides less opportunity to observe maintenance and safety issues between inspections. PUC has indicated that they will align inspection frequency with VTDEC during the Act 161 rulemaking process.

PUBLIC SAFETY

With many dams in poor condition and the recent increase in larger and more intense floods, the risk of dam failure is increasing. In the past four years, two partial failures have taken place and four emergency drawdowns have taken place to reduce downstream risks. Vermont has been lucky to not have had a recent complete dam failure leading to loss of life and damages.

"Hazard creep" has taken place at many Vermont dams where downstream development has occurred over time leading to increased risk of loss of life and damages if a dam were to fail. The dam hazard class has not been updated even though potential danger has increased over time. The state has started to conduct projects to update hazard classifications for groups of dams to realize actual risks. The number of HIGH and SIGNIFICANT hazard dams is likely underestimated in Vermont.

51 dams in Vermont have an Emergency Action Plan (EAP) in place. However, approximately one-third of the EAPs are out of date and have been completed with a low level of detail. New rules are expected to require full EAPs for HIGH hazard dams and a simplified EAP for SIGNIFICANT hazard dams. This change will increase public safety as more EAPs are developed when lifeline, property, and infrastructure losses may take place during dam failure.

FUNDING

Funding for operation and maintenance is the responsibility of the dam owner. However, dams typically receive little investment when they have limited use or are obsolete. PUC and FERC dams generate income from hydropower production and tend to get regular investment for required maintenance and improvements. Private dams that have limited use and no public funding mechanism are often unmaintained and progressively deteriorate until they breach during flooding. If a dam goes through unsafe dam proceedings, then dam owners are eligible for a $50,000 loan for repairs or a $25,000 grant for removal through the unsafe dam revolving loan fund created in 2014. One-time funding from FEMA and IIJA/Bipartisan Infrastructure Law funds are being used for high priority needs.

A need exists for a state funding program for private and municipal owners to provide the resources owners need to comply with new dam safety rules and bring dams into compliance to increase public safety.

Funding to the VTDEC Dam Safety Program has increased with new temporary staff positions that should be made permanent to maintain the recent progress in dam inventory database work, inspections, rulemaking, and project regulation. The last four years have been marked by numerous accomplishments by the Vermont Dam Safety Section to improve management of dams and public safety.

For example, the State has a FEMA High Hazard Potential Dam Grant and is using it to perform Risk Assessments on 7 HIGH hazard dams with POOR condition. This work will help the owners and State understand the risks at these dams while also positioning these dam owners to be able to obtain future grant funds for their dams.

The temporary staff are needed on a permanent basis to meet the desired inspection frequency; manage 14 state dams including operations, maintenance and repair; accomplish administrative tasks such as project management and updating the Vermont Dam Inventory; and perform regulatory reviews.

FUTURE NEED

VTDEC Dam Safety Program has identified a continuing need for at least two additional staff to carry out their dam safety mission. The need for increased staffing is more evident following the passage of Act 161 that adds additional dam safety tasks in the State.

The Vermont Rivers Program in the Agency of Natural Resources (ANR) has identified a need to review some dam safety permits, provide technical outreach and education, assist with dam removals, and assist with non-jurisdictional dams. The Vermont DEC River Scientists and Engineers have assisted with removal of jurisdictional dams and other non-jurisdictional dams. This assistance is important for project development and implementation, and should continue. The current ANR list of active dam removal projects contains 46 projects in various stages including feasibility study, design, permitting, and implementation.

More dam owners are becoming aware of their operation and maintenance responsibilities with the implementation of an annual fee based on hazard classification for all jurisdictional dams. The fee appears to be motivating more owners to pursue repair or removal. Education and outreach on dam safety and maintenance is needed to guide dam-owners on decision-making about the aging structures on their property. The PUC should consider having a dam safety engineer involved in overseeing dams under their jurisdiction.

PUBLIC SAFETY

Some of the largest dams in the state are flood control dams that protect downstream communities that are regularly inspected by state or federal officials. As part of the second round of Act 161 rulemaking, the VTDEC Dam Safety Program will establish consistent and current design requirements for dam repair and maintenance for non-federal, non-power dams. The design guidance will include standardized spillway design

floods, changing design floods with climate change, and methods for incremental breach analysis. The state inspection process will be updated to include more in-depth information on stability, structural condition, and hazard class that will provide more information on dam condition. These improvements to dam safety methods will improve the condition of dams and lead to increased resiliency over time.

Comprehensive inspections for HIGH and SIGNIFICANT hazard dams at 10-year and 15-year intervals will get current information on dams to compare original design intent versus current performance. The decadal evaluations will require special inspections (e.g., pipe inspections, structural inspections), updated hydrology and hydraulic analyses, updated stability analyses, review of original design and performance data, and risk assessment.

RESILIENCE

19 dams have been removed in Vermont in the last 4 years. Dam removal is increasing resiliency in the state by reducing flood levels, increasing river channel stability, restoring natural transport of sediments and nutrients, restoring riparian habitat and allowing ecosystems to respond to flood or drought disturbance quicker. The removal of aging dam infrastructure and restoration of natural stream processes through river reconnection is a nature-based solution to climate resilience. For example, Dunklee Pond Dam in Rutland City was initially breached in 2019 and then removed in 2021 after the deteriorated structure contributed to episodic flooding that required the evacuation of nearby households nine times since the year 2000, eliminating risk to three adjacent and 28 downstream homes and US Route 7.

Dam removals have been funded by a variety of sources targeting ecosystem restoration, fish passage, habitat improvements, water quality improvements, and public safety. More funding is being brought to Vermont and the region for dam removal for both habitat improvement and risk reduction. Dam removals may be supported with new funding tied to the Clean Water State Revolving Loan Fund (SRF) that would allow for up to 10% of the value of clean water infrastructure projects to be used for restoration projects.

INNOVATION

The Vermont Dam Inventory is in the final stages of update that will contain all dams in the state. The new database will allow for better coordination between state and federal agencies, and allow the public to understand the location, condition, and risk associated with dams. The new database will be easier to update and have a data input tool to upload and view inspection data. Most of the dam safety information in the database will be available to the public.

Through Act 161, innovations have and will be incorporated throughout new guidance. Upgrades to newer technologies such as automatic gates or inflatable spillways will be part of the design alternatives analysis to innovate and bring dams up to current standards.

SOLUTIONS TO RAISE THE GRADE

Vermont ASCE makes the following recommendations:

- Increase the staffing for the VTDEC Dam Safety Program from 2.0 full-time equivalent (FTE) to 6.0 FTEs to meet statutory and program obligations.
- The PUC should coordinate with VTDEC Dam Safety to have similar inspection schedules and hazard classification definitions. PUC should hire a dam safety engineer on staff to manage its dams.
- Increase staff numbers and training in the VTDEC Rivers Program to assist with planning and implementing dam removals.
- Continue projects to update hazard class and develop EAPs for HIGH and SIGNIFICANT hazard dams.
- Continue projects to inspect all HIGH hazard dams and confirm classification of all SIGNIFICANT hazard dams.
- Complete the second phase of the rulemaking process as part of Act 161 led by VTDEC and with participation of dam safety engineers around the state.
- Congress and FEMA should fully fund the High Hazard Potential Damn Rehabilitation Program, as part of the 2023 reauthorization of the National Damn Safety Program or future appropriations packages. The rehab program originally passed in the Water Resource Development Act of 2016.
- Pursue the development of a state dam repair funding program accessible to private and municipal owners.

AUTHORS/CONTRIBUTORS

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Jessica is a registered engineer in the State of Vermont with 17 years of experience in civil and water resource engineering, specializing in hydraulic and hydrologic studies for dam removal and repair, stormwater planning and design, flood control and river and habitat restoration, including modeling, analysis, mapping, and field assessment. Jessica graduated from the University of Vermont in 2004 with a BS in Civil and Environmental Engineering and in 2006 with an MS in Civil and Environmental Engineering with a water resource focus. Jessica is a Past President of the Vermont Section of ASCE and was the 2013 Vermont Young Engineer of the Year.

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Roy has over 25 years in water resource science and engineering, specializing in channel and floodplain restoration, flood resiliency, fluvial geomorphology, hydrology and hydraulics, dam removal, fish passage improvement, and channel stabilization. Roy is a 1993 graduate of the University of Rochester with a BS in Engineering, a 1996 graduate of the University of Washington with an MS in Environmental Science and Engineering, and a 2005 graduate of Yale School of Forestry and Environmental Studies with a Ph.D. in Stream Restoration and Aquatic Ecosystems.

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7. Personal Communication with Vermont Department of Environmental Conservation, Rivers Program, River Management Engineer , Todd Menees, P. E., October 27, 2022.
8. Personal Communication with VNRC Restoration Ecologist and Chair of the Vermont Dam Task Force, Karina Dailey, October 27, 2022.

DRINKING WATER

2023 Grade: C | 2019 VT: C- | 2021 Nat'l: C-

SUMMARY

As of 2020, Vermont's drinking water assets included approximately 1,382 active public water systems serving 59% of the state's 645,000 residents. Those utilities average higher than 95% compliance with state and federal laws. Most water systems in Vermont are not expanding in size or demand, but aging infrastructure needs to be replaced. A 2019 state law expanded safety testing in public buildings and has already identified thousands of immediate repair needs. A 2021 University of North Carolina study found the median water utility in Vermont collects operating revenue of $296,000, which only barely funds its $284,000 annual expenses – before counting capital projects. The state expects to receive $355 million over five years from the 2021 Bipartisan Infrastructure Law – compared to a $374 million funding need identified by the legislature that year. Most of those federal funds will address emerging contaminants and lead service line replacements. Vermont's average monthly water bill is $46, compared to the national average of $68, creating a structural funding gap as climate change threatens aging water systems.

BACKGROUND

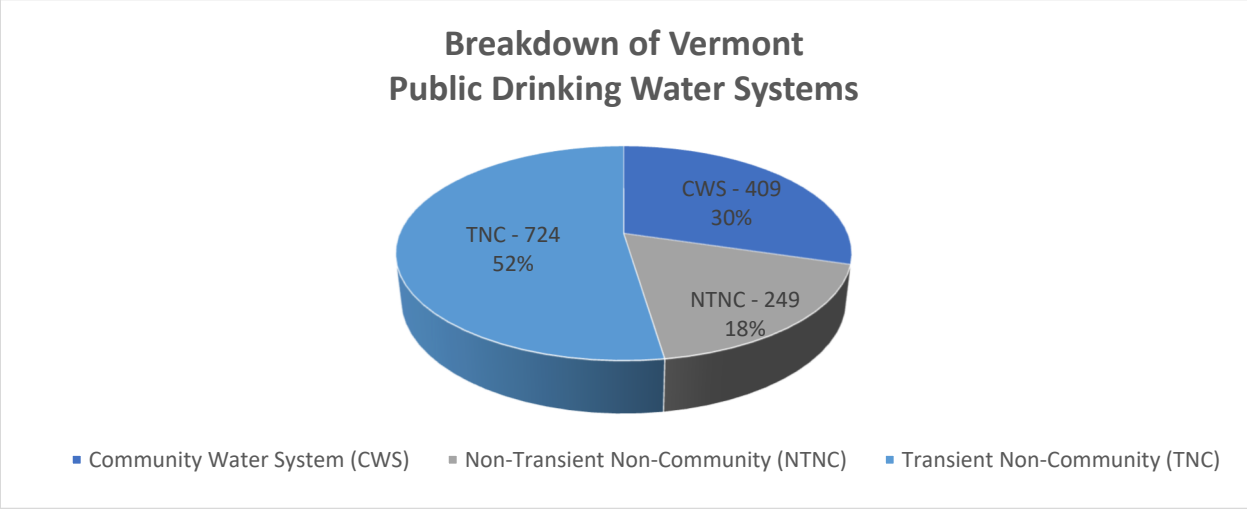
The Environmental Protection Agency (EPA) regulates public drinking water systems through regulations instituted by the Safe Drinking Water Act (SDWA). Additional regulations set by the EPA include the National Primary Drinking Water Regulations and National Secondary Drinking Water Regulations. The Vermont Water Supply Rule, revised March 17, 2020, empowers the Vermont Drinking Water and Groundwater Protection Division (DWGPD) to implement and enforce the federal and state drinking water provisions. The DWGPD oversees 1,382 public water systems, ensuring all public water systems comply with federal and state regulations.

There are three (3) types of public water systems as outlined below.

Community Water Systems (CWS)	Serve 25 or more year-round residents; or 15 or more year-round residential connections
Non-Transient Non-Community (NTNC)	Serve 25 or more people of the same people at least 6 months per year (ex. daycares, schools, office bldgs.)
Transient Non-Community (TNC)	Serve 25 or more people per day at least 60 days per year (ex. restaurants, hotels, campgrounds). The persons served do not need to be the same people.

Figure 1 summarizes the total number of public water system types and percentage.

Figure 1: VT Public Water Systems



The State of Vermont has a total population of 643,077 based on 2020 census data[1]. According to the Vermont Department of Health, nearly 41% of Vermont residents utilize private water systems, the remaining 59% are

[1] https://www.census.gov/quickfacts/VT

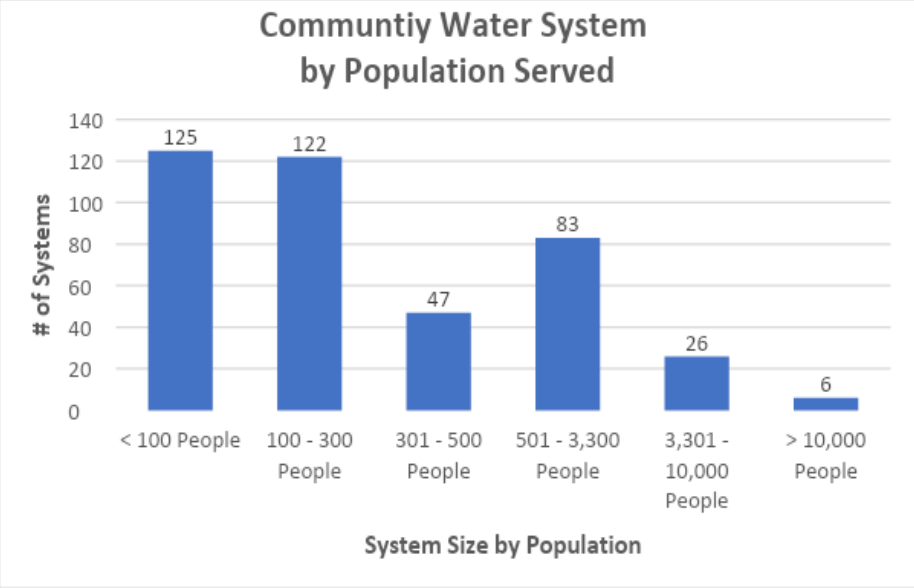
served by public water systems[2]. As information on private systems is not readily available, the drinking water infrastructure evaluation focuses on public systems.

