2019

REPORT CARD FOR VERMONT'S INFRASTRUCTURE

American Society of Civil Engineers Vermont Section

INFRASTRUCTUREREPORTCARD.ORG/VERMONT

ASCE

AMERICAN SOCIETY OF CIVIL ENGINEERS

EXECUTIVE SUMMARY

Infrastructure is the backbone of our state and supports our economy and our way of life. Unfortunately, infrastructure and the important role it plays be sometimes be overlooked – pipes deliver clean water, our light switches work, and bridges carry our cars and goods. We only pay attention when things break down or stop working as they should.

Reliable and safe infrastructure requires sufficient investment, thoughtful planning, and preparation for the future. For a long time, underinvestment at all levels of government threatened our competitive advantage and the health, safety, and welfare of our residents. Fortunately, the state and many local governments have taken recent measures to provide additional support for our infrastructure. While the new funding and higher prioritization is welcome, additional steps can still be taken to ensure Vermont's infrastructure is fit for the future.

The Report Card was created to help Vermont understand the state of our infrastructure. As civil engineers, our job is to plan, design, construct, and maintain our infrastructure networks. This document allows us the opportunity to share that information with the public. The Report Card provides a snapshot for residents and policymakers to engage in a conversation about where we are and where we want to be. We hope that this information provides the insight needed to start that conversation and ignite action.

ABOUT THE INFRASTRUCTURE REPORT CARD

Vermont's ASCE Infrastructure Report Card Committee is comprised of 15 engineers from Vermont that volunteered their time to collect and analyze data, review their findings, and establish a grade for infrastructure within their specialty. The committee worked with staff from ASCE National and ASCE's Committee on America's Infrastructure to provide a snapshot of our infrastructure, as it relates to us at home, as well as on a national basis.

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:

PROMOTE INNOVATION AND FORWARD THINKING

Vermont's infrastructure is aging, and is challenged yearly by climate change and other external factors. To meet these challenges, an emphasis on adequate planning for future repairs, replacement, and new technologies is needed. Forward thinking can extend assets' lifespans, reduce costs, and improve the environment. Resilient infrastructure that can adapt with the times to provide economic and environmental benefits and utilizes emerging technologies should be promoted whenever possible.

PREPARE FOR MORE SEVERE WEATHER CONDITIONS

Our key infrastructure systems must be resilient against the consequences of climate change. Our infrastructure should not only be able to withstand increasingly severe storms, but support emergency response and facilitate a return to regular order as efficiently as possible. State agencies have been putting systems in place to increase resiliency that should be supported, expanded, and maintained even as the memories of Tropical Storm Irene begin to fade.

SUPPORT SUSTAINABLE LOCAL FUNDING SOURCES

While Vermont depends heavily on federal funding and financing to supplement our state budget, our leaders at both statewide and municipal levels must establish balanced and forward-thinking budgets that incorporate sustainable funding practices for infrastructure. Funding sources should consider the long-term cost of infrastructure over its full lifespan, including operation and maintenance. Much debate has occurred recently on how this will take shape as we work to improve our water quality and road infrastructure, but the conversation should be expanded to other categories of infrastructure.

BALANCE THE NEEDS OF URBAN AND RUAL COMMUNITIES

Vermont's communities are very diverse in structure and density, with equally diverse infrastructure needs and investments required to meet individual community needs. 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.

INVEST IN WATER INFRASTRUCTURE

Vermont's water infrastructure, defined as Stormwater, Wastewater, and Drinking Water, are among the lowest scoring infrastructure categories in the state. 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.

2019 REPORT CARD FOR VERMONT'S INFRASTRUCTURE

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SPECIAL THANKS TO

VT-ASCE Board of Directors

ASCE Infrastructure Initiative Staff & Committee on America's Infrastructure, and the ASCE Foundation

VT Department of Environmental Conservation

Vermont Agency of Transportation (VTrans)

AVIATION C-

SUMMARY

Vermont is home to 16 public-use airports, 12 of which are included in the National Plan of Integrated Airport Systems (NPIAS). Vermont's one primary commercial airport – the Burlington International Airport (BTV) – is classified as a small hub. Flights out of BTV are concentrated between 6 and 10 am to allow for connecting flights at large hub airports, contributing to capacity constraints both in the terminal and at airport parking positions. Fortunately, the pavement condition at BTV is in good condition and construction is underway to create a full-length parallel taxiway for the primary runway. However, the aviation system at-large is underfunded. From 2017 to 2021, it is estimated that approximately 80% of state airport needs would go unmet, while approximately 60% of BTV's needs would go unmet. Airport taxes, predominately generated at the primary commercial airport, are insufficient to support facilities and services at civil aviation airports throughout the state. This is compounded by funding shortfalls at the national level.

INTRODUCTION

Airports range in size and function and can include a variety of different infrastructure, including runways, taxiways, aprons, hangars, terminals, air traffic control towers, and much more. Aviation infrastructure also represents the interconnected network of airports within Federal Aviation Administration (FAA)-controlled airspace, operated by FAA navigational and communications systems. The capacity of aviation infrastructure is generally defined by its capability to support the safe and efficient operation of aircraft both on land and in the air.

The State of Vermont is currently in the process of updating its Vermont State Aviation System Plan (VTSASP) and has issued four of the draft chapters. The VTSASP, which includes the most current information available, was relied upon heavily to populate this report. Other sources of information include the Aviation Program-Wide Business Plan dated January 2012, the Vermont Airport System and Policy Plan dated February 2007, and the National Plan of Integrated Airport Systems (NPIAS) for 2017-2021.

Vermont's aviation infrastructure is comprised of 86 airports and other landing facilities. However, this report will focus on the 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), which includes airports determined to be of significance to the national air transportation network. These airports are eligible for grants through the Federal Aviation Administration's (FAA) Airport Improvement Program (AIP). The NPIAS network in Vermont consists of:

- 1 Primary Commercial Service Airport
- 1 Reliever Airport
- 10 General Aviation Airports

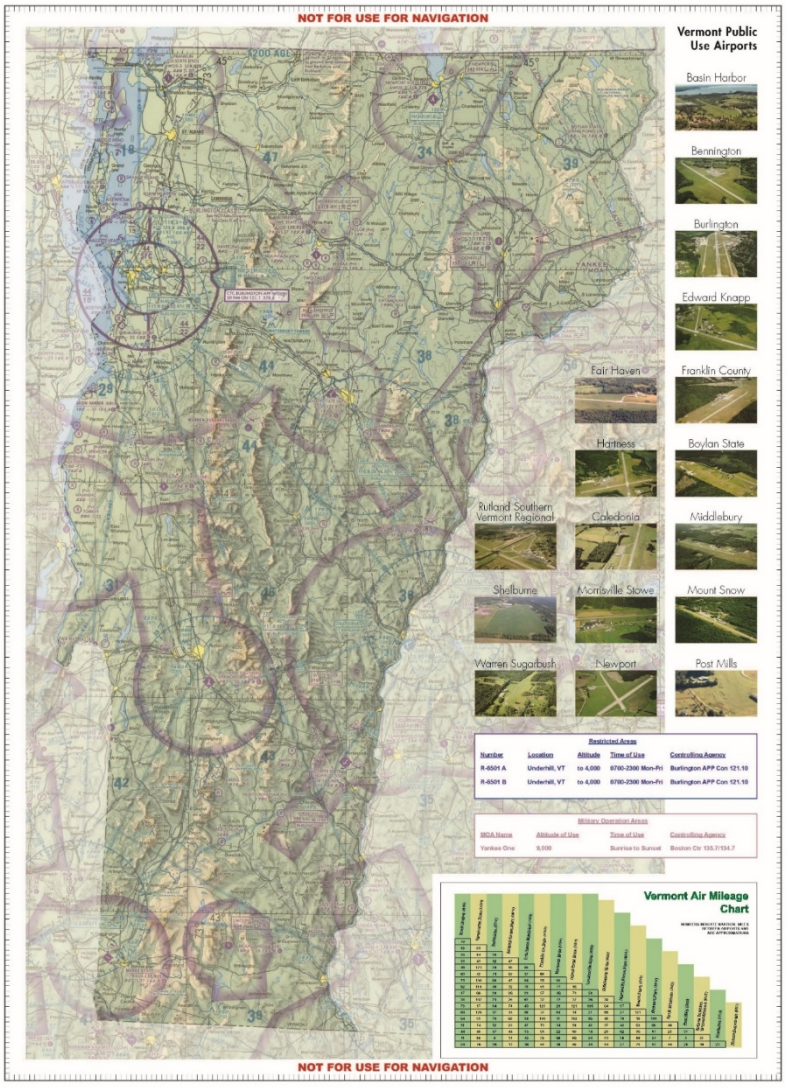
The FAA has its own methods for funding and analyzing the status of airports within the NPIAS system. This report attempts to combine the FAA's methods with the methods defined by the State of Vermont.

CAPACITY

The performance of Vermont's airport system is evaluated according to measures in the following three performance categories: accessibility, development, and safety and security. The accessibility portion of the analysis speaks mostly to the capacity of the system. In 2007, when the last Vermont Airport System and Policy Plan (VTSASP) was published, the Vermont airport system was determined to provide coverage at the following benchmarks:

- 93% of the population within 60-minute drive of commercial service airport
- 62% of population within 30-minute drive of airport with a 5,000-foot long runway
- 44% of population within 30-minute drive of an airport with a 5,000-foot long runway with a precision instrument approach

At the time, "the performance was determined to be good overall, but that improved accessibility was still needed to provide Vermonters with an airport system that could meet business, recreation, and personal needs."



The recent effort to update the VTSASP uses different benchmarks, but still indicates gaps in performance. For example, the VTSASP airport network provides access to 93% of Vermont's population within a 30-minute drive, but only 52% of the population can access the primary commercial airline services provided at Burlington International Airport. The VTSASP 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. All 16 public-use airports in Vermont were evaluated and scored in the VTSASP based on existing facilities and services provided. In Vermont, the number of operations on the runway does not impact capacity, but the availability of facilities and services does. For example, there are a total of 42 T-hangars at Vermont system airports, along with 154 conventional or box hangars. As reported by airport survey participants, there are currently 45 aircraft operators on waiting lists for hangar storage facilities. Due to capacity constraints, almost 20% of the need is not being met. As Vermont moves forward with updating the VTSASP, they will use the performance scores as a tool for understanding where capacity shortfalls exist.

Airport Master Plans are critical to determining whether an airport has sufficient current and future capacity, with respect to both airfield infrastructure and landside infrastructure. Only five of the 16 airports published Airport Master Plans

within the last 10 years. The State's VTSASP is a great first step towards redefining the future of Vermont's State Airports, and that plan is targeted for completion in 2019. The Burlington International Airport is currently working to update their Airport Master Plan.

As for the capacity of commercial flights, the state relies mainly on Burlington International Airport (BTV) to provide those services. The airport scored a 100 on the VTSASP due to the robustness of facilities and services provided. However, if you dive deeper into the day to day operations at BTV, it becomes clear that their facilities are not currently designed to maximize capacity. For example, let's discuss their terminal apron and holding room designs. Leading up to the last Airport Master Plan Update dated 2011, BTV's commercial aircraft mix was predominantly some small aircraft, with a consistent shift towards more and more regional jets. The industry trends at the time were supporting the future forecast of regional jets for non-hub airports such as BTV. A mere seven years later, BTV has several mainline aircraft flights every day. Both the terminal apron and terminal building holding rooms were designed for regional jets with ±70 passengers, not mainline aircraft with ±150 passengers. Compounding this issue is the fact that flights out of BTV are concentrated between 6-10am to allow for connecting flights at large-hub airports. The aircraft that fly in at night remain overnight to accommodate the early morning flights out, and the terminal apron is currently over capacity. In 2017 parking positions were added to the terminal apron to accommodate the growing demand, however they did not have access to a jet bridge. Aircraft parked in these positions are required to either board passengers from the ground, an option that becomes very difficult with rain and snow, or wait for availability of a jet bridge during the morning rush hours. As BTV works towards updating their Airport Master Plan, they will identify these capacity constraints and develop a plan for future growth in an effort to meet forecasted demands.

	Performance Score
John H. Boylan State	7
Basin Harbor	9
Post Mills	12
Deerfield Valley Regional	17
Warren Sugarbush	31
Shelburne	36
Middlebury State	40
William H. Morse State	54
Caledonia County State	54
Morrisville-Stowe State	59
Franklin Couny State	59
Edward F. Knapp State	84
Hartness State	90
Northeast Kingdom International	90
Rutland - Southern Vermont Regional	97
Burlington International	100

CONDITION

Airports are encouraged, and in some cases required, by the FAA to perform a Pavement Condition Analysis for airfield infrastructure. This analysis is used to prioritize airfield projects with respect to runways, taxiways, aprons, and perimeter roads. The Vermont airports included in this report each have a runway, but have varying levels of supporting infrastructure such as aprons and taxiways. As such, this report focuses on condition information available regarding the runway condition. The VTSASP reports that most airports have runways in good or excellent condition. One airport is reported to be in fair condition. Over the 10-year period from 2007 to 2017, the Vermont general aviation airports were awarded over $37 million in FAA AIP grant funding specifically for runway, taxiway, and apron improvement projects. This funding supports efforts to keep the airport in good condition.

The Burlington International Airport recently updated its Pavement Condition Report. The BTV runway is reported to be in good condition. In fact, all runways and taxiways are reported to be in good or satisfactory condition at BTV. Taxiway G, which had deteriorated to just fair condition, is currently undergoing construction. Similarly, sections of the terminal apron vary in condition from very poor to good, but the apron is partially through a multi-phase rehabilitation project to address this shortfall. The remaining airfield infrastructure includes general aviation aprons and the perimeter road, which vary in condition but generally lean towards the poor side of the spectrum. As BTV looks to update its Airport Master Plan, the Pavement Condition Report will drive project prioritization. Once the taxiways and aprons are rehabilitated, it will be time to shift focus to the general aviation aprons and perimeter road. In the meanwhile, BTV will also need to carefully track the condition of the runway. In 2010, each end of the runway was closed for full depth reconstruction. However, the middle section of the runway remained open during the day while a mill & overlay surface treatment was performed section by section at night. These types of surface treatments usually prolong the pavement life for seven to 10 years. At some point in the near future another surface treatment will be required, or the airport will have to find a way to perform full depth reconstruction on the middle third of the runway. This type of project is complicated for a commercial airport that cannot close its runway for months at a time to perform repairs and rehabilitation.

Pavement is constantly deteriorating with time and use. Airports are always reprioritizing projects to maximize conditions given limited funding. FAA funding can be used to rehabilitate pavement, but maintenance of the infrastructure is the responsibility of the individual airport. Without regular attention, pavement conditions – especially in northern climates - deteriorate quickly from good to fair, poor, serious and failed thus affecting airport condition.

OPERATION & MAINTENANCE

Operations and maintenance is managed very differently between state-owned airports and the Burlington International Airport (BTV). The state has a very small team of full-time employees and will bid out operations and maintenance services to contractors, or lean on internal resources for support. For example, in a snow storm the state may lean on the highway plow crew to clear snow from the runway, but for many general aviation airports the runway is only plowed after the highway is cleared. This lack of on-site resources causes some state airports to close down in the winter or during snow storms. The VTSASP suggests that only nine of the 16 airports provide snow removal services, which translates to only 56% of the network in Vermont.

When pavement markings need to be restored on the runways and taxiways, the state will bid a contract competitively to obtain services for multiple airports at a time. At BTV, these tasks are performed by the ±30 full time employees on staff. These employees also repair catch basins, patch pavement, cut grass, maintain the terminal buildings & hangars, keep all the maintenance vehicles operational, and much more.

BTV has maintenance staff that provides snow removal services, but over half of their snow removal equipment is more than 10 years old. In fact, a lot of their maintenance equipment is closer to 20 or more years old. Similarly, the maintenance facilities at BTV are approaching the end of their useful life. They are no longer sized or equipped to meet the needs of the maintenance staff. As such, BTV has been looking for a more cost-effective way to improve snow removal equipment and storage facilities. This shortfall will be discussed in the upcoming Airport Master Plan Update.

BTV has ±10 full time operations staff who are in charge of making sure the airport is compliant with FAA rules and regulations. The state also employs operations personnel, but in some cases these resources are shared across multiple airports. Operations staff perform a variety of tasks including, but not limited to, maintaining safety & security, overseeing

airfield construction work, wildlife management, pavement friction testing, regular airfield inspections, escorting people in secured areas, and much more. The Operations staff are usually the people who drive the inventory of maintenance tasks, as they are constantly inspecting airfield conditions.