CONDITION & CAPACITY

Drinking water infrastructure encompasses sources, treatment, storage, pumping facilities, and pipes. Community water systems in Vermont date back to the late 1800s and early 1900s in well-developed communities. Many of these community water systems started as privately owned water systems that local municipalities later acquired. Another boom in community water systems occurred in 1975 following the issuance of the SDWA by the EPA in 1974.

Vermont water systems serve a predominantly rural customer base resulting in small water systems with limited customers as outlined in Figure 2. Furthermore, Vermont's population is experiencing a declining younger population (0-24 years) in contrast to the older population (60+), which continues to rise.

Figure 2: Community Water Systems by Population Served



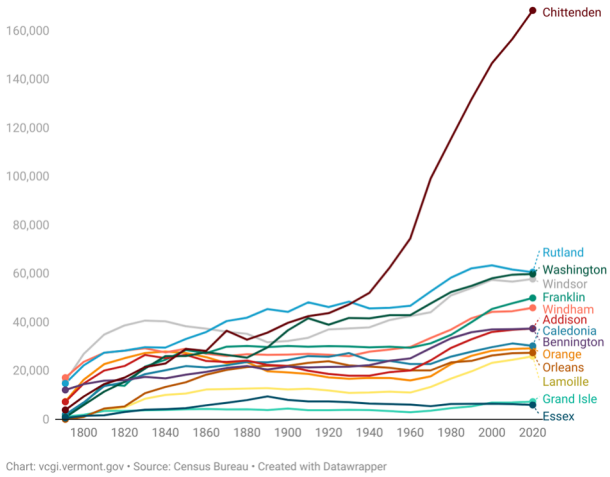
The only area within Vermont that can be considered urbanized is Chittenden County, which contains 7 of the 11 largest municipalities by population[3]. Chittenden County is the only county in Vermont that has seen a significant increase in population growth over the past 20-40 years as shown in Figure 3, courtesy of the Vermont Center for Geographic information[4]. With the advancement of technology and water saving fixtures, water usage in Vermont remains stagnant in Chittenden County, where most population growth is occurring.

[2] https://www.healthvermont.gov/sites/default/files/documents/pdf/guide_to_fluoride_levels_in_public_water_systems.pdf

[3] https://www.vermont-demographics.com/cities_by_population

[4] https://vcgi.vermont.gov/data-release/2020-census-data

Figure 3: Vermont County Population (1791 – 2020)



The priority for community water systems in Vermont should be focused around upgrading and maintaining existing infrastructure. Critical infrastructure such as treatment, storage, and equipment require frequent repair and replacement to maintain operation and meet drinking water standards and are visible by operators. Horizontal assets such as pipes, service lines, and valves, are typically buried below grade, where problems with condition, functionality, and criticality are only detected during an emergency, such as a water main break.

The American Water Works Associate (AWWA) estimates that water systems in the United States lose approximately 16% of water through either real or apparent loses. Real losses are considered to be losses introduced by leakage, apparent losses are meter inaccuracies or unmetered flushing. Up to 75% of this water loss is recoverable[5]. Much of this can be attributed to transmission, distribution, and service lines that have exceeded their useful life; typically 80 years.

The federal Lead and Copper Rule Revision require that all water systems complete a lead service line inventory and replacement plan by October 2024 for all service lines, both public and private, within the water system. This regulation will require a concerted effort on records review, interior inspections, testing, and visual inspections of water services over the next several years, and necessitate additional replacement projects.

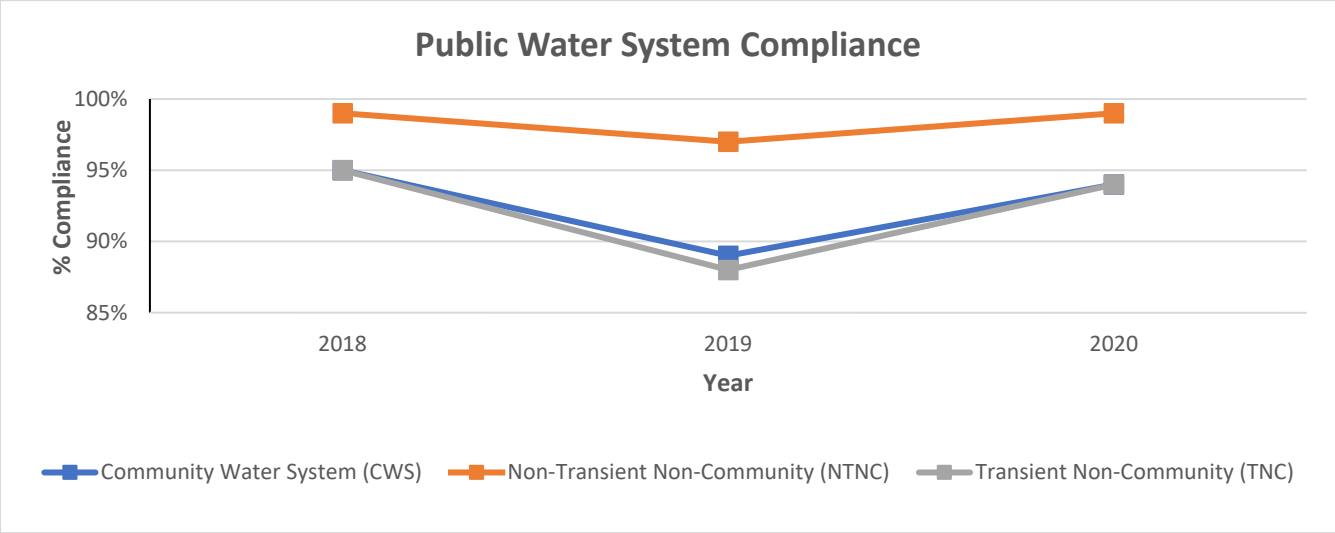
OPERATION & MAINTENANCE (O&M)

Water systems have shown continued compliance with federal and state regulations as evident by Figure 4. While a slight decrease in compliance occurred in 2019 for all public water systems, since 2014 compliance

[5] https://www.epa.gov/sites/production/files/2015-04/documents/epa816f13002.pdf

overall has averaged above 95%.

Figure 4: Community Water System Compliance



Public water systems utilize user rates to fund their operation and maintenance (O&M). As yearly system demands fluctuate with seasonal weather, most user rates are funded with a fixed and a variable (usage) rate. The fixed rates recover costs that do not fluctuate with water usage (i.e. debt retirement, salaries, etc.). Usage rates recover variable costs (i.e. chemicals, electricity, etc.). While water meters are not mandated by law; local, state, and federal authorities encourage water system to install and utilize water meters for billing purposes. Water meters provide the ability to charge customers equitably, but also allows water systems to track water production versus usage, which can highlight unaccounted water loss.

The Environmental Finance Center at the University of North Carolina (UNC) completed a rate study[6] in 2021 which concluded that the median water utility in the State of Vermont has 225 connections and serves a population of 642 residents. The same study estimated that the median water utility has an operating revenue of $296,340 versus an operating expense of $284,295. This slight difference indicates that many water systems are barely able to cover operating expenses. While not explicit by these figures, it's unclear if these water systems are setting aside any capital reserve or sinking funds for future asset replacement or capital projects.

The average national monthly water bill is ~$68/month[7]. The average monthly water bill for Vermont utilities that participated in the UNC survey was $46.12. However, the minimum average monthly bill was $4.33 in contrast to the maximum monthly water bill of $150.50. In Vermont, the median household income is approximately $63,477, according to 2020 census data. On average, Vermonters spend slightly less than 1% of

[6] https://dashboards.efc.sog.unc.edu/vt
[7] https://balancingeverything.com/average-utilities-cost/

their median household income (MHI) on water. Table 1 provides a summary by county of the information compiled by the UNC. The highest MHI counties, Addison and Chittenden, have the lowest % annual water bill per income. Excluding these two counties, it's apparent that the lowest MHI water systems are paying higher water bills compared to their MHI.

Table 1: User Rates by County

County	Monthly Water Bill[ix]			Median Household Income[ix]	% Annual Water Bill of MHI
	Min.	Median	Max.		
Addison	$20.00	$32.20	$39.69	$70,262	0.55%
Bennington	$31.17	$48.65	$74.69	$58,200	1.00%
Caledonia	$8.33	$35.92	$83.33	$52,481	0.82%
Chittenden	$17.05	$34.75	$110.45	$76,316	0.55%
Essex	$30.68	$44.17	$86.14	$47,035	1.13%
Franklin	$26.67	$50.84	$150.50	$65,314	0.93%
Grand Isle	$49.08	$70.83	$107.68	$81,667	1.04%
Lamoille	$14.58	$49.51	$83.50	$64,179	0.93%
Orange	$22.50	$37.50	$78.08	$62,737	0.72%
Orleans	$24.95	$40.00	$79.78	$54,390	0.88%
Rutland	$4.33	$41.91	$100.00	$57,176	0.88%
Washington	$27.19	$50.00	$70.50	$64,862	0.93%
Windham	$16.15	$28.88	$83.33	$54,188	0.64%
Windsor	$20.80	$39.00	$106.02	$61,503	0.76%

Rural Vermont communities are facing a declining population and declining water usage. Water systems investment will be required over the next 20 years, resulting in significant rate increases.

FUNDING & FUTURE NEED

Larger projects that cannot be funded through annual O&M budgets and capital reserves require outside funding sources. The DWSRF, United States Department of Agriculture – Rural Development (USDA RD) Water and Waste Disposal Loan, Vermont Municipal Bond Bank (VMBB) are the major funding sources for Vermont public water systems.

The DWSRF program offers source exploration, planning, design, and construction loans for Vermont public water systems. Funding terms range from 0% to 2% and extend from 20 to 40 years. From Federal Fiscal Year (FFY) 2018 through 2020, the DWSRF has made sizable contributions to provide funding to public water systems. However, the funding needs have also increased, especially as compared to FFY 2015-2017. Table No. 2 summarizes the DWSRF program contributions over the past three (3) finalized fiscal years.

Table 2: DWSRF Funding Summary (FFY 2018 - 2021)

Fiscal Year	Actual FFY18[8]	Actual FFY19[9]	Actual FFY20[10]
Total Funds Requested (Millions)	$73.77	$76.02	$78.19
Total Loans Proposed (Millions)	$32.96	$44.61	$18.39
Total Subsidy Proposed (Millions)(1)	$2.22	$6.05	$27.22
Unfunded Total (Millions)(2)	**$38.59**	**$25.36**	**$32.58**

Notes:

1) Total Subsidy Proposed includes both disadvantaged and additional subsidy.
2) Unfunded Total = Total Funds Requested – Total Loans Proposed – Total Subsidy Proposed.

DWSRF subsidies are readily available on a first come first serve basis to disadvantaged communities. MHI is a key metric for considering disadvantage; however, it is recommended that the DWSRF define the MHI for households directly connected to the water systems. More public water systems may qualify for disadvantage subsidies by defining the water system MHI.

In FFY20, the DWSRF provided subsidies to all projects based on total project costs. All water systems will continue to combat aging infrastructure and subsidies will aid in the replacement and upgrade of drinking water infrastructure.

The VT DWSRF program has also offered disadvantage subsidies for lead service line replacement projects and inventory. However, to ensure that all public water systems complete a thorough and comprehensive inventory, the DWSRF and DWGPD should explore opportunities to subsidize all public water systems lead service line inventory efforts.

The USDA RD – Water and Waste Disposal Loan provides another funding option for public water systems by offering a loan/grant program. Rates change quarterly based on market conditions, but grants can extend to 45% or beyond for impoverished areas. Unlike the DWSRF program, USDA RD requires that water systems utilize water meters. Table No. 3 summarizes the USDA Rural Development Water and Water Disposal Loans for drinking water projects only over the past three (3) fiscal years[11].

[8] https://anrweb.vt.gov/DEC/IronPIG/DownloadFile.aspx?DID=177637&DVID=0
[9] https://anrweb.vt.gov/DEC/IronPIG/DownloadFile.aspx?DID=177638&DVID=0
[10] https://anrweb.vt.gov/DEC/IronPIG/DownloadFile.aspx?DID=194330&DVID=0
[11] https://www.rd.usda.gov/sites/default/files/VT%20FY%202019%20Projects%20by%20County.pdf

Table No. 3: USDA Rural Development Water and Waste Disposal Loan – Water Only Funding Summary (FFY 2018 - 2021)

Fiscal Year	Actual FFY18	Actual FFY19	Actual FFY20
Amount Funded (Millions)	$10.59	$4.3	$0.00

In 2015, the EPA estimates that Vermont will need to invest more than $642.9 million in public drinking water infrastructure in the next 20 years[12]. A 2021 legislative report noted that Vermont's needs for drinking water repair and upgrades amount to $374 million. Vermont will receive $355 million over five years from the 2021 Bipartisan Infrastructure Law – or Infrastructure Investment and Jobs Act (IIJA), – the majority of which will be used to address emerging contaminants and lead service line replacement[13].

PUBLIC SAFETY, RESILIENCE, & INNOVATION

As noted in previous sections, public health and safety considerations are central to the regulations and investments in the water infrastructure sector at the local, state, and federal level. In 2020, through the DWSRF, Bennington received $11 million to replace 1,575 lead service lines.[14] Vermont passed a law in 2019 which requires all school districts, supervisory unions, independent schools and child care providers to test their drinking and cooking water for lead. Vermont's maximum lead level is four times stricter than national law. The state announced late 2022 that each tap was tested since 2017, Nearly half of the more than 15,300 taps tested contained unsafe levels. One out of five taps tested was at or above a level required to take the fixture out of service because it has a higher chance of harming children.

On September 22, 2020, the legislature passed the Global Warming Solutions Act (Act 153), which established the Vermont Climate Council and directed it to develop the first Climate Action Plan (CAP) by December 1, 2021. The section that impacts most municipalities involves building resilience in the built environment, including in water infrastructure and reducing the vulnerabilities of water infrastructure systems through the "Vital Communities" area of the CAP. The IIJA has allocated ~$6 billion in funding infrastructure resilience. Vermont should have access to some of that funding to implement relevant aspects of our CAP. Of the five main areas that the CAP is organized into; the "vital communities" area that relates to "protecting people and infrastructure" covers drinking water infrastructure directly.

Other statewide efforts that address resiliency with infrastructure improvements include a renewed stakeholder engagement to develop the next State Hazard Mitigation Plan (SHMP) and multiple nonprofit and academic organizations that are working on water infrastructure resilience indirectly. For example, several

[12] https://www.epa.gov/sites/default/files/2018-10/documents/corrected_sixth_drinking_water_infrastructure_needs_survey_and_assessment.pdf

[13] https://www.whitehouse.gov/wp-content/uploads/2021/08/VERMONT_Infrastructure-Investment-and-Jobs-Act-State-Fact-Sheet.pdf

[14] https://www.wqpmag.com/treatment/drinking-water/news/10974723/vermont-receives-11-million-to-extract-lead-water-pipes

clean water projects undertaken through 2021 continue to provide multiple co-benefits. Resilience is also being built by engaging and partnering with multiple state agencies and nonprofits. For example, from SFY 2016-2021, over 300 acres of forested riparian buffers plantings prevented stream bank erosion and held back sediment and pollution runoff. 1,100 conservation easements along waterways, conservation of over 21,000 acres of lands, dam removals and resizing culverts that helped connect 480 stream miles and floodplain restoration activities should help improve the quality of surface and groundwater sources.