With appropriate levels of funding, the state and BTV would be able to improve on operations and maintenance equipment and services. Both would look to increase staff levels, purchase new equipment, and expand or build new facilities, should funding become available for such improvements.

FUNDING

Generally, there are four sources of funding used to finance airport development: airport cash flow; revenue and general obligation bonds; federal/state/local grants, including the Airport Improvement Program (AIP); and Passenger Facilities Charges (PFCs).

Airports within the NPIAS system are eligible for funding through the FAA AIP, which funds up to 95% of the cost of a project. The remaining funding must come from state and locally matched funds. Depending on the size, function, and number of operations at an airport, the amount of AIP funding available will vary, as well as the percent required for local and state match to the grant. The entitlement funding for the State of Vermont is estimated at ±$1,350,000 in AIP funding each year, whereas BTV is estimated at ±$3,500,000. Discretionary funding is sometimes provided above and beyond the entitlement funding if proposed projects are determined to be a high priority in the region. To receive AIP funding from the FAA, the project must be eligible. Eligible projects include those improvements related to enhancing airport safety, capacity, security, and environmental concerns.

Commercial Airports can use additional funding through the FAA's PFC program, but this program also has some restrictions. The PFC funding cannot be used for any revenue-generating projects such as car rental facilities. 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 18 years, this crucial funding source for commercial airports is becoming less and less effective.

Another source of funding for airports comes in the form of taxes. FAA requires that taxes collected for airport facilities and operations be used at airports. Currently, the state collects these taxes and uses them predominantly for operating the state airports or providing the state match required for AIP Projects. This funding level has been sufficient in years where Vermont only receives AIP entitlement funding for infrastructure projects. More recently, during fiscal years where the Vermont airports receive additional AIP discretionary funding, the revenue collected from airport taxes has not been sufficient to meet all airport needs. As Vermont looks to expand their state facilities and services, these funding shortfalls will become more common if not supplemented with other sources of revenue.

FUTURE NEED

The VTSASP provides a preliminary recommendation of infrastructure needs for Vermont's airports based on the existing inventory of facilities and services:

- Category 1 Airports, as defined by the State of Vermont as facilities that provide a basic level of facilities and services that are best suited to serve single engine piston and light twin engine aircraft: The primary areas of need for VTSASP Category 1 Airports are basic shelter facilities and 100LL fuel services.
- Category 2 Airports, defined by the State of Vermont as facilities that offer a higher level of facilities and services

than Category 1 Airports, supporting more operations as access points for more active operators in their host community and surrounding areas: The primary areas of need for VTSASP Category 2 Airports are: runway length, GPS instrument approaches, visual navigational aids, fixed base operators and self-serve 100LL fuel services, and airport management and operations staff on-site.

- Category 3 Airports, defined by the State of Vermont as airports that can accommodate jet activity during a broader range of weather conditions, and serve as regional gateways for activities such as corporate aviation, charter services and small cargo-feeder operations: System airports in Category 3 meet many of the minimum facility and service objectives. However, as a group, the performance and impact of these facilities is weakened due to several airports not meeting the minimum runway length requirement (≥5,000 feet).
- Category 4 Airports, defined by the State of Vermont as facilities with the most robust compliment of facilities, equipment, and services that can accommodate the full-range of aircraft in the active fleet: Burlington International meets all minimum facility and service objectives for Category 4 Airports. Rutland-Southern Vermont Regional also has all of the basic facilities and services required of a commercial passenger service airport; however, not at the level of maturity or as Burlington.

To provide a sense of the current and future infrastructure needs in Vermont, we look to the NPIAS Report to Congress for 2017-2021. The report estimates that Vermont state airport's need approximately $34 million over this five-year period for infrastructure. Given their entitlement funding is only ±$1,350,000 per year, approximately 80% of the needs would go unmet. Furthermore, the Burlington International Airport infrastructure funding need is approximately $45 million during this same time period. Given their entitlement funding is only ±$3,500,000 per year, over 60% of the needs would go unmet.

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 January 2015, estimates that in 2012 Vermont civil aviation accounted for $1.124 million in output, $316 million in earnings, $622 million value added, and 11,081 jobs. Similarly, The Economic Impact of Commercial Airports in 2013 publication, dated September 2014, estimates that Vermont commercial airports, which includes Rutland-Southern Vermont Regional and Burlington International Airport, accounted for $277.6 million in payroll, $840.3 million in output, and 9,710 jobs. It is important to consider the value aviation provides when discussing future investments in infrastructure. Part of the ongoing VTSASP effort includes an economic benefit analysis, as well as the ongoing efforts by BTV to update their airport master plan.

INNOVATION

The FAA is currently preparing and working to implement its NEXTGEN initiative, which is intended to modernize the outdated U.S. Air Traffic System. NEXTGEN includes 8 specific programs designed to improve Weather Interpretation, Air Traffic Management, Data Collection, System Integration, & Information Exchange. The NEXTGEN system hopes to use digital technologies such as GPS to reduce cancellations, weather delays, taxi & take-off delays, as well as improve safety through accurate aircraft tracking and improved communication between ATC and pilots. The Air Traffic Manager at Burlington International Airport has already begun to implement transitions to NEXTGEN systems.

Vermont state airports are slowly transitioning to more innovative systems such as asset management programs, including online databases for keeping track of land leases. BTV is using an asset management system for keeping track of all lands owned and acquired by the airport, as well as airfield inspections and maintenance logs. Operations staff perform regular

inspections of both land side and airfield facilities and log any discrepancies using a tablet. The maintenance staff are notified of the work order, which comes with a GPS location, pictures, and any other pertinent information. As the airport grows, it will become essential to integrate all facilities, services, and operations to an asset management program. This effort is incredibly time consuming and expensive, so appropriate levels of funding are critical to implement this improvement.

PUBLIC SAFETY & RESILIENCE

Public safety is the top priority for FAA and all of the Vermont airports. Capacity is always constrained by how safely a particular aircraft can operate at each airport given the level of services and facilities provided. As the industry grows, airports will need to improve upon their existing capabilities to safely meet the rising demand. Some existing features at BTV will need to be included at other State airports, such as full perimeter fencing and security systems, wildlife management plans, snow removal services, deicing capabilities, instrument approaches, and much more. The airport network coverage would need to be expanded to provide coverage in the existing gaps where an aircraft is not within a 15 nautical-mile radius of an airport that is equipped to provide safe landing and other emergency services in all seasons and during all weather conditions.

Over the past couple of years, BTV has been working closely with power companies to provide redundant services to the airport, and upgrade backup sources such as batteries and generators, so power can be maintained at all times to the critical infrastructure, such as runway lights. These projects improve upon both public safety and resilience. Vermont is subject to northern climates, so resilience against natural disasters and generally poor weather is always on the forefront of infrastructure discussions.

RECOMMENDATIONS TO RAISE THE GRADE

- Complete the updates to the Vermont State Aviation System Plan and the Burlington International Airport Master Plan, which will provide current information on existing and future needs.
- Accelerate and increase investment in Airport Improvement Programs, and other projects which increase capacity.
- Implement & enhance technology related to FAA's NextGen initiative, including safety improvements.
- Increase airport revenues and identify new revenue sources such as public-private partnerships.
- Encourage state leaders to advocate in Congress for increased funding for the AIP program and removal of the PFC cap.

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BRIDGES C+

SUMMARY

Vermont has made excellent progress over the last five years in reducing the number of structurally deficient bridges in its inventory. On average, approximately 5% of bridges are structurally deficient, compared with 9.6% in 2012. The decrease in structurally deficient bridges has been accomplished despite a recent shortfall in funding. However, progress could be slowed or even reversed without a clear and consistent funding mechanism that provides long-term support for bridge infrastructure. In addition, there are many bridges that are functionally obsolete, which places constraints on traffic flows and impacts economic activity. Finally, Vermont's bridges are an average of 57 years old, much higher than the national average of 43 years, resulting in many functionally obsolete bridges. Aging and functionally obsolete bridges require increased funding for additional maintenance and repairs.

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 2,739 bridges (greater than 20 feet) on interstate, state, and town highways. Vermont inspects these bridges in accordance with the National Bridge Inspection Standards (NBIS) which require each bridge to have an inspection at least every two years. There are an additional 1,265 short structures (less than 20 feet) in Vermont's transportation network.