As Vermont experiences climate change, resilient drinking water infrastructure will have to keep up with treatment of new contaminants which threaten the safety of our water supply, ability to ensure safe and reliable water supply in hard winters as well as during summer drought, and balance facilities design and O&M for declining populations in some parts and increasing new Americans and climate refugees in other communities. Vermont will also need to elevate efforts in leak detection and management to use the water resources judiciously. An adequately trained workforce to build, operate and manage the state's water infrastructure will also be key to ensure sustained resilience.

SOLUTIONS TO RAISE THE GRADE

Vermont's public drinking water infrastructure supports a rural centric population with increasing financial investments caused by aging assets, new regulations, and emerging contaminants. Over the next 20 years, much of Vermont's drinking water infrastructure will need to be replaced and upgraded to maintain compliance and ensure quality drinking water to customers.

Vermont ASCE supports the following recommendations:

- Encourage drinking water systems to find creative solutions to replace aging infrastructure. Solutions may include new technology to extend asset life, coupling water line improvements with other utility projects, and applying for state and federal grant programs.
- Develop service line inventories and replacement plans to meet the October 2024 EPA deadline. Work with state officials to subsidize inventory and replacement plans for all water systems.
- Encourage drinking water systems to prepare for needed improvements and actively utilize low interest funding opportunities offered by State and Federal agencies. Prioritize moving projects toward "readiness to proceed" by advancing preliminary engineering reports and final designs.
- Support and encourage the investment of Federal Funds to sustain and increase funding to the DWSRF and USDA RD – Water and Waste Disposal Loan Programs. Define new initiatives to subsidize water investment projects.
- Prepare and plan for future climate change impacts through mitigation and resilient infrastructure.

AUTHORS/CONTRIBUTORS

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Nathan has over 13 years of experience in water resources engineering, primarily in the study, design, permitting, and construction of municipal infrastructure. Mr. Pion is currently the Director of Engineering at Champlain Water District, the largest wholesale municipal water utility in Vermont. Previously, Mr. Pion worked as a project manager and

company shareholder at Aldrich & Elliott, PC, assisting local municipalities with their water resources projects. He is a 2010 graduate of the University of Vermont with a BS in Civil Engineering. In 2017, Mr. Pion was recognized as Vermont's 2017 Young Engineer of the Year. He has served as Vermont Section of ASCE Secretary, President, and Past-President.

TARA KULKARNI, PhD, PE, *Associate Provost for Research and Associate Professor, Norwich University*
Tara is a licensed Professional Engineer (Michigan) with over eighteen years of experience spanning state government (in industrial wastewater, RCRA, and petroleum cleanup), environmental management consulting and academia. She is the Associate Provost for Research at Norwich University and an associate professor of civil engineering. She was the founding director of the university's Center for Global Resilience and Security. Tara's expertise is at the intersections of water, energy and environment with critical infrastructure and security. Tara has been a mentor for ASCE's ExCEED program and chairs the Environmental Water Resource Institute's environmental council. She has a Ph.D. in Civil Engineering from Florida State University.

ENERGY

2023 Grade: C+ | 2019 VT: B- | 2021 Nat'l: C-

SUMMARY

Vermont households use less energy than 80% of American states. Despite that efficiency, Vermont consumes more than three times as much energy as it produces. Importing that extra power leads to some of the highest rates in the nation: on average $0.19 per KWh for residential, as of February 2022. In 2020, 100% of the electricity generated in Vermont was from renewable sources. Recent plans outline ambitious goals for shares of energy used with renewables, 45% of transportation use by 2040 and 70% of heating by 2042. Electrical transmission infrastructure is a significant constraint on these changes. By the end of June 2021, Vermont had approximately 266 MW of solar capacity installed, but power lines can't carry that volume around Vermont or to other New England states. Increased transmission capacity, resilience, and interconnection is required for Vermont to utilize current and future renewable generation – and to meet growing demand from electrification in residential and commercial use.

CONDITION, CAPACITY, OPERATIONS AND MAINTENANCE

Vermont is part of the New England electric grid which consists of a network of over 8,000 miles of transmission lines, substations, and associated equipment. The Vermont Electric Power Company (VELCO) was established in 1956 when Vermont's local utilities established the first statewide transmission-only company. At that point, it consisted of 738 miles of transmission lines, 55 substations, switching stations and terminal facilities.

In 2020, Vermont produced approximately 10.8 Gigawatt hours (GWh) – one billion watthours: over 6 GWh from wood and waste and approximately 4.8 GWh from other renewables. According to the U.S. Energy Information Administration, in 2020, Vermont generated nearly 100% of its electricity from renewable resources, and approximately 50% of the utility-scale in-state generation came from conventional hydroelectric power. In June 2022, this equated to 68,000 Megawatt Hours (MWh) – one million watthours – produced from Hydroelectric renewables and 89,000 MWh from Nonhydroelectric Renewables. Vermont has a total of five utility-scale wind farms, and 47 hydroelectric plants at dams around the state. Between 2015 and 2020 Vermont's solar energy contribution increased nearly four times, and now utility-scale and small-scale installations account for nearly one-seventh of Vermont's total net generation – with each contributing approximately 7%. By the end of June 2021, Vermont had approximately 266 MW of solar capacity installed. Unfortunately, due to capacity constraints with transmission lines throughout the state, not all of the renewable energy generation capacity can be utilized.

The Sheffield Highgate Export Interface (SHEI) is an ISO-New England defined transmission region in northern Vermont. This area produces more power than it uses. But due to limited capacity in transmission lines, the amount of power that could be sent to the rest of Vermont and New England is constrained. So, generation in

the region is often curtailed. Improvements to increase the capacity of the transmission lines would allow more renewable energy generation in the region.

VELCO is currently planning a $65 million project that would replace and upgrade a key transmission line in Franklin County over the next several years. This approximately 16.5 mile line, built in 1958, running from Highgate to Georgia is a major transmission path for energy from Quebec and power produced in northern Vermont. The new line would be built to allow additional space in the company's existing right-of-way for a second power line in the future should there be a need for additional grid capacity through the area. While this project is still in the planning phase and has not yet gone before the state's Public Utility Commission for approval, the current plan is to begin the permitting process in 2023 and begin construction in 2024. Investments like these are needed all over the state to upgrade Vermont's aging grid system to allow the state to keep up with the growing demand.

RESILIENCE, PUBLIC SAFETY, INNOVATION

Building resilience of Vermont's energy infrastructure can be broken into four areas.

Preparing for extreme weather events exacerbated by Vermont's climate change, can disrupt electricity generation, transmission, and distribution. Two climate simulations show that overall power outage risks are projected to increase by approximate 5-10% through 2050. Vermont's legislators, state agencies and nonprofit organizations are actively advocating for interventions such as building redundancy, hardening infrastructure components and building microgrids in response. Vermont's Green Mountain Power (GMP) utility successfully redeveloped rural Panton, VT's electric system. GMP built a microgrid attached to a solar power plant, which allows Panton residents access to uninterrupted power during large snow or rain events that may result in fallen trees and power outages. After two years spent in modeling electrical scenarios and testing components, Panton's redevelopment was the first utility-built community microgrid able to run on renewable power without a fossil fuel backup.

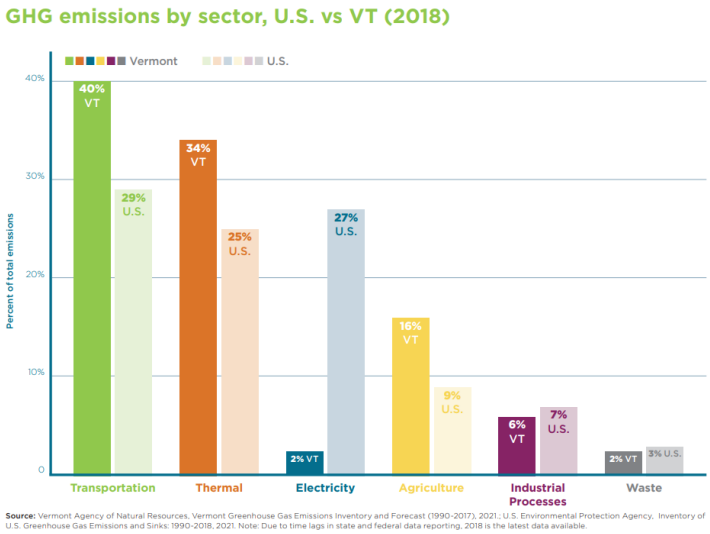
Reliable and affordable supply of energy for consumers. This involves diversifying the portfolio of energy sources as in the Panton example, but also building principles around equitable access, incentives, and loans to help low-income Vermonters, etc. Various state and federal incentives have afforded many Vermonters the opportunity to install solar panels, buy electric cars, and battery backup systems that can reverse flow and cover a community's electric needs during peak times. Low-income Vermonters have also been able to access many of these programs thanks to organizations such as Efficiency Vermont and Capstone Community Action, whose efforts helped weatherize almost 300 homes in 2021 and enabled close to 1200 Vermonters to stay warm with emergency heating services.

Emission reductions will build co-resilience in allied sectors. The Vermont Department of Environmental Conservation (DEC)'s 2021 Greenhouse Gas (GHG) Emissions Inventory (1990-2017) revealed that 40% of Vermont's greenhouse gases were produced by the transportation sector. Currently, the state has more than 160 public electric vehicle (EV) charging stations and over 2,300 EVs. [2] However, to reduce the enormous

output of emissions from transportation, the Energy Action Report (EAN) recommends purchase of 46,000 EVs to replace gas vehicles by 2025, and 120,000 EVs by 2030. Therefore, one out of every four new cars purchased in Vermont over the next five years must be electric, followed by one out of every two vehicles purchased between 2026 and 2030.

Transportation, the largest sector of energy consumption in Vermont (31% in 2020), utilizes the most imported fossil fuels 71% of which is gasoline and 21% is diesel. As Vermont doesn't have petroleum, natural gas, coal reserves or energy production facilities that convert these fossil fuels into energy, this poses a significant vulnerability in the event of a natural or manmade disaster that will prevent the transportation of fossil fuels, largely via trucks and trains from Canada, and threatens Vermont's resilience. As of 2020, petroleum remains one of the most consumed energy providers in Vermont which translates into 14 million barrels and makes up around 60% of the transportation sector consumption. This is used mainly in transportation and home heating and accounts for almost three fifths of Vermont's energy use.

To offset the thermal sector's contribution of approximately 34% of Vermont's GHG emissions. Vermont has to stimulate a five-fold increase in home weatherization over the next decade. An EAN report notes *"Weatherizing an additional 120,000 homes by 2030 would create over 4,700 new jobs. And for every dollar invested in weatherization, approximately 60 cents will recirculate in the Vermont economy, while only 25 cents of every dollar spent on fossil fuels stays and recirculates in the Vermont economy."* [4] Moving to non-fossil fuel heating sources, heat pumps or wood, benefits Vermont's economy by ensuring that more of the money spent on heating stays in the state. *"Vermont's electricity portfolio is around 93% carbon-free, so using an efficient electric option, such as heat pumps, is a powerful way to cut emissions."* [4] While wood heat is not always carbon-neutral, it is nearly always "carbon better" than fossil fuels — particularly when the wood is supplied locally and sustainably. Statistically, more than one-third of Vermont schoolchildren attend facilities heated by wood products produced and distributed from local Vermont facilities. [4]



Source: Energy Action Network Annual Progress Report for Vermont, 2022

The heating interventions that help save on energy costs and emissions also impact health effects in vulnerable regions of the state. Tools such as the VT Department of Health's Heat vulnerability index offer a way to plan and develop solutions for impacted populations.

Education and outreach – in workforce development and demand response. EAN reports that Vermont's climate workforce is made up of approximately 18,900 people who work at least some of the time in climate mitigation, adaptation, or resilience. However, they estimate that we may need much higher numbers. For example, 6,200 more people in weatherization areas up from approximately770 current workers in this area and 450 people more HVAC workers to install heat pumps up from 225. Education and outreach efforts that help Vermonters access the programs that are right for them are also critical needs. An example of a new program is Capstone's GreenSavingSmart launched in March of 2022 to provide free coaching services and assistance to low- to moderate-income individuals and families. The program prioritizes BIPOC (Black, Indigenous, and People of Color) and New American communities. Coaches help to navigate the complex landscape of Vermont's services and programs provided by energy efficiency utilities, financial institutions, local utility companies, fuel providers, and others.

FUNDING AND FUTURE NEED

According to the 2022 Vermont Comprehensive Energy Plan, the State outlines its goals to meet 25% of its energy needs from renewable sources by 2025, 45% by 2035, and 90% by 2050. While these are ambitious goals, it further breaks down the focus to three sectors, transportation, thermal and electric. The goals include meeting 10% of its energy needs from renewable energy by 2025 and 45% by 2040 in the transportation sector, 30% by 2025 and 70% by 2042 in the thermal sector, and 100% of energy needs from carbon-free resources by 2032 with at least 75% from renewable energy in the electric sector.

In November 2021 the Infrastructure Investment and Jobs Act (IIJA), a $1.2 trillion bipartisan infrastructure bill, passed and was signed into law, and included funding for all 17 ASCE Report Card categories. The bill invests $73 billion to rebuild the electric grid nationwide and calls for the construction of thousands of miles of new power lines and expanding renewable energy. There are provisions of the bill aimed at reinforcing the resilience of the electric grid including a new program which would be authorized at $5 billion over five years for projects, activities, technologies, equipment, and hardening measures that reduce the likelihood and consequences of disruptive needs.

In August 2022 the Inflation Reduction Act was signed into law. The law increases the federal investment tax credit for homeowners who install solar panels (up to 30%, through 2032), and also expands the tax credit to include battery storage technology. Tax credits for energy efficiency home improvements are also increased to 30% through 2032. These funding sources enhance the rebates for low-income Vermonters and provide rebates to cover up to 100% of the costs to install efficient technologies. (https://www.vermontpublic.org/show/vermont-edition/2022-08-30/what-does-the-inflation-reduction-act-mean-for-vermonts-climate-ambitions)

According to the Energy Action Network Annual Progress Report for Vermont 2022 (EAN), approximately three-quarters of Vermont's greenhouse gas emissions come from the transportation and thermal sectors. To meet Vermont's climate requirements, the State needs to reduce greenhouse gas emissions from these two sectors.

Vermont is expected to receive $21 million over five years to support the expansion of an EV charging network in the State, and will have the opportunity to apply for the $2.5 billion in grant funding dedicated to EV charging under the IIJA. (VERMONT_Infrastructure-Investment-and-Jobs-Act-State-Fact-Sheet.pdf (whitehouse.gov)).