According to the National Bridge Inventory (NBI), approximately 5% of Vermont's bridges were structurally deficient (SD) in 2017, down from 7.5% in 2014. The total bridge area that was structurally deficient in 2017 was 5%. Nationally, just under 9% of all bridges are structurally deficient, or just under 6% by bridge area. While not necessarily unsafe, structurally deficient bridges may have limits imposed 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. The breakdown of Vermont bridges listed as either structurally deficient or functionally obsolete (FO) is shown in Table 1. Functionally obsolete bridges are bridges that do not meet current engineering standards, such as narrow lanes or low load-carrying capacity.

Table 1- Vermont "Highway" Structure Population (as reported to FHWA in April 2017)[1]

Structure Type	Bridges Number	SD Number	SD Percentage	FO Number	FO Percentage	SD or FO Number	SD or FO Percentage
Long Structures							
Interstate	309	5	1.6%	95	30.74%	100	32.3%
State Hwy	781	40	5.1%	93	11.9%	133	17.0%
Town Hwy	1642	89	5.4%	364	22.1%	453	27.6%
Other	7						
Total	2739	134	4.9%	552	20.1%	686	25.0%
Short Structures (under 20 feet in length)							
Interstate	211						
State Hwy	1054						
Town Hwy	----						
Other	----						
Total	1265	66	5.2%				

SD = Structurally Deficient; FO = Functionally Obsolete

Vermont should be proud of the progress it has made in reducing the percentage of structurally deficient bridges in the network. However, there are significant challenges in the near future. Vermont's bridges are aging. 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. There are 1,579 bridges that are 50 years or older, and 722 bridges that are 80 years or older, according to the 2018 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 57 years, compared with an average of 43 years according to ASCE's 2017 Report Card on the Nation's Infrastructure. Figure 1 provides a structure count by age.

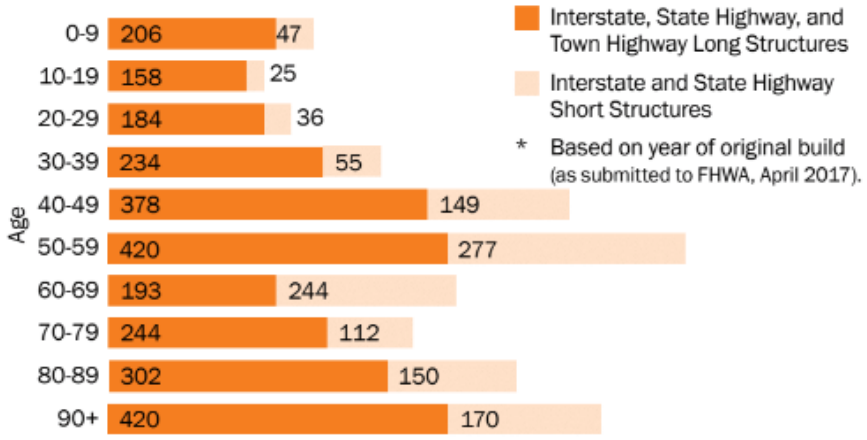

Figure 1 – Structure Count by Age (in years*)[2]

OPERATION AND MAINTENANCE (O&M), FUNDING, AND 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 Fixing America's Surface Transportation (FAST) Act in 2015, authorizing $305 billion over fiscal years 2016 through 2020 nationwide. The federal government's share of a 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.

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[2,3]

	FY 2017 (approved)	FY 2018 (projected)	FY 2018 (approved)	FY 2019 (projected)	FY 2020 (projected)	FY 2021 (projected)
Interstate Bridges	52,785,723	40,830,105	36,599,190	31,672,489	33,698,061	38,147,322
State Highway Bridges	32,639,048	53,383,986	31,403,328	53,084,543	54,229,055	49,463,650
Town Highway Bridges	20,021,730	18,161,343	16,524,009	20,929,847	17,975,595	14,475,000
T-Fund	6,633,405	-	5,052,233	-	-	-
TIB	6,836,563	-	4,946,150	-	-	-
Federal	90,384,482	-	72,149,331	-	-	-
Local	1,592,400	-	0	-	-	-

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. One issue is that the gasoline tax is not simply a flat fee. A portion of the tax is a percentage of the retail price of gasoline which has remained low, counter to the higher gasoline prices that were anticipated.

Despite this recent shortfall in funding, Vermont has made significant progress in addressing bridge needs over the past 10 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. For the period 2007 to 2017 the deficiency status of interstate, state, and town bridges has greatly improved as shown in Figure 2.

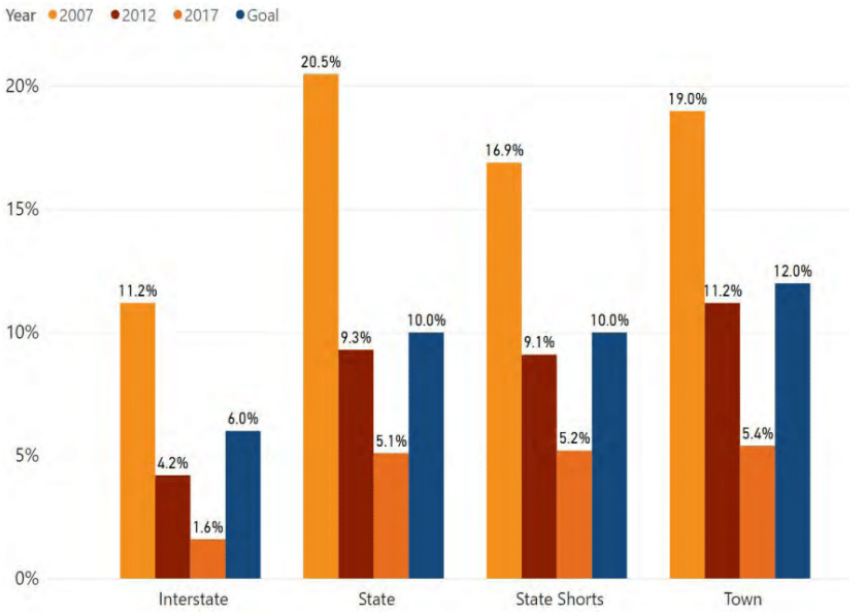

Figure 2 - Percent Structurally Deficient Bridges over Time[1]

RESILIENCY

VTrans has been working to evaluate the risk of flooding and damage to bridges and culverts and to incorporate river science into their infrastructure planning. Vermont bridges are designed for resiliency to flooding and scour. The VTrans Hydraulics Manual requires a minimum of 1 foot of freeboard between the lowest point on the bridge and the water surface for the design flood. The design flood is based on the roadway classification. For freeways, the design flood is one that has a 1% chance of being exceeded in any given year (i.e., the 1% annual exceedance flood or the 100-year flood). For most other roads, except local roads, this probability increases to a 2% chance of exceedance (i.e., the 2% annual exceedance flood or the 50-year flood). The manual also states that bridge design for stream crossings must consider and accommodate the impact of dynamic hydraulic and geomorphic processes on the bridge foundation.

Additionally, VTrans has developed the Vermont Transportation Flood Resilience Planning Tool (TRPT) for three pilot watersheds in the state. This tool is used for vulnerability assessment, criticality assessments, and risk ratings for roads, bridges, and culverts due to flood inundation, erosion, and deposition hazards. The TRPT also can be used to develop initial prioritization of mitigation strategies to reduce hazards. The TRPT will be expanded in the coming years to cover more of the state to guide planning and project development. Figure 3 shows a screenshot of this tool and some of the information available.