As of July 1, 2022 there was $12.3 million available for the State of Vermont incentive program for new plug-in electric vehicle purchases or leases. The incentive amounts vary by income and type of vehicle, all-electric or plug-in hybrid model. Vermont has two ways for consumers to receive the EV Incentive – either at a participating auto dealer at the point of sale or through a consumer-direct application after the vehicle is purchased.

		State Incentive Amount	
Tax Filing Status	**Adjusted Gross Income (AGI) Limits for Enhanced and Standard Incentives**	**Plug-in Hybrid Electric Vehicle**	**All-Electric Vehicle**
Individual filing as **single** or **head of household**	$50,000 or less	$3,000	$4,000
	$50,001 up to $100,000	$1,500	$2,500
Married filing **jointly**	$75,000 or less	$3,000	$4,000
	$75,001 up to $125,000	$1,500	$2,500
Married filing **separately**	$50,000 or less	$3,000	$4,000
	$50,001 up to $100,000	$1,500	$2,500
Individual filing as qualifying **widower**	$75,000 or less	$3,000	$4,000
	$75,001 up to $125,000	$1,500	$2,500

Vermont also provides an incentive program for consumers purchasing used vehicles: MileageSmart, as well as for those purchasing eBikes, and a Replace Your Ride program for the replacement of an old internal combustion engine vehicle. (https://www.driveelectricvt.com/incentives/vermont-state-incentives)

GMP currently provides Electric Vehicle Rebates up to $2,500 when customers purchase an all-electric vehicle or plug-in hybrids. Specific income limits and vehicle costs apply; however, this provides additional incentive for customers to switch to electric vehicles and continue to decrease the greenhouse gas emissions in the transportation sector in Vermont. Additionally, GMP is currently offering a free Level 2 charger to use while being a GMP customer participating in their home charging program.

(https://greenmountainpower.com/rebates-programs/electric-vehicles/ev-rebate/). Other electric utility companies providing incentives for the purchase of electric vehicles include Burlington Electric Department, Stowe Electric Department, Vermont Electric Coop, VPPSA, and Washington Electric Coop.

The legislature appropriated $750,000 in 2020 to continue building out the network of DC fast charge stations for remaining gaps and redundancies in high use areas on highway corridors. Installation is planned for Summer/Fall 2022 to install stations at six priority locations. In 2021 $1,000,000 in funding was appropriated to pilot a program incentivizing the installation of charging stations in multi-unit dwelling affordable housing units. Recently 13 project proposals from affordable and non-profit multi-unit housing providers across 8 counties were submitted. This will result in 84 new Level 2 charging ports at 37 locations and will reduce the home charging access barrier to EV ownership for 6,230 homes in affordable multi-family buildings. (https://accd.vermont.gov/community-development/funding-incentives/electric-vehicle-supply-equipment-evse-grant-program)

The Department of Public Service will also add two new residential programs using federal funding from the Inflation Reduction Act of 2022 to boost Vermont's weatherization and electrification efforts. These include the Home Energy performance Based Whole House Rebates (HOMES) program, and the High Efficiency Electric Home Rebate Program which provide rebates between $2,000 to $8,000. The Inflation Reduction Act also provides training and workforce development grants, which should ensure availability of qualified contractors to undertake the necessary retrofits and new installations.
(Source: https://publicservice.vermont.gov/efficiency/inflation-reduction-act-bolster-vermont-weatherization-and-electrification-efforts)

SOLUTIONS TO RAISE THE GRADE

Vermont has a reliable source of over 60 hydroelectric dams and is continuing to grow its non-hydroelectric renewable energy production. While the state has a well-connected transmission system and smart grid capabilities many of them are in need of upgrades to increase capacity and resiliency against large storm events. The State also needs to continue to focus on its consumer pricing, domestic consumption, and transportation systems. To improve its grade Vermont should focus on implementing the following recommendations:

- Expand the capacity and interconnection, the redundancy and resilience, of energy transmission lines.
- Continue to develop renewable generation through new wind and solar projects and reduce reliance on outside utility networks.
- Reduce fossil fuel use in the transportation network by providing further incentives for companies to build electric charging stations both in the home and on the road.
- Continue to provide consumers with incentives to encourage the switch to electric vehicles and continue to invest in and develop public transportation in rural communities.
- Continue investing in residential improvements including increasing energy efficiencies, switching from fossil fuels to entirely wood or electric heating, and implementing smart metering and other efficiency standards in every home.

- Continue to develop and adapt the long-range plan for the transmission and distribution systems and rebuild vulnerable sections of the grid to maintain and improve resilience and reliability.

AUTHORS/CONTRIBUTORS

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Stephanie is a licensed Professional Engineer in the State of Vermont and a 2011 graduate of the University of Vermont with a BS in Environmental Engineering. She has experience working in Pennsylvania, Maine and Vermont where she has filled positions in transportation design, traffic modeling, and site/civil engineering. Stephanie is a Civil Engineer with VHB in their Land Development Department where she specializes in renewable energy projects and is a current Region 1 Governor of ASCE. She has served as Vermont Section of ASCE Secretary and President, and is Vermont's 2023 Young Engineer of the Year.

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ROADS

2023 Grade: C+ | 2019 VT: C+ | 2021 Nat'l: D

SUMMARY

Vermont's roadway system totals 14,250 miles, 20% of which are maintained by the Vermont Agency of Transportation (VTrans) and the remaining 80% run by 237 municipalities, with no county-level ownership. In 2022, average weighted pavement condition across the network was 68 – compared to the state goal of 70. 39% of roadway surfaces were in good condition, compared to 45% in the 2019 report card, and 31% rated fair compared to 25% in the previous report. While Vermont's motor fuel taxes are higher than nearby states, their portion of state-level transportation funding (31% in FY23) is much lower than fee revenue. VTrans budget grew 20% annually to $434 million in FY23, thanks in part to the 2021 Bipartisan Infrastructure Law, helping improve resilience of roads to more frequent, harmful storm events. Workforce development – retention and new talent pipelines – are necessary to meet those challenges and a surge in traffic deaths, which increased every year since the 2019 report card – doubling from 0.64 to 1.2 fatalities per 100 million vehicle miles traveled.

BACKGROUND

The National Highway System (NHS) in Vermont includes interstate (I-89 & I-91) and major regional highways (US 7, US 4, VT 9, and VT 103). Class 1 Town Highways form the extension of state highway routes and carry a state-highway route-number but are maintained by the Town. Class 2 Town Highways are municipal-maintained roads selected as the most important highways in each town (in addition to Class 1 highways) and approximately 20% are unpaved. Class 3 Town Highways, which are 75% unpaved, are other town-maintained roads negotiable under normal conditions by a standard passenger car.

CONDITION & CAPACITY

There are approximately 14,250 miles of roadways in Vermont, 90% of which are in rural areas. 20% of the state's roadways are owned and/or operated by the Vermont Agency of Transportation (VTrans). The remaining 80% are owned by Towns.

Public Roadways - Miles by Ownership[1]

	Federal	State	Town	Total
Rural	157	2,369	10,224	12,750
Urban	0	259	1,240	1,499
Total	157	2,628	11,464	14,249

Nationally, Vermonters typically experience some of the least 'Annual Peak Hours Spent in Congestion per Auto Commuter', however, these results fluctuate yearly. In 2020, The average Vermont driver experienced 6.23 hours in congestion, compared to the national average of 23.83 hours.[2]

Annual Report No.	Year	Annual Peak Hours Spent in Congestion per Auto Commuter	Rank
23rd	2017	8.42	6
24th	2018	10.17	10
25th	2019	30.60	30
26th	2020	6.23	14

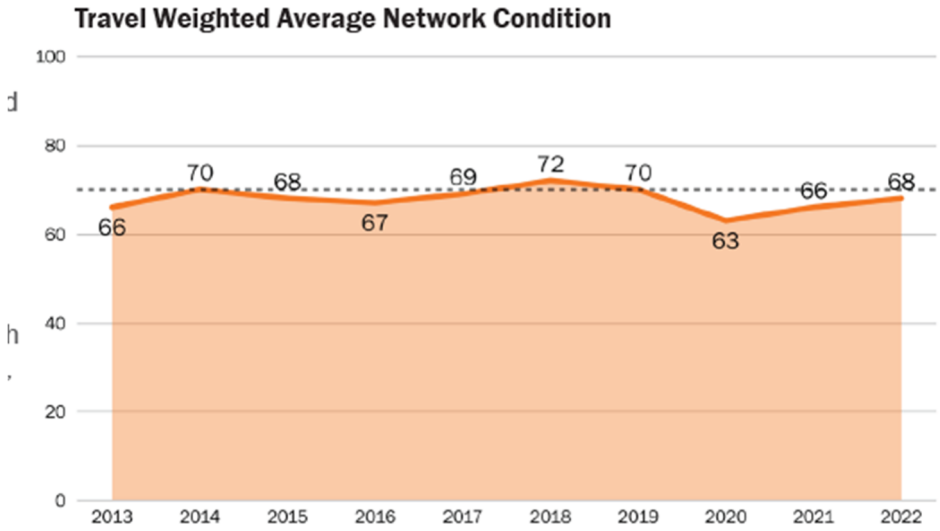
Vermont's only urban area is the City of Burlington where most of the state's congestion is experienced. In 2021, VTrans increased the number of traffic signals with remote communication capabilities from 74 to 104, which covers 64% of the state system, and other signal replacement and upgrade projects reduced the number of signals in poor condition from 36 to 28.[3]

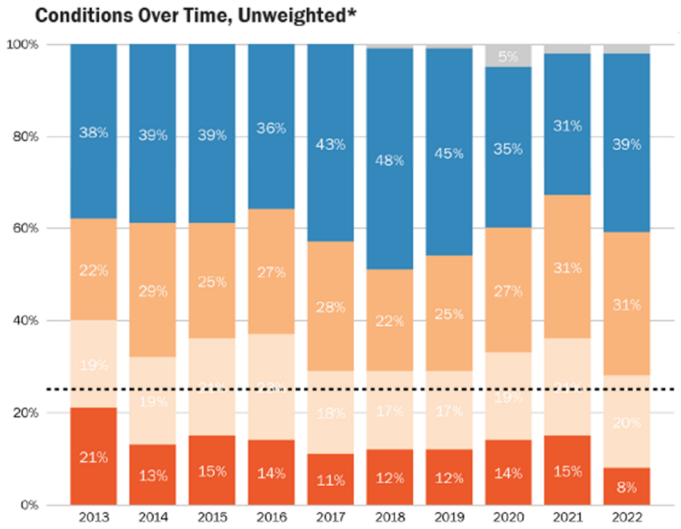
Vermont's National Highway System is very reliable. Since this program was initiated in 2017, Vermont has consistently exceeded the travel time reliability goals set by FHWA's National Highway Performance Measures.

Highway Performance Monitoring System (HPMS)[4]

Reliability Metric	Target	Average 2017-2020
Interstate Highway Reliable Person-Miles Traveled	90% (min)	99.5%
Non-Interstate NHS reliable Person-Miles Traveled	80% (min)	96.2%
Truck Travel Time Reliability Index	1.75 (max)	1.66

VTrans evaluates pavement condition with two metrics: (1) "Travel Weighted Average Network Condition", which hovers around the performance goal of 70; and (2) "Unweighted Condition Distribution", which seeks to limit roads in "Very Poor" condition to 25%, a goal that is consistency achieved.[5]





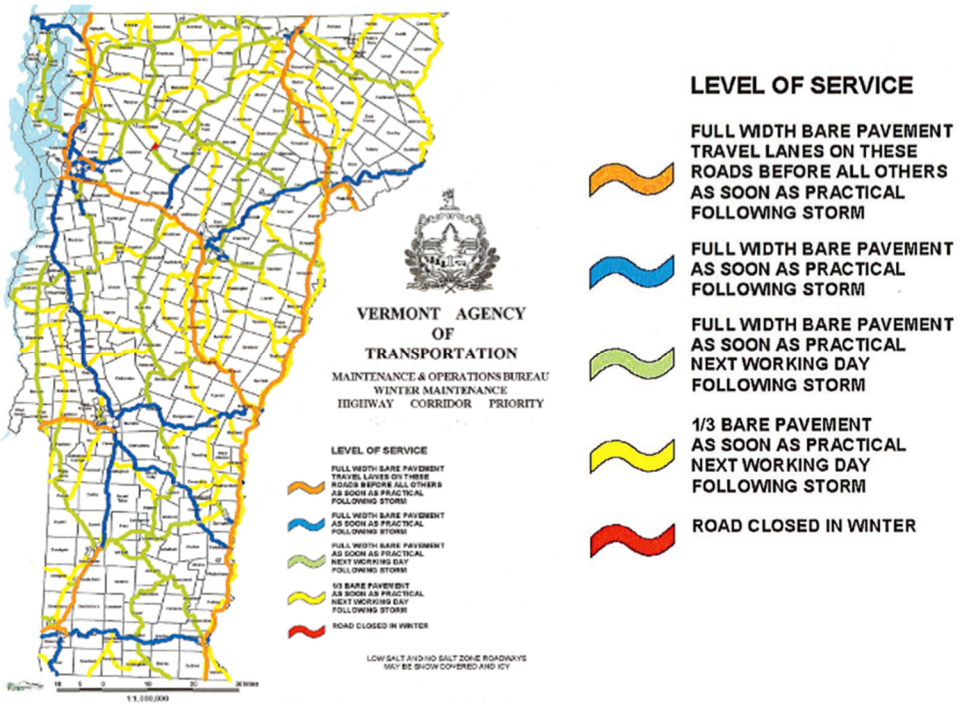
OPERATIONS & MAINTENANCE

VTrans Maintenance is divided into nine districts with a total of 64 garages. The state highway system is maintained by 256 heavy truck snowplows and 106 graders, excavators, and loaders. 68% of these vehicles are less than 8 years old. In the 2021/2022 winter season, state crews plowed and cleared 1.7 million lane-miles at a cost of nearly $31 million.[3]

Since the early 1980's, VTrans has adopted a "safe roads at safe speeds" policy around winter maintenance as stipulated in their Snow and Ice Control plan (SIC). This varies from a "bare roads" policy where the

expectation is that roads will not be returned to a bare state until after a storm event. VTrans clears snow during winter events on a corridor priority basis.[6]

Vermont's town highways are exclusively maintained by the respective municipalities. Fleet sizes and available budgets vary by town. As more than 70% of VT Roads are owned by Towns in rural areas with limited tax base and budgets, the timeliness of winter maintenance activities also varies across the state. State aid appropriations are provided for maintenance of town roads based on the total mileage of town highways. VTrans also provides technical support and funding to municipalities through the Vermont Better Roads Program.

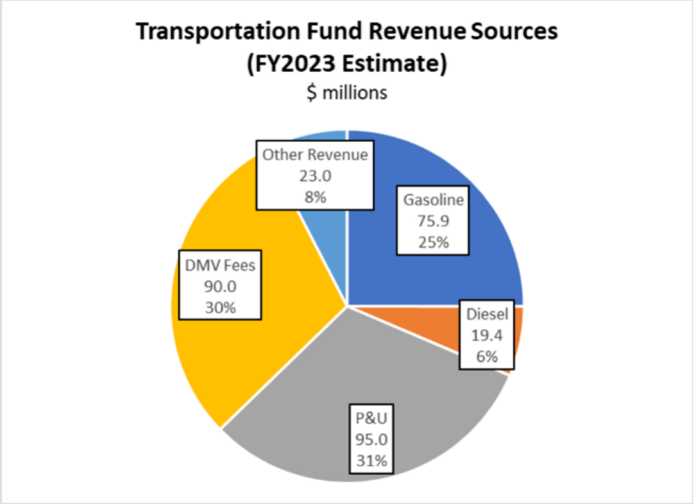


FUNDING

The operations and maintenance of Vermont's transportation systems is funded through federal, state, and local sources that are largely based on gasoline and diesel taxes. Vermont's gasoline and diesel taxes are 32.14 cents and 33.0 cents, respectively, while those for surrounding states are: New Hampshire 23.83 and 23.83 cents, New York 25.32 and 23.55 cents, Massachusetts 24.0 and 24.0 cents, and Maine 30.0 and 31.2 cents respectively.[7] Gasoline and diesel user fees are not indexed to inflation, thus, spending power has decreased over time. With the growth of hybrid and electric vehicles, and Vermont's transit, rail, park-and-rides, and carshare programs, gasoline consumption in Vermont has been declining since the early 2000s. **Vermont is currently assessing a mileage-based user fee program for light-duty plug-in electric vehicles using odometer readings through its existing vehicle inspection process. VTrans expects a 2025 implementation date with the support of the Infrastructure Investment and Jobs Act (IIJA), aka Bipartisan Infrastructure Law.**

The chart below summarizes current funding sources (only within the State) including but not limited to motor vehicle fuel taxes, demonstrating the gap vehicle field taxes are expected to leave in the State's transportation funding.

Gas and diesel taxes account for about 31% of the total transportation fund revenue for 2023. The Purchase and Use Tax (P&U) revenue is made from Vehicle Registration/Title Changes (6% of the vehicle's market value) and Short-term vehicle rentals (originating in VT, 9%) which contributes 31% of 2023 revenue. DMV fees make up another 30% from Vehicle Registration Fees, Driver's Licenses, Commercial Driver's Fees, and International Registration Plans. Other miscellaneous revenue (accounting for 8% total of 2023 revenue) comes from Title certificates, oversize permits, inspection sticker fees, civil traffic fines, and railroads.[8]



Considerations to gain additional revenue are summarized in the bullets below:

- Increasing DMV fees due to inflation (estimated to generate an additional $14 million)
- Motor Fuel Taxes
- Increase split of P&U tax for Transportation and charge higher rate for non-EV or non-hybrid vehicles.
- Registration and Charging Fees for Electric Vehicles (EV)
- Transfer revenue from other state funds

Raising the gas tax to grow with inflation as well as instating charging fees for electric vehicles would help supplement transportation funds as more users switch to electric and hybrid vehicles.

Federal funding increased due to passage of the IIJA. The 2023 budget is $433,491,915 which is a 19.9% increase compared to 2022.[9] This increase allows for more funds allocated to Town Highway programs, rail projects, airport improvements, EV charging infrastructure, paving projects, and bicycle-pedestrian locations, per Governor Scott's recommended FY 2024 budget.

FUTURE NEED

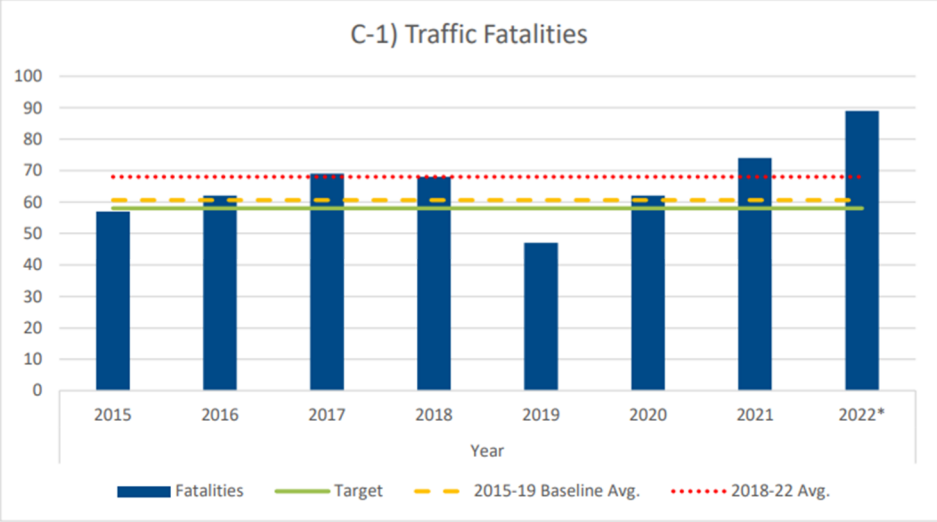
The Vermont Agency of Transportation (VTrans) developed the Long-Range Transportation Plan (LRTP) in 2018 to provide a blueprint for the State's transportation investments over the next 20 years. The plan focuses on highways and bridges, public transit, railways, and airports in addition to information systems, signals, automated message boards, and other technology.[10] VTrans is updating the current LRTP to reference its PROTECT Resilience Improvement Plan and incorporate technological changes since 2018 including the impacts due to COVID, all of which builds on the 2023 Vermont Transportation Equity Framework.

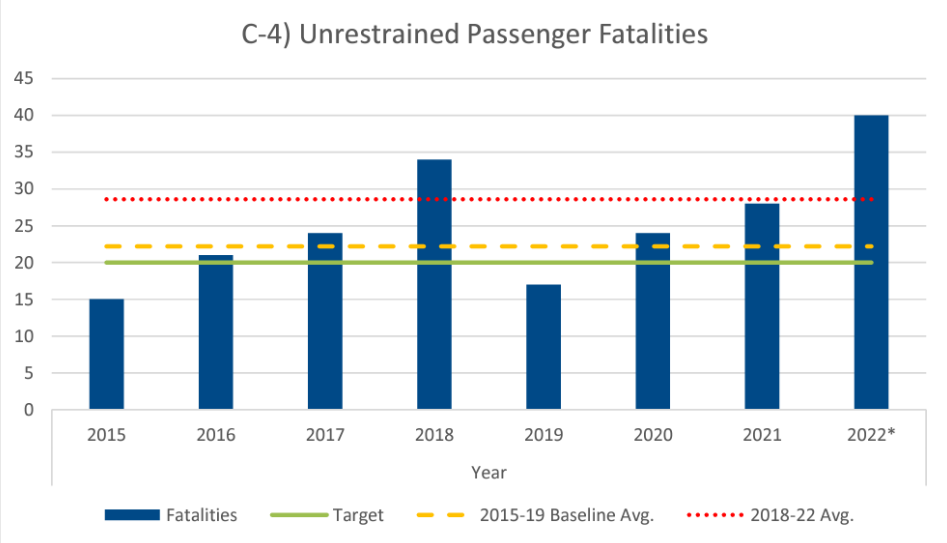
VTrans has developed a program to select and prioritize state transportation capital improvement projects. VPSP2 (Vermont Project Selection and Prioritization) intends to maximize the "transportation value" for Vermont taxpayers by evaluating projects based on the 8 criteria (safety, asset condition,

mobility/connectivity, community, economic access, environment, resiliency, and health access.). In addition, VPSP2 aims to develop a system for Regional Planning Commissions and communities to provide input in the selection and prioritization of projects.[11]

PUBLIC SAFETY

Traffic deaths in Vermont have increased each year since 2019, doubling from 44 in that year to an estimated 89 in 2022 – climbing from 0.64 deaths per 100 million vehicle miles traveled (VMT) in 2019 to 1.2 deaths at that same rate. [12, 13, 14] Each year in the previous four, the lack of seatbelts has increased as a portion of fatal crashes, rising to half of those in 2022. Speeding, drivers under 20, and motorcycle use have all increased as variables in a portion of that whole.





Vermont's 2022 update to the State Highway Plan set aimed to reduce fatal crashes to 65 in 2023 and outlines reduction targets in each crash category, with a "Toward Zero Deaths" aim but "setting realistic and achievable goals." To accomplish those goals and deploy the plan's data, Vermont invests in a Highway Safety Improvement Program (HSIP) awarding money to projects increasing traffic safety across engineering, enforcement, education, and emergency response. In FY 2021, $13 million in (HSIP) funds were obligated to 26 different safety projects.[14]

RESILIENCE

Many of Vermont's major roadways are constructed along river corridors that are vulnerable to flooding during extreme weather events. VTrans has developed a Statewide Transportation Resilience Planning Tool (TPRT) which combines river science, hydraulics and transportation planning methods applied at a watershed scale to identify potential mitigation measures based on roadway vulnerability. The TRPT is enhanced by regularly updated reports and webtools that are connected to the publicly accessible database to focus on assets that have been damaged in multiple governor- or president-declared storm events.[15]

The TPRT identifies a roadway's flood risk by averaging the scores of both 'flood vulnerability' and 'network criticality'. 'Network criticality' is scored as the relative travel time impact associated with closing each unique road segment regarding the traveling public and emergency service accessibility. Flood vulnerability is scored based on the amount of recovery time required to restore travel and the typical size of the impact based on the geographical location.

Vulnerability Score	Failure Mode	Influence	Distance	Vulnerability Type
1, 2, 3	Partial Closure	Singlelane closure, reduced capacity with some allowable travel, <24 hours	<0.25 miles	Inundation
4,5	Full Closure	Multi-lane closure, detour required, 24 hours to several days	0.25 - 1 mile	Inundation, Erosion, or Deposition
6, 7, 8	Temporary Operational Failure	Partial destruction of facility. Several days to 1 week for recovery.	0.25 - 1 mile	Inundation, Erosion, or Deposition
9, 10	Complete Failure	Complete destruction of facility. 1 week to months for recovery.	Varies	Erosion or Deposition

Novak, David C. and James L. Sullivan, "A link-focused methodology for evaluating accessibility to emergency services", Decision Support Systems, Volume 57, January 2014, Pages 309-319.

After aggregating this over the entire network, the results of this analysis show that 21% of the roads in Vermont can be categorized as "High" or "Medium" risk of flooding during a 100-year storm event.[15]

Flood Risk Level	Risk Score Range	Total Length (Miles)	Percentage
High	8-10	397	2%
Medium	4-7	3,688	19%
Low	1-3	11,967	61%
No Risk	0	3,595	18%

Following Hurricane Irene in 2011, the State updated hydraulics design standards to reflect a better understanding of bank full conditions and prevent development within the floodway and river corridor. They also started the Better Roads program and Local Technical Assistance Program (LTAP) to support municipalities and promote erosion control, maintenance techniques, and improve road networks.[16] [17] [18] By providing specifications and design guidance, such as increasing minimum culvert sizes to 24 inches, these programs improve resiliency for town highways across the State. In addition, some towns are creating their own bylaws to prevent development within the floodway and river corridor. VTrans is in the process of preparing a PROTECT Resilience Improvement Plan.

INNOVATION

Vermont has a small, aging population and will need to find innovative solutions to compensate for its diminishing workforce. The Agency of Transportation and its partners have taken on various innovative systems to help support a staff of over 1200 employees. VTrans participates in FHWA's Every Day Counts (EDC) program through the State Transportation Innovation Council (STIC) where transportation leaders meet to collaborate on innovative practices.

Since 2017, the STIC has hosted an annual Research and Innovation Symposium where both agency and academic contributors share their research and innovation projects with the transportation industry (https://vtrans.vermont.gov/planning/research/learn). Two example projects that are being piloted by VTrans include (1) the concept of "Civil Integrated Management" - a transportation equivalent of Building Information Modeling (BIM) where assets are recreated in a 3D model as Digital Twins, and (2) developing the Vermont Asset Management Information System (VAMIS), which allows VTrans to manage the network of transportation assets from a broader perspective and make risk and performance based, data driven, programming decisions.[19]

SOLUTIONS TO RAISE THE GRADE

- Improve pavement condition deterioration through targeted investment to bring the Travel Weighted Average Condition above the agency target of 70.
- Develop and implement an alternative funding source to combat the deterioration of the gas tax purchasing power. Tie the state gas tax to inflation, implement a mileage-based fee program, or develop an alternative funding source from electric vehicles.
- Reverse the recent trends of increased fatalities and reduce the overall number of fatalities and serious injuries by 10%.
- Follow through on plans to identify top priority corridors for flood risk and use TRPT, PROTECT, and other FEMA grants like Pre-Disaster Mitigation to make roadways more resilient and prevent isolating communities.
- Continue to explore the opportunities with Digital As-Builts and Digital Twins to create more seamless connections between Construction and Asset Management.

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Jeff is a licensed Professional Engineer in the State of Vermont with 11 years of experience in Transportation Engineering in both Vermont and Massachusetts. Jeff earned a Bachelor of Science and Master of Science in Civil Engineering from Northeastern University in Boston, MA and worked in Massachusetts for 5 years before moving to Vermont in 2017. Jeff is currently employed by VHB as a Transportation Engineer where he specializes in roadways, highways, bridge approaches, intersections, and pedestrian/bicycle facilities.

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SOLID WASTE

2023 Grade: C+ | 2019: B- | 2021 Nat'l: C+

SUMMARY

In 2021, approximately 639,835 tons of municipal solid waste (MSW) were generated in the State of Vermont. Of that, about 219,501 tons – 34 percent – of material were recycled or otherwise diverted from landfills or incinerators. That diversion rate is consistent with the 34% average of the last 10 years and much lower than Vermont's 50% goal by 2024. Vermonters disposed of MSW at an average of 1,302 pounds per person per year in 2021, much above the State's 2024 goal of 1,000 lbs/person/year. Vermont's Solid Waste Infrastructure Advisory Committee determined that approximately $45 million (in 2015 dollars) was needed to meet these goals. A structural flaw should be corrected in Vermont's solid waste funding model: funds are generated in proportion to the amount of trash disposed and Vermont's goal is to minimize that total while maximizing amount diverted.

INTRODUCTION & BACKGROUND

Vermont generated approximately 639,835 tons of municipal solid waste (MSW) in 2021. Approximately 66% of Vermont's MSW was either disposed of in Vermont landfills or hauled out of state for disposal in 2021. The remaining 34% of MSW generated in Vermont was recycled or otherwise diverted from landfills or incinerators. Vermont also generated and disposed of approximately 29,520 tons of materials that were used beneficially in Vermont landfills as alternative daily cover or road base, including contaminated soils, sludge, and construction and demolition (C&D) debris. The typical composition of Vermont's residential MSW (including bulky wastes as part of Special/Other category) based on a 2018 study prepared by DSM Environmental is presented in Figure 1.