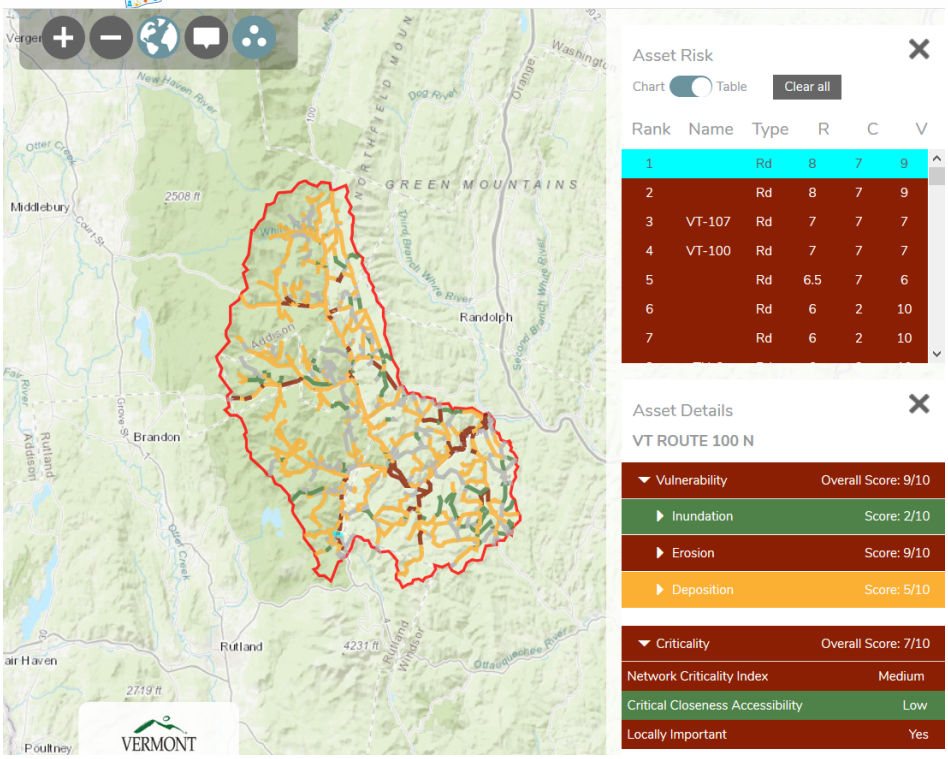

Figure 3 – Screenshot of Vermont Transportation Flood Resiliency Planning Tool

INNOVATION

Vermont has implemented some of the leading-edge materials in the industry, such as ultra high performance concrete (UHPC) for closure pours during prefabricated bridge construction. This high strength material has been used in approach slab closure pours in Waitsfield and Ludlow, and VTrans looks to extend its application to bridge deck panel closure pours and bridge deck rehabilitation.

In addition to its use of innovative materials, VTrans has taken a programmatic approach to alternative project delivery. The Accelerated Bridge Program (ABP) was created in 2012 to address rising bridge construction costs and an aging inventory of bridges. The program's goal is to streamline project delivery and construction through use of Accelerated Bridge Construction (ABC) Techniques (such as prefabricated bridge elements or slide-in construction), Innovative Materials, and Alternative Delivery. Projects are selected for either the conventional or accelerated path during the scoping phase. Approximately 25% of VTrans's bridge projects are managed under this program. These projects were found to have on average a 40% reduction in cost over conventional projects for preliminary (design) engineering and construction engineering. Cost savings are achieved through an accelerated design schedule (24 months), standardization of construction details, and use of prefabricated bridge elements. Improvements continue to be made to this program and the project delivery process to further reduce costs.

RECOMMENDATIONS TO RAISE THE GRADE

The state has made excellent progress in reducing the number of structurally deficient bridges in its inventory and is well below its target goals in this area. However, given the age of Vermont's bridges, the structurally deficient percentage has the potential to grow quickly.

- Vermont needs a clear and consistent funding mechanism to address the aging bridge population.
- 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 population is addressed over time and not all at once.
- Continued development of resilient designs and incorporation of innovative materials and asset management approaches are encouraged. For resiliency, this could include sustainability requirements for design and construction bids. For innovation, this could include the use of public-private partnerships for asset management or further use of leading-edge materials like UHPC.

AUTHORS/CONTRIBUTORS

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Adam earned a BS in Civil Engineering in 2011 and an MS in Civil Engineering in 2013 from the University of New Hampshire. His graduate research focused on structural health monitoring of bridges. He worked for 5 years in the transportation industry as a bridge design consultant with VHB. He is a registered professional engineer in the State of Vermont and has completed the NBIS course for Safety Inspection of In-Service Bridges. Adam is currently serving as Treasurer of the Vermont Section of ASCE and works for GLOBALFOUNDRIES as an air emissions and decontamination engineer. An outdoorsman and skier, he actively volunteers with Vermont Adaptive Ski and Sports.

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DAMS C

SUMMARY

Vermont's 1,014 dams serve a variety of purposes, including recreation, flood-control, and hydropower. Eight percent of Vermont's dams are high-hazard potential, meaning should they fail, loss of life is expected. Statewide, 77% of these high-hazard potential dams have emergency action plans in place. With the large number of deteriorating dams and predicted increases in flooding, additional funding is required to mitigate the risk of dam failures, especially for the 155 dams listed as in poor condition. Vermont has been fortunate to not experience a recent dam failure leading to loss of life or property damages, despite limited funding for inspections, maintenance, and repairs. VT Department of Environmental Conservation (VTDEC) Rulemaking is now underway to formalize methods for dam inventory, hazard classification, inspection, and design. Removal of obsolete and decaying dams that typically do not meet dam safety standards is taking place to improve public safety and restore aquatic ecosystems. Nineteen dams have been removed over the last five years. The state needs additional resources to increase staffing levels in the VTDEC Dam Safety Program and River Management Program to properly manage dams in the state and maintain public safety.

BACKGROUND

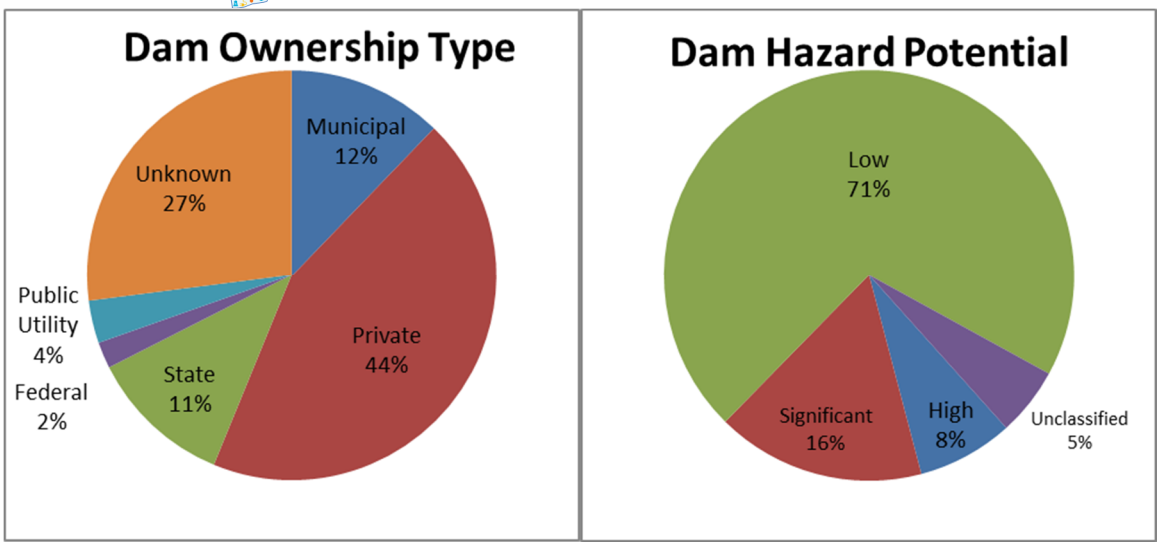
Vermont has 1,014 dams inventoried by Vermont Department of Environmental Conservation (VTDEC). The dams span a range of sizes and uses such as large flood-control, medium hydropower, and small recreation. The majority of dams are small, old, and privately owned. Most Vermont dams are more than 50 years old.

Some Vermont dams are owned and operated by federal, state, and local governments (Figure 1). VTDEC regulates 413 dams that are capable of impounding 500,000 cubic feet of water and sediment. These "jurisdictional dams" are visually inspected on an informal schedule by two full-time VTDEC Dam Safety Engineers with assistance of one summer intern. There are an additional 256 partially jurisdictional dams that impound less than 500,000 cubic feet that are less scrutinized.

The Federal Energy Regulatory Commission (FERC) regulates and inspects 79 dams in Vermont. The Vermont Public Utility Commission (PUC) regulates 23 dams that are inspected by consulting engineers. The federal government owns, operates, and regulates about 15 dams in the State, including the U.S. Army Corps of Engineers, U.S. Forest Service, and U.S. Fish & Wildlife Service.