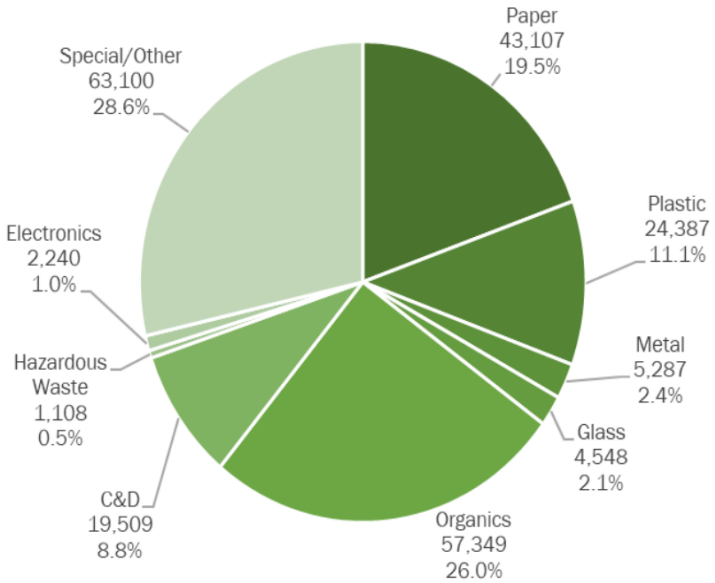

Figure 1: Vermont Residential Waste Disposal (2018)

Vermont enacted the Universal Recycling law (Act 148) in 2012 to focus efforts on increasing the waste diversion rate. Act 148 encourages diversion of materials from the landfill by phasing out certain items including mandated recyclables, food scraps, clean wood and leaf and yard debris. The MMP anticipates a 10% decrease in waste generation and a push toward achieving a 50% recycling/composting rate by the year 2024. Vermont's historical generation, diversion, and disposal rates are shown on

Figure 2 along with projections for 2022 and 2023. This graph shows that diversion rates have stayed considerably stagnant over the years. The MMP diversion goal seems improbable.

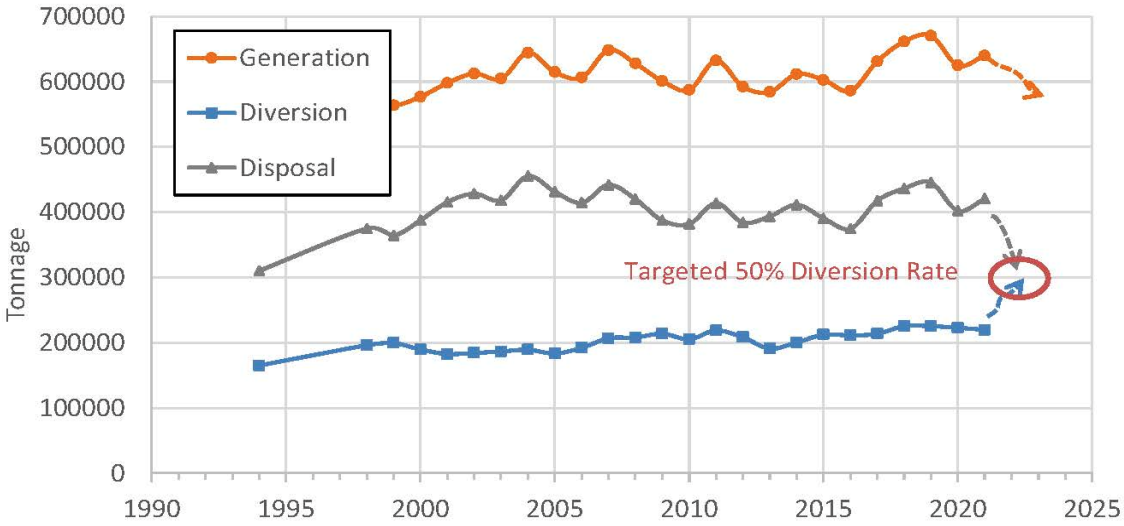

FIGURE 2: Vermont Disposal and Diversion Graph

CONDITION & CAPACITY

Solid waste collection in Vermont is primarily performed by private haulers with some assistance from municipalities and solid waste districts. In addition, many households and some small businesses haul their waste and recyclables to transfer stations and drop-off facilities. There are currently 210 facilities certified to collect MSW refuse and/or recyclables and more than 350 transporters that are permitted to transfer many types of waste materials throughout Vermont. In addition, as of January 2019, there are 12 facilities certified to process food scrap materials through composting or anaerobic digestion, 13 permitted food scrap haulers, and 17 farm digesters.

The majority of Vermont's solid waste is hauled to and disposed of in a Resource Conservation and Recovery Act (RCRA), Subtitle D lined landfill facility located in Coventry, Vermont in the northeast corner of the state. This is the only permitted and operating solid waste landfill within Vermont. A solid waste certification has been issued that permits a 51-acre landfill expansion and is currently being constructed in multiple phases, with an overall life expectancy of 22 years. This expansion has drastically increased future landfill capacity in the State of Vermont. A second smaller landfill located in Sheldon in northwestern Vermont has a permitted fill rate of 20,000 tons per year; however, the landfill is not yet operating and there are no current plans for construction. In addition, about 15% of Vermont's waste (in 2021) was transported to an out-of-state facility in either New Hampshire, New York or Massachusetts for disposal.

The State of Vermont Solid Waste Management Rules are a set of established procedures and standards to protect public health and the environment by ensuring the safe, proper, and sustainable management of solid

waste in Vermont. These standards prohibit solid waste facilities in the State of Vermont from being sited in environmentally sensitive areas. In addition, these rules ensure rigorous landfill design requirements and construction quality assurance. Historical, unlined landfills pose risk to human health and the environment and should continue to be evaluated including for the presence of per and polyfluoroalkyl substances (PFAS). Vermont has adopted a 20 part per trillion (ppt) Maximum Contaminant Level (MCL) for five PFAS and landfills are known source areas.

An emerging challenge for current and future landfill operators in Vermont is the regulatory requirement to treat landfill leachate for PFAS. As part of the recently issued Pretreatment Discharge permit for the only operating landfill in the State, the VT Department of Environmental Conservation (DEC) is requiring the landfill operator to develop a pilot system to reduce the amount of PFAS in the leachate. With the limited information available regarding treatment of PFAS in a complex matrix such as leachate, there is considerable uncertainty regarding future leachate treatment operational requirements and costs.

Recycling

In 2021, Vermont diverted approximately 219,501 tons of MSW through recycling facilities, bottle redemption, direct to market economic recycling, scrap metal facilities, organics and household composting, and reuse facilities and programs. Act 148 (adopted in 2012) is intended to increase the diversion rate of organics and Act 175 (adopted in 2014) is intended to increase C&D recycling rates; however, currently there are a limited number of facilities devoted to reuse and recycling of these materials.

Compost

The passage of Vermont's Universal Recycling Law (Act 148 adopted in 2012) included a statewide ban on food scraps in landfills implemented on July 1, 2020. It is anticipated that continued composting efforts of food scraps and yard waste will significantly contribute to Vermont's diversion goals over time. An estimated 58% of Vermont households compost roughly 367 lbs of food waste annually. In addition, the passage of Vermont's Single Use Product Law (Act 69 adopted 2019) includes regulations on the use of single-use plastic bags, straws and stirrers, and sale of expanded polystyrene food containers which could help reduce plastic pollution in compost.

Electronic Waste

In 2010, the Vermont legislature passed Act 79 related to the recycling and disposal of electronic waste (e-waste). Act 79 bans the disposal of e-waste in landfills and provides a manufacturer-funded recycling program. During the 2021 program year, 1,478 tons of e-waste were collected and recycled.

Household Hazardous Waste and Universal Waste

Household hazardous waste (HHW) and universal waste is collected and managed separately from MSW to reduce the risk to public health and Vermont's environment from disposal of these materials. Since 1992, each district, alliance, or municipality has been required to develop and implement a Solid Waste Implementation

Plan (SWIP) that must include a minimum of two HHW collection events per year, as well as a public education and outreach component. Currently, participation rates in Vermont range from 1% to 20%, average around 8%. However, based on the frequency of HHW disposal and accessibility, 14% is considered to be a successful participation rate.

INNOVATION & RESILIENCE

Act 148 set forth a hierarchy of beneficial uses for organics (Figure 3). This represents a guide to the highest and best priority uses for food waste in the state.

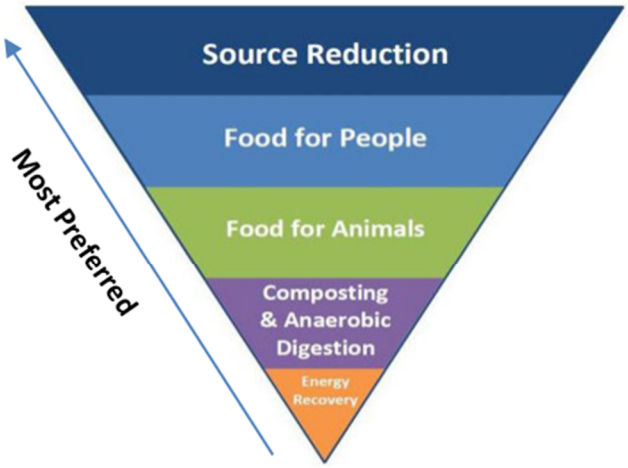

FIGURE 3: Vermont Food Recovery Hierarchy

In Vermont, it is estimated that organic materials (food scraps, leaf and yard debris, etc.) make up roughly 26% of residential waste (57,349 tons), and approximately 23% (45,779 tons) of industrial, commercial, and institutional waste. Vermont has made a significant effort through Act 148 to incentivize investment in recycling, food donation and organics diversion. This includes Pay as You Throw pricing, which gives residents control over their solid waste costs and the more they recycle and compost, the more money they save. While many towns and haulers were already using this type of pricing, the legislation has led to adoption of town ordinances that require weight or volume-based pricing statewide.

In 2009, Farm to Plate Investment Program (F2P) legislation was signed into law, which led to the creation of a 10-year Farm to Plate Strategic Plan. This was renewed in 2019 to implement the 2021-2030 Vermont Agriculture and Food System Strategic Plan. The primary goals of the legislation are to increase economic development in Vermont's food and farm sector, create jobs in the food and farm economy, and improve access to healthy local foods. Since the implementation of the first strategic plan, Vermont's food system economic output expanded 48%, has added over 6,000 jobs, and Vermont farms have sold $781 million worth of product each year. This program complements Act 148 in that one of the goals of the program is for edible food, food scraps, and other food residuals to be used for their highest purpose, and not be considered waste.

FUNDING, FUTURE NEED, OPERATION & MAINTENANCE

Continued success of Act 148 implementation will require improved recycling infrastructure and services. There still remain gaps in areas of Vermont where centralized small-to-large-scale organics management facilities will need to be developed to process residential organic material and high volumes of organics from the commercial sector.

Current solid waste funding in Vermont relies on the amount of trash disposed of, therefore there is a need to create a more sustainable funding system. A shift in this system is needed, as Act 148's goal is to decrease trash disposal which will eventually result in an overall revenue decrease. The SWIAC determined that approximately $45 million (in 2015 dollars) is needed to meet the proposed infrastructure investments estimated to implement Act 148 with 25% ($12 million in 2015 dollars) coming from public grants. This comes from the cost of building effective statewide infrastructure for recycling and organics management which Vermont is continuing to expand.

Economic incentives, such as grant funding and a Solid Waste Service Fee (including trash, recycling, and organics) still need to be explored and prioritized. To support the increased stream of diverted materials, incentives and funding opportunities should be made to incite the development and expansion of essential infrastructure. Vermont will need to continue to grow and support programs to manage and divert other materials from landfills, such as e-waste, HHW, and universal waste.

Despite rising diversion rates from improved recycling infrastructure and services, there will still be a need for landfills to dispose of the portion of solid waste that is not recycled. Vermont has made progress in recent years with ensuring that adequate landfill capacity is available for waste disposal for the coming years, however as landfills will continue to be a primary component of the State's solid waste management program Vermont will need to continue planning for future landfill development.

SOLUTIONS TO RAISE THE GRADE

- Devise and implement solid waste funding mechanisms that generate additional funding for greater MSW diversion and MSW generation numbers at or below 1,000 lbs/person/year.
- Create long-term funding programs to encourage the establishment of centralized small-to-large-scale organics management facilities.
- Continue promoting statewide public education and outreach programs to encourage recycling/composting.
- Support research and invest in alternatives for the use of waste as resources, such as aerobic digesters and plasma gasification.
- Establish new hazardous waste collection facilities to improve accessibility and convenience for every region of the state.
- Perform evaluations to assess the presence of PFAS around landfills. Vermont has adopted a 20 ppt MCL for five PFAS. Landfills are known source areas.

- Develop recycling, processing, and disposal infrastructure in underserved areas of the state.
- Develop legislation to reduce single-use packaging for consumer products and supply chain inputs to limit MSW.
- Perform evaluations of historical landfills for risks to human health and the environment, including assessment for the presence of PFAS.

AUTHORS/CONTRIBUTORS

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STORMWATER

2023 Grade: C- | 2019: D+ | 2021 Nat'l: D

EXECUTIVE SUMMARY

Stormwater runoff can be harmful to the health, safety, and performance of the built or natural environment. Vermont made a positive step in 2022 reducing the minimum requirement for stormwater engineering in developments down to 0.5 acres of impervious surface area, and more thorough stormwater permits if greater than 3 acres. Such area shuttles stormwater at too high an intensity and volume for the watershed to safely absorb it. 2015's Act 64 and subsequent changes have enabled the establishment of 17 stormwater utilities reporting 11.5 million gallons of untreated stormwater runoff in 2022. Vermont's state government should assist communities with new state financial support and help accessing new federal funding to meet a $2.3 billion need over 20 years to grow public works capacity to construct, collect data on, and interconnect stormwater infrastructure.

BACKGROUND

Stormwater is runoff due to rain events or snowmelt. Engineered designs should collect and treat stormwater in a safe and efficient manner to ensure the security the built environment: roads, buildings, above ground public spaces, and underground infrastructure like wastewater systems. Not only does ample stormwater management benefit humans directly, but it also provides an improved natural environment, better water quality, wildlife habitat, stream geomorphology, and flood protection.

The Vermont State legislature showed commitment to meet the stormwater challenge facing the state with the 2015 passing of Act 64. Through Act 64 and subsequent updates Vermont has established the Municipal Roads General Permit (MRGP), an overall management plan to bring State-owned roadways to a high standard, a new Municipal Separate Stormwater System (MS4) General Permit, the implementation of the new Stormwater General Permit 3-9050 (GP 3-9050), a new Municipally Owned Developed Land Permit, and an expanded system of application and operating fees to help fund the Statewide Stormwater Program.

Source: *https://dec.vermont.gov/watershed/stormwater*

Most recently, enacting GP 3-9050 has been a massive step forward towards helping Vermont meet its goals for water quality moving into the future. As a result of the roll-out of the new permit, many more projects and many existing properties will be required to manage stormwater and reduce environmental impacts from their development.

Funding sources like the 2021 American Rescue Plan Act (ARPA) and the 2021 Bipartisan Infrastructure Law are certainly helping, but they do not go far enough. As a small and generally rural state, Vermont still lacks stormwater utilities, full-time town managers, and public works directors with capacity to plan for and manage stormwater infrastructure needs. Despite these challenges, Vermont is making measurable gains, with substantial emphasis on installing Green Stormwater Infrastructure (GSI) and utilizing Low Impact Development (LID) techniques wherever feasible.

CONDITION AND CAPACITY

Vermont has a rigorous permitting process in place to address stormwater design. Prior to 2022, when development is proposed that will create impervious surface coverage greater than 1 acre, a certified designer must incorporate structural and non-structural stormwater treatment practices into the site design. Depending on the underlying soils and groundwater elevation, designers choose practices that first focus on recharging the water table and improving the water quality of the runoff and secondly control outfall flow rate to improve the impact downstream.

Effective on July 1st, 2022, this threshold was lowered to 0.5 acres, roughly imagined as 2-3 single family homes sharing a development road. Lowering the threshold to 0.5 acres captures many more projects which were previously not required to provide treatment. In 2022, Vermont also enacted the "3-acre rule" which required sites that have never had an operational stormwater permit or were permitted to standards in place prior to the 2017 Stormwater Management Manual to obtain coverage under the general permit. The state currently has a public list of 750 properties that meet this criterion. The change goes a long way to address stormwater runoff from older sites like ski areas and strip mall developments built before modern understanding of the water quality and peak flow-related impacts of stormwater runoff. Untreated flow from these sites has been difficult to address. Historically, existing infrastructure is grandfathered in at the time new laws or permitting rules are established.

Programs under Act 64 continue to be implemented to significantly reduce stormwater-related pollution from paved and unpaved municipal roads. Twelve municipalities, The University of Vermont, and the Burlington International Airport are Municipal Separate Stormwater System (MS4) General Permit holders, and along with the Transportation Separate Storm Sewer System (TS4) General Permit, regulate and hold permittees to higher standards of stormwater treatment. The MRGP, a requirement of Act 64, is intended to significantly reduce stormwater-related pollution from paved and unpaved municipal roads.

17 municipalities have created stormwater utilities, since authorized in 2002. In 2022 all 17 municipal stormwater treatment systems reported discharges of untreated stormwater combined with sewage for a total of 11.5 million gallons. Although cities like Burlington have installed peak flow mitigation practices to prevent overflows, with aging infrastructure, additional conveyance, treatment, and management systems are needed.

OPERATION AND MAINTENANCE

Proper operation and maintenance are critical for systems to achieve desired function and maintain design capacity. Recent changes in the rules, requiring permits under a wider range of conditions, results in many more individual property owners being responsible for operating and maintaining stormwater infrastructure and BMPs.

The state's operational stormwater rule requires permittees to assume responsibility for the ongoing maintenance of permitted stormwater infrastructure. The rule further requires annual inspection of all permitted stormwater infrastructure by the permittee or other qualified party, and a restatement of compliance by the design engineer every three years while under permit. This accomplishes two things; one: it creates funding to assist in maintaining Vermont's stormwater program, and two: it requires the owner to be responsible for the continued functionality of the systems. With the 2017 update of the stormwater management manual, there is a focus on relatively low-maintenance treatment practices. A simple operation and maintenance plan is required to be part of the application for every operational stormwater permit. Increasing the adoption of utilities at the municipal level to create a consistent and adequate revenue source for management and improvement of local stormwater systems is an area where Vermont can still improve.

Members of the City of South Burlington stormwater maintenance crew clean a catch basin with a Vactor 2100 jet/vac Truck.

Vermont focuses heavily on Combined Sewer Overflow (CSO) systems as heavy rainfall and snow melt within CSO watersheds often contribute to the pollution of State waterways. CSO municipalities and the Department of Environmental Conservation (DEC) are working hard on mitigation, especially in the Lake Champlain basin, where EPA funding has recently been directed specifically at leveraging GSI to remove stormwater from CSO sewersheds and attempt to return stormwater runoff to pre-development conditions as often as possible.

PUBLIC SAFETY

The Vermont Stormwater Manual requires designers to design stormwater treatment practices that treat storms of varying intensity. The primary goal is to infiltrate smaller volume and less intense storm events such as summer thunderstorms. The secondary goal is to mitigate the runoff velocity of larger and higher-intensity storms like prolonged rain showers.

Although it is helpful that new stormwater systems are designed based on rainfall data that is always being updated, improvements to existing stormwater infrastructure have not kept pace with the rate of climate change. Much of Vermont's municipal infrastructure was not designed to treat stormwater runoff from high intensity, short duration rain events. In Vermont, there are 14 cities and towns with CSOs which can be overwhelmed and release mixed sanitary wastewater and stormwater into rivers or Lake Champlain. Although even accounting for CSO discharges, the Vermont Department of Environmental Conservation states that wastewater treatment plants only contribute 3% to the phosphorus pollution in Lake Champlain. The major sources of phosphorus pollution in Lake Champlain are from agricultural runoff and road runoff.

Lake Champlain has been a public safety priority as the largest waterbody in the state that provides recreational activities and more importantly, drinking water. In the northern and southern portions of Lake Champlain, warm, shallow water combines with elevated phosphorus levels due to runoff which creates a habitat ripe for blue-green algae to flourish. Exposure to blue-green algae can cause severe digestive issues as well as irritation of the skin, eyes, and throat, which can lead to breathing difficulties and even death in humans and other animals.

FUNDING & FUTURE NEED

It was estimated by Vermont Treasurer Elizabeth Pearce in January of 2017 that for the state to reach compliance as outlined by Act 64, Vermont would need to spend $2.3 billion within the next 20 years. Since then Vermont has been busy enacting Phosphorus Control Plans (PCPs), clean water projects through the new Clean Water Service Provider (CWSP) program aimed at mitigating stormwater runoff and pollution, and numerous other programs. While funding in a small, rural state like Vermont is always a challenge no matter the cause, funding opportunities through the Vermont Water Investment Division (WID) Vermont DEC continue to be available.

Additionally, since the onset of the COVID-19 pandemic, ARPA funds have been made available for clean water projects. Opportunities include:

- CSO Elimination and Abatement (25 million dollars allocated over the next four years)
- Three Acre Stormwater Treatment
- Clean Water Initiative Program Grant Programs
- Clean Water State Revolving Fund (CWSRF) Loan Program
    - This program was pre-existing but has received ARPA funding to expand
- Vermont Pollution Control Grants
- Vermont Pollution Control State Revolving Fund (SRF) Clean Water Loans
    - This program was pre-existing but has received ARPA funding to expand
- Unsafe Dam Revolving Loan Fund
- Watershed Grants

In November 2021, the United States Congress passed the Infrastructure Bill (the Infrastructure Investment and Jobs Act) that contains $550 billion in new spending, of which approximately $55 billion is allocated over the next five years to new research, grant programs, and modernization projects to support water infrastructure and clean water nationwide. The package authorized many programs that will support stormwater management including studies on stormwater BMPs which will lead to more informed stormwater management potential and TMDL compliance strategies.

RESILIENCE

Overall, the annual average precipitation total has increased nearly 6 inches since the 1960s with the frequency of 2-inch extreme precipitation events being above the long-term average for more than 25 years (NOAA). Our stormwater systems need to handle larger storms to reduce potential for flooding. Hurricanes continue to cause billions of dollars in damage every year. Although Vermont is far North of most hurricane hot spots, in 2011, Tropical Storm Irene passed through Vermont delivering as much as 11 inches of rain in a 24-hour period causing $733 million in damage, including damage to 2,400 roads, 800 homes and businesses, and 300 bridges. Flooding was severe and caused damage to areas at the time defined by FEMA as being outside of the Special Flood Hazard Areas—and some areas in Vermont had not seen FEMA update their flood maps in over 30 years.

Since the last report card FEMA has been working with local communities, State, and other Federal Agencies to determine gaps in existing flood plain mapping data and create updated floodplain maps that better represent the effects of our changing climate patterns. Local zoning laws are effective at limiting development in floodplains, including prevention of the placement of fill in designated floodplains. The extent of damage caused by extreme flooding events and concerns over polluted runoff are hard to ignore and it is good to see that rule making authorities from around the state are taking strides towards building our infrastructure to be more resilient to future catastrophic events and improving pollution prevention techniques.

INNOVATION

The Vermont Stormwater Management Manual continues to emphasize GSI and LID techniques to reduce runoff and utilize a more naturalized approach to stormwater management. Burlington especially has been constructing above ground filtration practices on several city streets to offline street runoff from inundated sections of the city storm network to reduce pollutant loading and alleviate peak flow contributions. Several companies have invented high speed filtration practices that have minimal footprints compared to existing options which allow them to be installed in parking islands and along sidewalks. These types of practices are useful in new construction in densely populated urban environments and retrofit projects associated with the 3-acre rule. Other standard practices include infiltration chambers, bioretention, gravel wetland filtering practices, green parking, permeable pavement/pavers, planter boxes, and urban tree planting.

SOLUTIONS TO RAISE THE GRADE

VT-ASCE makes the following recommendations to raise the grade of Vermont's stormwater:

- Establish a state budget committee to effectively define and fund short-term and long-term needs.
- Establish scale-appropriate clean water utilities at the municipal level that provide a consistent and dedicated labor force for stormwater management improvements and maintenance.
- Establish an easily accessible statewide system that inventories the size, condition, capacity, procedures for operations and maintenance, and capital needs of all public and privately-owned stormwater assets.
- Improve stormwater infrastructure through retrofit of older systems that provide minimal water quality benefit and continue to embrace innovative water quality treatment practices for future new development and redevelopment.
- Fund research in stormwater management and treatment technology to improve water quality and reduce capital expenditures. This includes exploring options to address maintenance and monitoring of stormwater infrastructure, whether public or private.
- Develop additional funding sources for stormwater, GSI, and LID projects.

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Branden is a 2012 graduate of The University of Vermont where he obtained a BS in Civil and Environmental Engineering. Branden is involved in a variety of work including stormwater evaluation and design, stream and bank restoration, dam removal, illicit discharge detection and elimination, and agricultural water and waste management where he utilizes his skills in design, topographic survey, watershed assessment, and hydraulic & hydrologic modeling. Branden is currently working as a Project Engineer at Stone Environmental, Inc., and is a Past President of the Vermont Society of Engineers, as well as Past President and former New England Council Delegate of the Vermont Section of ASCE.

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Tyler is a 2014 graduate of Penn State University where he obtained his BS in Civil Engineering. He joined Engineering Ventures as a Staff Engineer in the spring of 2018 where he performs civil/site design for commercial and residential

projects of all sizes. Tyler's expertise includes multiple facets of engineering design, permitting, and surveying associated with land use development projects. He has been serving on the Board of Directors for the Vermont Chapter of ASCE since 2015 and served as President for the 2020-2021 year. In his free time, Tyler enjoys outdoor recreation in the Vermont wilderness and grooving to the Burlington music scene.

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WASTEWATER

2023 Grade: D+ | 2019 VT: D+ | 2021 Nat'l: D+

SUMMARY

50% of Vermonters are served by 116 municipal, direct discharging permitted wastewater treatment facilities (WWTFs), with the remainder of residents served by larger, shared soil-based wastewater system or individual on-site septic systems where connections to larger systems are not possible or feasible. Old infrastructure and operations led to 144 sewer overflow events from 2020 through 2022. From 2018 to 2021, permits issued annually to repair failed wastewater systems grew from 510 to 641. Annual wastewater infrastructure investments from Vermont declined from $29 million in 2019 to $12 million in 2022. The 2021 American Rescue Plan Act sent one-time funds to the state – of which $30M was used for treatment of combined sewer and sanitary sewer overflows. Sustained investment is necessary to meet goals for decreasing harmful chemicals and increase resilience.

BACKGROUND

The Vermont Department of Environmental Conservation (VT DEC) is the agency in charge of regulatory oversight and technical assistance (through its wastewater programs) to wastewater treatment facilities in collaboration with state, regional, and national organizations[1]. Both Federal and state-specific regulations, including Vermont's Clean Water Act of 2015[2], provide the primary regulatory structure for managing Vermont's wastewater infrastructure. In addition, decentralized systems that process 6,500 gallons or more of wastewater per day are permitted through the Indirect Discharge Program[3], and soil-based systems that process less than 6,500 gallons per day are administered through the VT DEC Regional Office Program serving majority of Vermont's more rural population[4].

CONDITION & CAPACITY

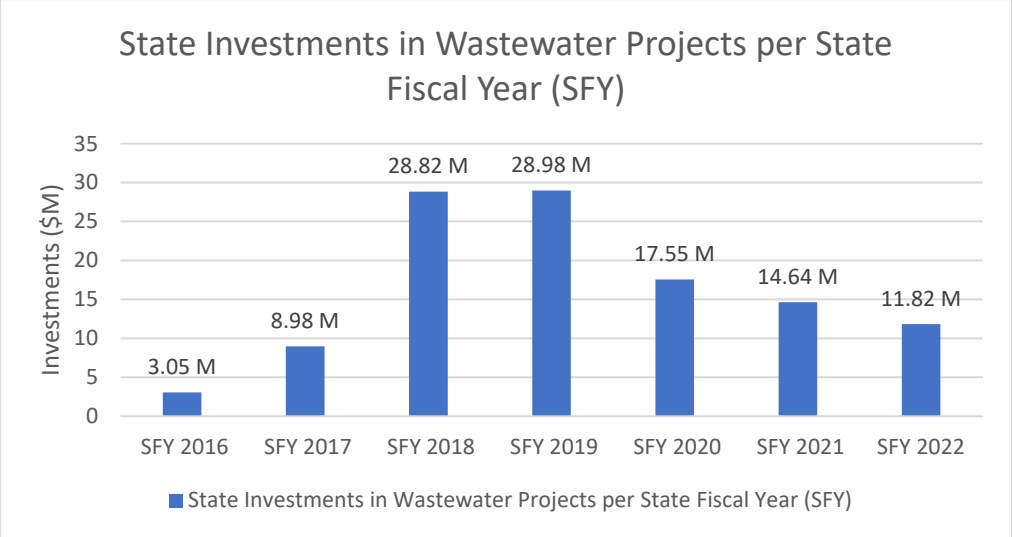
Vermont's wastewater infrastructure includes the WWTFs, their collection system, and decentralized or on-site systems. In addition to the 116 municipal WWTFs, there are pretreatment facilities that discharge to those plants and private WWTFs. As of December 2022, there are 252 WWTFs with active permits in Vermont[5] that are permitted for 179 million gallons per day. Much of the piping infrastructure predates their associated WWTFs and is up to 100 years old, with some even older exceptions.[5] Estimates are that most non-PVC (polyvinyl chloride) pipes will reach the end of their useful life within the next 20 years based on facility operator reports of infiltration associated with aging infrastructure.[6] Additionally, many WWTFs are out of BOD influent capacity, limiting their ability to accept high-strength waste from commercial or industrial facilities.