Of the fully regulated dams, 62 are high-hazard potential (8%). A high-hazard potential classification is an indication that should the dam fail or mis-operate, loss of life and significant economic loss is expected. An additional 135 dams are significant-hazard potential (16%). Should a significant-hazard potential dam fail, loss of life is not expected, but significant economic loss, including damages to downstream property, critical infrastructure, and more could occur. See Figure 2 for a breakdown of high-hazard potential and significant-hazard potential dams in Vermont.

The Vermont Dam Safety Statute, under which the VTDEC Dam Safety Program and the PUC are governed, was updated this year with the passage of Act 161. The passage of Act 161 to update the Vermont Dam Safety Statute (Chapter 43) will improve dam safety in Vermont. Rulemaking is taking place over the next few years to adopt formal standards for dam inventory, hazard classification, inspection, design, construction, and operation and maintenance.



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

CAPACITY

Of the 1,014 known dams in Vermont, 52 are used for water supply, 15 dams are used for flood control, and 100 are associated with power generation. Most of the dams in Vermont are used for recreation. Many dams are no longer in use and are typically ignored as they deteriorate.

One new regulated dam has been built in the last five years and it supplies snow-making water to a ski area. Construction of new dams is not common given that most of the optimal dam sites are already in use and state regulations place a priority on maintaining free-flowing rivers and streams. It appears that all of the desired uses by dams are generally being met.

CONDITION

155 state-jurisdictional dams are in poor condition. Of these 155, the 2016 National Inventory of Dams reports that 12 are high-hazard potential dams and three are federally owned. The same inventory reports that one state-owned dam in an unsatisfactory condition, the lowest condition rating. Poor condition dams make up 40% of the inspected dams – an 8% increase in poor condition dams since 2011. Small dams under partial jurisdiction of the State of Vermont are especially likely to be in poor condition; many are 50 to 100 years old and are not regularly inspected, although most are low hazard and do not pose dangers to downstream residents or property.

Enforcement to require dam owners to make repairs or needed improvements is difficult for VTDEC to carry out due to limited existing statutory authority beyond the cumbersome unsafe dam proceedings. The state prefers to work with dam owners to collaboratively improve the condition of dams.

The Act 161 rulemaking should clarify inspection and maintenance requirements and ultimately improve the condition of Vermont dams. The PUC and FERC dams tend to be in good condition as they have important uses, are regularly inspected and maintained, and have a process in place to implement a corrective action plan when deficiencies are identified.

With many dams in poor condition and the recent increase in larger and more intense floods, the risks of dam failure are increasing. Many experts feel that Vermont has been lucky to not have had a recent dam failure leading to loss of life and infrastructure, and it is just a matter of time unless we take action to improve dam condition.

OPERATION AND MAINTENANCE

The VTDEC Dam Safety Program does not have enough staff to keep up with the current inspection schedule and other obligations. Significant- and low-hazard potential dams are not being inspected within an appropriate timeframe due to limited available staff time. The focus for the state inspections is on the high-hazard dams to observe the most dangerous dams first.

The PUC inspection frequency is lower than VTDEC recommendations and the need exists to synchronize frequency of inspections. 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

Seventy-seven percent of high-hazard potential dams in Vermont have an Emergency Action Plan (EAP) in place, a rate that is similar to the national average. However, approximately one third of the EAPs in Vermont are out of date and have been completed with a low level of detail. "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 property damage if a dam were to fail while the dam hazard class has not yet been updated. The number of high-hazard dams in Vermont is likely underestimated due to hazard creep and hazard class updates are needed across the state.

Significant-hazard potential dams in Vermont are not currently required to have EAPs. During Act 161 rule-making, Vermont should consider requiring that significant-hazard potential dams also have EAPs as some other states in the region have done. This change would add a lot of work developing EAPs for many dams across the state.

The passage of Act 161 creates a "minimal" hazard class where there is no potential for loss of life or damage. This class will be defined further in rulemaking and applied to small dams that will now be listed in the Vermont Dam Inventory.

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 thus tend to have funding for required maintenance and improvements. Private dams that have limited use and no public funding mechanism are often unmaintained. 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.

Dam removals have been funded by a variety of sources targeting ecosystem restoration, fish passage, and habitat improvements. With the increase in the planning and implementation of the removal of obsolete dams to reduce construction costs and maximize public safety, funding is being stretched thin in the state and for the first time there is

now not enough funding to complete all of the projects under development. 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.

Funding to the VTDEC Dam Safety Program should be increased to cover additional staff positions to increase staff capacity. Staff are needed 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 one additional staff person to carry out their dam safety mission. The need for increased staffing is more evident following the passage of Act 161 that adds additional tasks that will be required to improve dam safety 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. More dam owners are becoming aware of their operation and maintenance responsibilities with the 2016 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.

PUC should consider having a dam safety engineer involved in overseeing dams under their jurisdiction.

RESILIENCE

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 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.

19 dams have been removed in Vermont in the last five years. Dam removal is increasing resiliency in the state by reducing flood levels, increasing river channel stability, and allowing ecosystems to respond to flood or drought disturbance quicker.

INNOVATION

The Vermont Dam Inventory is being updated that will contain all dams in the state – jurisdictional and non-jurisdictional. The new database will allow for better coordinate between state and federal agencies. The new database will be easier to update and have a data input tool to rapidly upload and view inspection data. Most of the dam safety information in the database will be available to the public.

Act 161 requires new dam safety rules on hazard potential classification, dam registration, and inspections by July 2020. Design standards and emergency action plan procedures will be prepared by July 2022. Innovations will be incorporated

throughout this 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.

RECOMMENDATIONS TO RAISE THE GRADE

The VTDEC Dam Safety Program's current staffing levels and funding are inadequate. More dam safety inspections and improved maintenance are needed across the state. Private and municipal dam owners are reluctant to fund required maintenance and repair of their dams, and the state has limited regulatory ability to force proper maintenance. Passage of Act 161 was an important step forward for improving dam safety in Vermont.

Vermont ASCE makes the following recommendations:

- Increase the staffing for the VTDEC Dam Safety Program from 2.0 full-time equivalent (FTE) to 4.0 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 staffing in the VTDEC Rivers Program from 0.1 FTE shared among the six river management engineers to 1.0 FTE focused on management of small dams and assisting with planning and implementing dam removals.
- Consider adding a requirement for Emergency Action Plans for significant-hazard potential dams.
- Complete the required rulemaking process as part of Act 161 led by VTDEC and with participation of dam safety engineers around the state.
- Fully fund the High-Hazard Potential Dam Rehabilitation Program that was passed in the Water Resource Development Act of 2016.

AUTHORS/CONTRIBUTORS

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Jessica is a registered engineer in the State of Vermont with 15 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 20 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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DRINKING WATER C-

SUMMARY

Vermont's approximately 1,391 public water systems consist of sources, treatment, reservoirs, pumping facilities, and pipes, which deliver quality water to customers. Overall, Vermont's public water systems have shown an improving compliance rate. However, the system is aging. In 2016, a leak detection service surveyed approximately 257 miles of pipe across 32 systems and identified 117 leaks. An estimated 963,720 gallons per day of drinking water was being lost through these leaks. The Environmental Protection Agency estimates that Vermont drinking water infrastructure will need $642.9 million over the next 20 years. This estimate is a large increase from previous EPA total needs numbers, and reflects that much of Vermont's drinking water infrastructure is aging and will need to be replaced and upgraded to maintain compliance and ensure quality drinking water to customers. Vermont's aging and rural populations are especially vulnerable to the costs associated with replacing aging assets and addressing emerging contaminants. The cost to maintain, replace and upgrade the infrastructure will ultimately be the responsibility of the water users. Smaller communities with low median household incomes will need to continue to utilize loan programs to offset needed improvements.

BACKGROUND

According to the Vermont Department of Health, 70% of Vermont's population is served by public community water systems, while the remaining 30% utilize private water systems[1]. Figure 1 provides a summary of percentage of Vermont's population served by drinking water sources. Private systems, not regulated by Vermont Drinking Water and Groundwater Protection Division, are monitored and maintained by their owners. As information on private systems is not readily available, this drinking water infrastructure evaluation will focus on public systems.

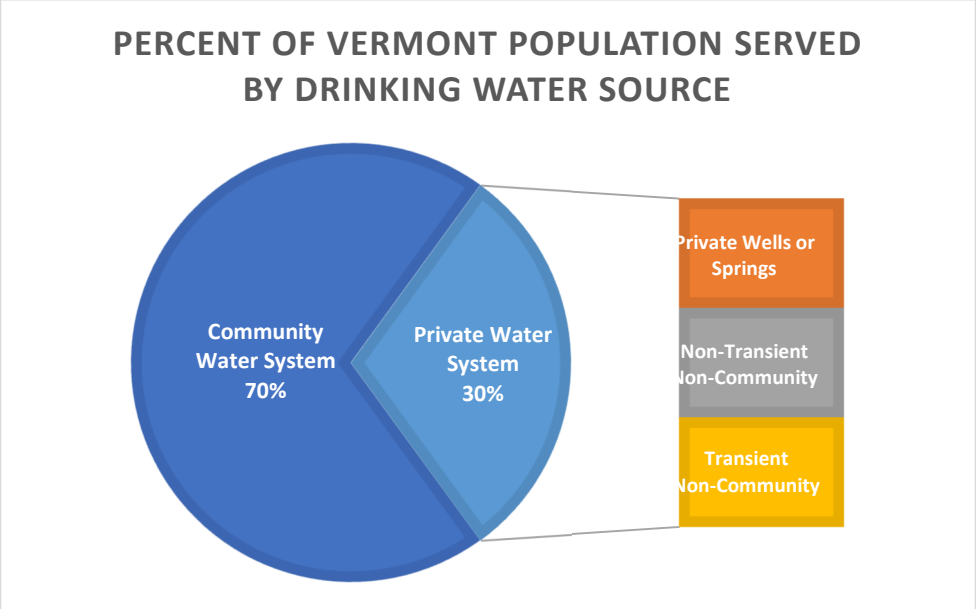

Figure 1: VT Public Water Systems

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 December 1, 2010, empowers the Vermont Drinking Water and Groundwater Protection Division (DWGWPD) to implement and enforce the federal and state drinking water provisions. The DWGWPD oversees 1,391 public water systems characterized as community, non-transient non-community, and transient non-community, ensuring all public water systems comply with federal and state regulations[2]. The definition of each public water system is outlined below.

Community Water System	• 25 or more year-round residents; OR • 15 or more year-round residential connections
Non-Transient Non-Community	• 25 or more people at least 6 months per year (ex. daycares, schools, office bldgs.)
Transient Non-Community	• 25 or more people at least 60 days per year (ex. restaurants, hotels, campgrounds)

CONDITION & CAPACITY

Drinking water infrastructure encompasses sources, treatment, reservoirs, pumping facilities, and pipes. Community water systems in Vermont date back from the late 1800s to the early 1900s in well-developed municipalities with a long history. While most water systems have gone through expansive and expensive upgrades, especially following the issuance of the SDWA in 1974, original infrastructure still exists, especially within the distribution system (i.e. pipes and valves). Critical infrastructure such as treatment, storage, and equipment require frequent repair and replacement to maintain operation and meet drinking water standards.

Infrastructure located underground tends to be overlooked by the public. For example, 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. Up to 75% of this water loss is recoverable[3]. Much of this can be attributed to transmission and distribution lines that exceed 80 years of useful life and materials which include cast and ductile iron, asbestos cement, galvanized, polyvinyl chloride and iron pipe. In 2016, the Vermont DWGWPD provided leak detection services to 32 public community drinking water systems. The leak detection service surveyed approximately 257 miles of pipe and identified 117 leaks. An estimated 669 gallons per minute (963,720 gallons per day) of drinking water was being lost through these leaks[2].

Community Water Systems serve 70% of the Vermont's population. In contrast to other states, Vermont has a predominantly rural population resulting in smaller community water systems as evident by Figure 2. These rural communities are facing a declining population and water usage, which will lead to increasing water rates as improvements

to the water systems occur.

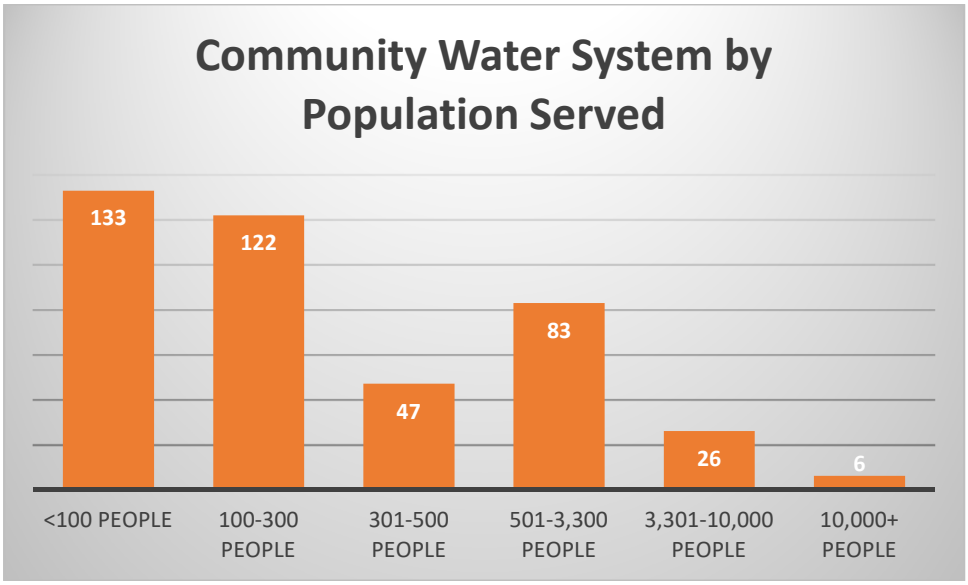

Figure 2: Community Water Systems by Population Served

Community water systems have continued to improve in their compliance with federal and state regulations as evident by Figure 3. Compliance between 2012 and 2017 increased by 10%, or 1.67% per year[(2)].

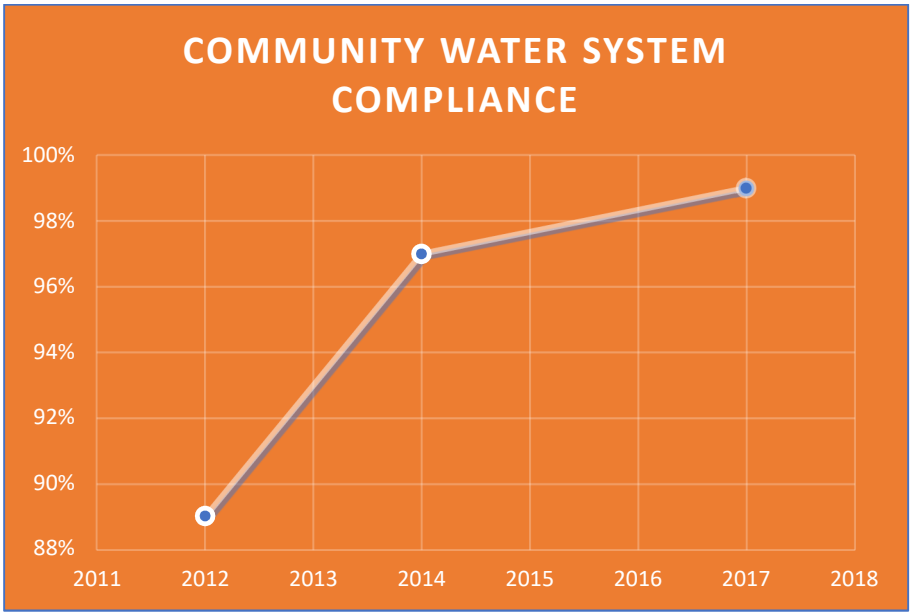

Figure 3: Community Water System Compliance

OPERATION & MAINTENANCE (O&M)

User rates fund the operation and maintenance for public water systems. Local and state authorities have encouraged water systems to install water meters for billing and tracking water production versus usage. Public water systems that utilize meters typically bill customers on a fixed and usage rate. The fixed rates recover costs that do not fluctuate with water usage (i.e. debt retirement, salaries, etc.). Usage rates cover O&M costs which are variable (i.e. chemicals, electricity, etc.). Water rates for small community systems are typically higher than larger community water systems. In Vermont, the median household income is approximately $57,513 and annual water rates can range from $132/year to $537/year for an average family (~9,000 gallons per quarter).[4]

FUNDING & FUTURE NEED

The DWGWPD has encouraged water systems through capacity evaluations and asset management training to plan for future needs and improvements. While capital reserves assist with smaller projects, many public water systems require loans to fund infrastructure improvements. Funding for public water systems is available through the Drinking Water State Revolving Fund (DWSRF), United States Department of Agriculture – Rural Development (USDA RD) Water and Waste Disposal Loan, Vermont Municipal Bond Bank (VMBB), Vermont Community Development Block Grants, etc. The DWSRF program offers source exploration, planning, design and construction loans. Funding terms range from 0% to 3% and extend from 20 to 30 years. Subsidies up to 40% are offered to public water systems based on the loan amount, user rates and median household income. Table No. 1 summarizes the DWSRF program contributions over the past three fiscal years.