Over 50% of the state's population is estimated to utilize on-site wastewater disposal commonly referred to as septic systems.[7] If these systems fail, they can contribute to public health hazards and surface water pollution due to surfacing effluent or groundwater contamination. There has been an increase in the number of failed

on-site systems over the past few years. There were 641 permits issued to repair failed wastewater systems in 2021, compared to 665 in 2020, 515 in 2019, and 510 in 2018 [8]. Causes of failure are typically attributed to the age of the systems or improper use by the owner/operator of the system.

FUNDING, OPERATIONS & MAINTENANCE (O&M)

The State primarily provides funding via loans through the Clean Water State Revolving Fund (CWSRF), the Clean Water Fund (CWF) (created via Act 64: Vermont Clean Water Act), with other smaller funding programs available. Although funding for wastewater projects has increased compared to 2016, there has been a steady decline in wastewater funding over the past three years[12].



Additionally, the American Rescue Plan Act (ARPA) provided $1.026B in State Fiscal Recovery (SFR) funds intended for use in various areas including water and sewer infrastructure. As of September 1, 2022, the State Fiscal Recovery appropriations from SFY 2022 and 2023 Big Bills included $30M for treatment of combined sewer and sanitary sewer overflows [9].

Municipalities generate revenue for capital improvements and operations and maintenance by setting their own rates for water, wastewater, and stormwater users. The average sewer rate for Vermont communities is $689.24 per year as of July 2021, with a high of $1,867.68 and low of $140.40 [10]. By comparison, the average sewer rate for the United States in 2021 was $794.40 per year[17]. In 2012 Vermont created the Wastewater and Potable Water Revolving Loan Fund, commonly referred to as the On-site Loan Program, providing low-interest financing for the repair or replacement of failed wastewater or water supply systems. This program is available to those with limited financial resources to repair systems that are becoming increasingly expensive, with a minimum loan amount of $3,000 and no maximum loan amount[18]. $16 million in ARPA funds have also

been made available to provide financial assistance for replacing failed systems through the Healthy Homes Program[19].

FUTURE NEED

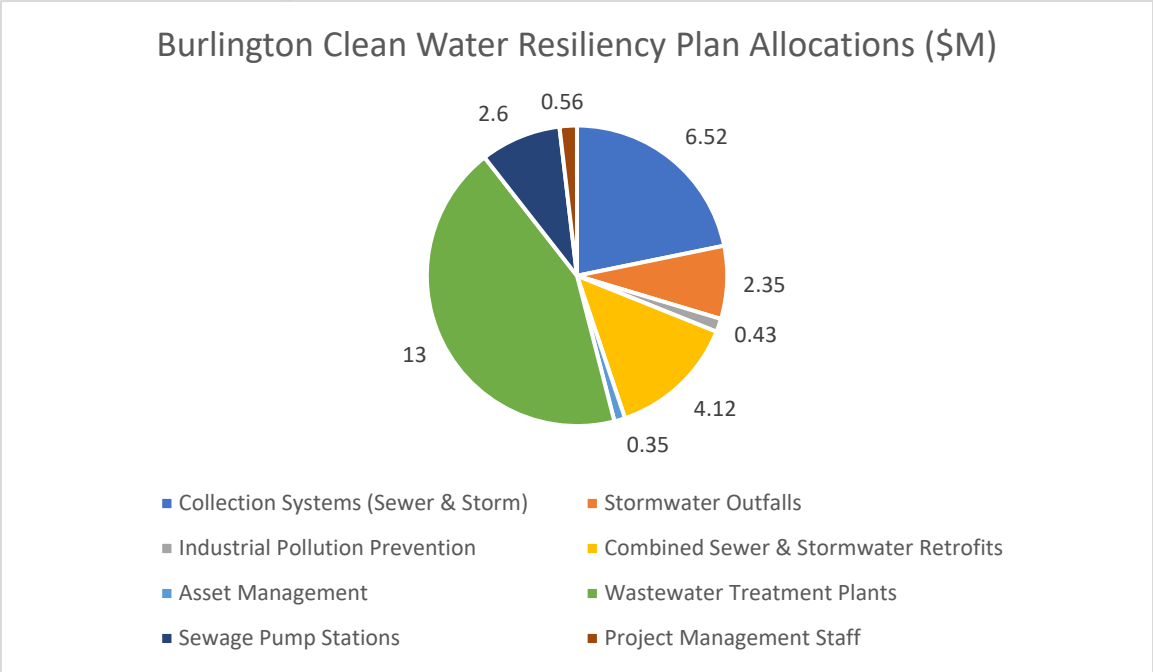
Villages are a key aspect of Vermont's rural nature. However more than 200 Vermont villages lack community wastewater systems, which can hamper revitalization and limit economic growth. To that end, a new Village Water and Wastewater Initiative – not to be confused with the Village Wastewater Solutions Initiative from 2018 – is working with communities in conjunction with ARPA funding, that will help municipalities develop community systems where the infrastructure is currently lacking. ARPA funds will be utilized as a "co-funding" model in conjunction with SRF funds, USDA rural development support, and locally available funding. This initiative will support 11 decentralized community wastewater systems and one drinking water system in the form of planning/design assistance, land purchase, or construction of active projects[11]. This is an innovative, promising start, but insufficient to meet the needs of those 200 Villages.

In addition to community systems, the Healthy Homes Program has shown a clear need for funding replacements of failed or inadequate on-site wastewater systems. In 2022, the program funded 108 wastewater systems, however there were over 600 applicants that applied and appeared to meet the eligibility requirements but did not receive funding. The program re-opened the application process in December 2022 and as of the writing of this report card has received over 400 additional applications, bringing the total over 1,000 eligible properties (with applications being accepted through January 2023), showing a clear need for funding[20].

In terms of assessing Vermont's future wastewater infrastructure, the 2021 Bipartisan Infrastructure Law amended the CWA and directed the EPA to conduct and complete an assessment of capital improvement needs [13]. Vermont is participating in the Clean Watershed Needs which will provide a clearer path toward what improvements and associated funding is required to meet TMDLs and water quality goals. Considering the millions of dollars invested in WWTFs over the years, it is imperative that these investments be protected.

RESILIENCE

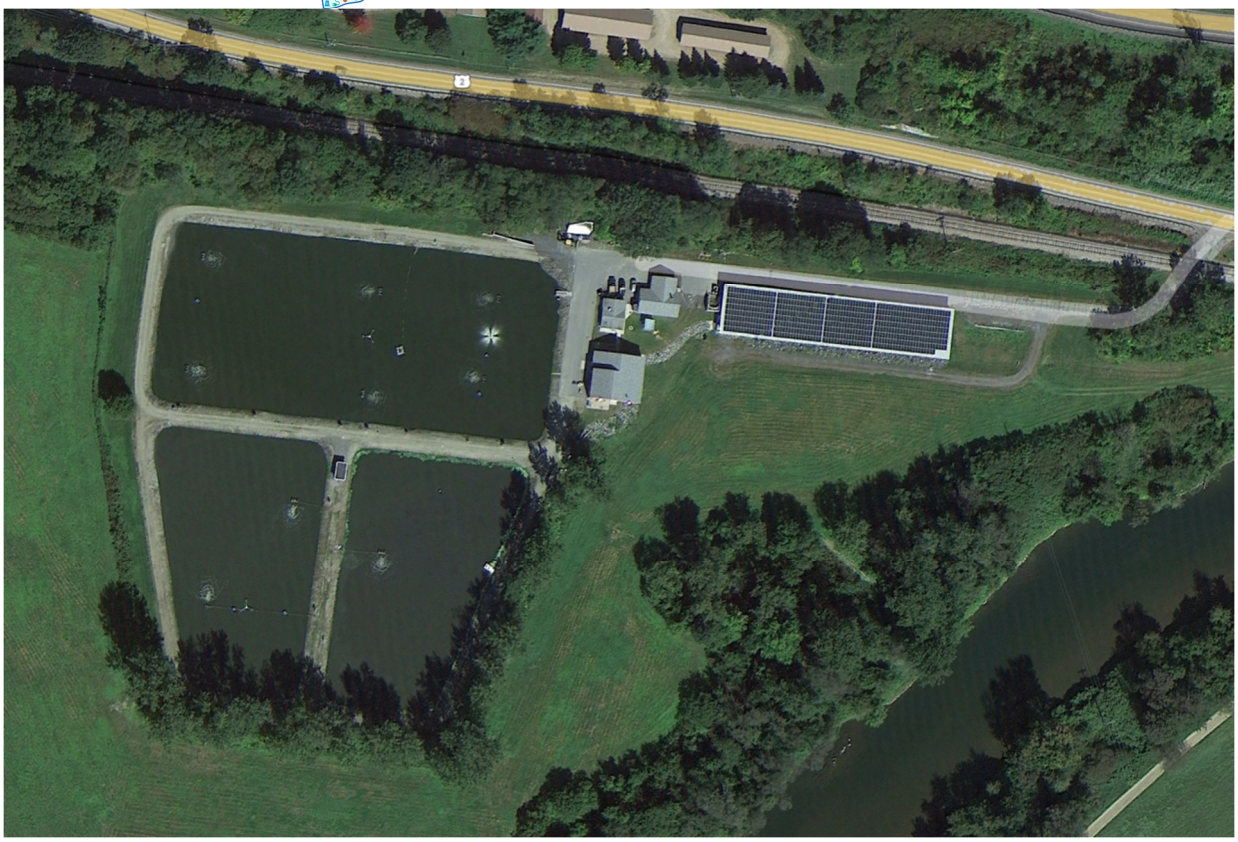
Vermont towns and municipalities are actively looking at ways to improve the resiliency of their wastewater infrastructure. One example of this is Burlington's Clean Water Resiliency Plan, which was passed by 90% of voters in 2018. The plan allocates $30M for improvements and identifies 7 key areas in which upgrades are needed to wastewater and stormwater infrastructure in order to protect Lake Champlain. As of March 2022, work completed under the plan has included WWTF upgrades, ongoing rehabilitation of 48,000 feet of sewer and stormwater mains, and implemented a new rate structure promoting equity and assistance programs for eligible ratepayers[14].



Additional statewide resilience measures are taking advantage of the distribution of ARPA funds that are available through December 31, 2024. VT Agency of Natural Resources (ANR) is currently developing guidance and criteria for applications on allocating these funds, which will include projects such as reducing sewer overflows, providing financial assistance to low-income homeowners with failed on-site systems, developing community sewer systems in villages that currently lack such systems, and designing and installing pretreatment processes to address high-strength wastewater commonly seen in small industries native to Vermont such as craft breweries, dairy and meat processing.

INNOVATION

A number of innovations of Vermont's wastewater infrastructure are being driven by phosphorus TMDLs, resulting in treatment upgrades at WWTFs. For example, the Waterbury WWTF was awarded a 2018 EPA Pisces award for their achievements in reducing phosphorous levels in treated wastewater through the use of innovative technology that was supported by CWSRF funds. The project resulted in a phosphorous reduction of more than 95% to less than 0.2 mg/l [15]. Individual municipalities are also taking approaches to improve wastewater infrastructure, such as the previously mentioned Clean Water Resiliency Plan adopted by the City of Burlington after numerous wastewater overflows that resulted in beach closures along Lake Champlain, affecting public health and safety, the environment, and commerce on the waterfront.



Waterbury VT WWTF (Image Courtesy Google Earth)

PUBLIC HEALTH & SAFETY

As noted previously, municipalities depend on voters to approve ballot measures to access loans for wastewater infrastructure upgrades. This is a major burden on both the municipalities and residents, because if these measures don't pass, and necessary repairs, and upgrades are not funded, there may be public health and safety concerns. Ensuring sustainable funding to safeguard performance of critical infrastructure, and protecting the investments made over time are vital to ensure public health and safety. Thirteen communities among eleven towns in Vermont have combined sewer systems, which cause CSOs during periods of heavy rainfall. The receiving waters of these CSOs are used for different recreational activities from swimming to fishing and boating. The State has begun drafting a Combined Sewer Overflow Long Term Control Plan Guidance Document, with the overall goal of helping individual CSO systems develop a plan to achieve compliance with water quality standards in their respective watersheds and outlines a wide variety of guidance for achieving compliance with the VT CSO Rule.

Another critical piece of ensuring public health and safety is education of homeowners on the importance of wastewater infrastructure, for both on-site and community systems and best management practices that should be implemented for households. Outreach programs are in place to advise homeowners on the negative effect that things such as food scraps, flushable wipes, commercial or industrial wastewater, and

high-strength waste can have on wastewater systems[16]. These programs should continue to be stressed and promoted to ensure the health and longevity of Vermont's wastewater infrastructure.

SOLUTIONS TO RAISE THE GRADE

In order to meet clean water goals for Lake Champlain and other waters of the State, Vermont's wastewater infrastructure is in need of upgrades to replace aging and failing systems, reduce the number CSO events resulting in discharges of untreated wastewater, and to protect existing investments into these improvements. Vermont should take advantage of all available funding sources, including ARPA funding, and utilize the Clean Watersheds Needs survey to assess the need for capital improvements. Impacts of these projects and innovative/resilient systems should be clearly conveyed to Vermonters to emphasize their benefits and resulting impacts on water quality. Therefore, Vermont ASCE assigns a grade of D+ to the State's wastewater infrastructure and recommends the following:

- Vermont must continue investing in wastewater infrastructure to meet clean water goals through all available funding sources and use the results of the Clean Water Survey to establish plans for improvements and long-term capital needs.
- Vermont's utilities must be able to set rates to cover the full cost of service, including operation, maintenance, and capital needs.
- The ongoing innovation efforts in Vermont's WWTFs developed as part of the overall TMDL goals should be expanded, emphasized, and promoted.
- Improvements, upgrades and funding deficiencies identified through ARPA programs pertaining to wastewater infrastructure need to be reviewed and implemented, with additional sustainable funding sources investigated.
- Vermont should expand programs and continue to educate homeowners on best management practices for both municipal and on-site wastewater systems to protect investments in wastewater infrastructure.
- Vermont communities and infrastructure owners should participate in the Clean Watershed Needs Survey to better identify wastewater infrastructure needs in maintenance and upgrades.
- The U.S. Census should include questions related to wastewater and drinking water in the 2030 survey and other, annual data collections so that decision-makers can utilize data more recent than the 1990 Census water estimates.

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Use your zip code to find your Elected Officials.

KNOW

Check the VT Legislative Tracking Center to find legislation that you care about (hint... infrastructure)

DISCUSS

Now that you know who your Elected Officials are, ***EMAIL THEM*** and let them know that you care about Vermont's infrastructure

BE SOCIAL

Use our hashtag ***#ASCEVTReportCard*** or tag us to show your support of Vermont's Infrastructure

ABOUT ASCE – VERMONT

The Vermont Section of ASCE was originally founded 1955 and represents around 380 members across the State. The Vermont Section takes pride in advancing and promoting the profession of civil engineering through carrying out ASCE's mission of advancing technology, encouraging lifelong learning, developing civil engineer leaders, and advocating for infrastructure and environmental stewardship. Vermont achieves these goals through monthly meetings highlighting regional projects, providing members information through our newsletter, mentoring student members, and promoting the profession to the general public through special projects.

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