Table 1: DWSRF Funding Summary (2015-2017)

	Actual	Actual	Actual
Fiscal Year	**FY15**	**FY16**	**FY17**
Proposed Funding (Millions)	$14.65	$26.00	$23.10
Amount Funded (Millions)	$20.65	$16.60	$13.35
Remaining Funds (Millions)	**($6.00)**	**$9.40**	**$9.75**

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 the United States economics, but grants can extend to 45%, or beyond for impoverished areas, based on similar factors to the DWSRF program. Unlike the DWSRF program, USDA RD requires that water systems utilize water meters.

Table 2: USDA Rural Development Water and Waste Disposal Loan Funding Summary (2015-2017)

	Actual	Actual	Actual
Fiscal Year	**FY15**	**FY16**	**FY17**
Amount Funded (Millions)	$3.42	$7.66	$5.30

According to 2010 census data, Vermont's population stands at approximately 625,741 and projections suggest that the population will increase by 4.4% (653,575) by 2020 and 7.1% (670,073) by 2030[5]. Vermont's population is experiencing a declining younger population (0-24 years) in contrast to the older population (60+), which continues to rise. In relation to water usage, with the advancement of technology and water saving fixtures, water usage in Vermont remains stagnant in Chittenden County, where the majority of population growth is occurring. Rural Vermont counties and communities

are facing a declining population and declining water usage. Water systems will continue to require investment that will increase water rates over the next 20 years. Communities with declining populations in rural Vermont will likely experience significant rate increases as the water users decrease and water budgets increase. The Environmental Protection Agency (EPA) estimates that Vermont will need to invest more than $642.9 million in public drinking water infrastructure in the next 20 years[6]. In comparison, the EPA in 2013 estimated that Vermont public water infrastructure investment needs was $510 million, an increase of $132.9 million[7] between a two year study.

PUBLIC SAFETY

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 Vermont, compliance rates across municipalities have been consistently improving, with 97% and 99% compliance in 2014 and 2017 respectively. However, incidents such as the discovery of perfluorooctanoic acid (PFOA) in groundwater samples in Bennington in 2016 highlight the fact that Vermont's water treatment facilities are only designed to look for and treat conventional pollutants. PFOA is used in the manufacturing of everyday products such as Teflon, non-stick coatings, firefighting foam, waterproof fabrics, etc. and may affect individual's health and increase their risk of cancer. While the municipal water supply was not contaminated in Bennington, levels above Vermont's provisional drinking water health advisory limit for PFOA of 20 parts per trillion (ppt) were recorded in the five private wells that were tested[8]. Emerging contaminants, such as PFOA and pharmaceuticals need to be better understood and also illustrate the need to adopt new compliance measures for monitoring, maintaining, and documenting private systems.

With the recent developments in Flint, Michigan, lead exposure in drinking water has caught the eye of the nation. The EPA is working to revise the Lead and Copper Rule to more effectively address lead, and ensure safe drinking water. The VT DWGWPD Capacity Development Program awarded two (2) communities a Lead Reduction Strategies Grant in 2017 to develop and implement risk reduction strategies for other communities to model. The objective of this grant was to create an inventory of publicly and privately-owned lead service lines and/or lead containing infrastructure; develop strategies for removing lead infrastructure and reducing exposure; and communicate with system users.

RESILIENCE & INNOVATION

The impacts on water infrastructure in the aftermath of Tropical Storm Irene of 2011 were documented in the 2014 VT ASCE Infrastructure Report Card. As cleanup efforts ensued, conversations on adaptation, and resilience grew stronger. Additionally, the state of Vermont embarked on its hazard mitigation planning process in 2016, which identified extreme heat and droughts, as top ranked hazards, which have direct and indirect impacts on the state's water infrastructure. For example, extreme heat trends in Vermont's State Hazard Mitigation Plan state that shortened winters, and an increase in the average annual temperature in Vermont by 2.6º F from 1895-2015, can lead to increased stratification in water bodies, creating more favorable conditions for the development of cyanobacteria and the release of cyanotoxins in water. There is also likely to be an increasing demand for water supplies, even as higher temperatures can cause increased evapotranspiration rates and an increased frequency of short-term droughts.

Droughts also cause the loss of potable water when wells run dry. The corresponding economic impact includes construction of new community water supplies with better storage capacity and drilled wells that are deepened to capture additional yields when sustainable yields drop during the drought period. Vermont's state climatologist and geologist have been working together to secure funding to map the state's groundwater resources to better understand the statewide vulnerability to the hazard. The 2018 Vermont State Hazard Mitigation Plan aims to make "Vermont safer and more

resilient in the face of climate change and natural disasters" [17] and identifies groundwater protection as a necessary precaution to minimize vulnerability to future fluctuations in groundwater levels due to both anticipated increased precipitation and prolonged drought periods. Groundwater resources mapping, expansion of the number of monitoring wells across the state and a thorough analysis of water level monitoring data have been identified as mitigation actions under the 2018 Vermont State Hazard Mitigation Plan's "Promote Drought Resilience" strategy.

RECOMMENDATIONS TO RAISE THE GRADE

Vermont's public drinking water infrastructure supports a rural centric population with increasing financial investments caused by aging assets 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 develop asset management programs and long-range plans to assess and evaluate existing infrastructure and plan for future needs and improvements.
- Drinking water systems must actively increase rates to cover increasing operating and capital costs, while mindfully balancing the incomes of their users, especially those on fixed incomes.
- Encourage drinking water systems to prepare for needed improvements and actively utilize low interest funding opportunities offered by State and Federal agencies.
- Support and encourage the investment of federal funds to sustain and increase funding to the State Revolving Funds and USDA Rural Development – Water and Waste Disposal Loan Programs. Initiate public outreach and education on the importance of drinking water infrastructure, future needs and investment.

AUTHORS/CONTRIBUTORS

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ENERGY B-

SUMMARY

Vermont has the lowest energy production in the nation, at 174 GWh in July of 2018, though it is a small state with a low population and low energy demands. Hydroelectric is by far the state's largest source of local electric power generation at close to 60% of total generation, followed by around 20% from biomass, over 12% from wind, and over 6% from solar. Vermont has an advanced and well-connected smart grid thanks to a 2012 effort to install smart meters throughout the state, upgrade and install new grid automation controls, and expand the fiber optic backbone connecting the state's substations. Vermont is committed to a goal of 90% renewable energy by 2050 across all energy uses, with no coal or nuclear power plants and insignificant amounts of petroleum energy production. However, the state currently still relies on energy imports from its neighbors, especially fossil fuels for transportation and natural gas for heating. Though it has an advanced grid, it is also home to some of the highest electricity costs, at around $0.17 per kWh in 2017.

CAPACITY AND INNOVATION

According to the U.S. Energy Information Administration, in 2016 Vermont produced about 28.4 Trillion British thermal units (BTUs), including 8.323 terawatt-hours (TWh) of renewable electricity. In July 2018, this amounted to about 97 Gigawatt-hours (GWh) of electrical generation by hydroelectric sources and 77 GWh by other renewable sources. Vermont utilizes its abundance of natural streams and rivers that flow down from the Green Mountains to power approximately 50 hydroelectric power plants located throughout the state as shown on Figure 1. With more than 80% of the state covered in forest, the second largest power generator is biomass, mostly generated from wood and wood waste. The state also has wind, solar, landfill gas, and anaerobic digester facilities that generate electricity. Vermont conducts around 60% of its local power generation from hydroelectric, around 20% from biomass, over 12% from wind, and over 6% from solar, with the rest coming from methane or insignificant sources. In 2017, the state boasted five utility-scale wind farms along the spine of the Green Mountains and the five largest solar farms came online from 2016 to 2017. A total of 163.2 MW of solar capacity came online from 2011 to 2017. With the shutdown of Vermont Yankee Nuclear Power Station in 2014 due to cheap electricity from competing natural gas-fired power plants, Vermont no longer houses any nuclear power production.

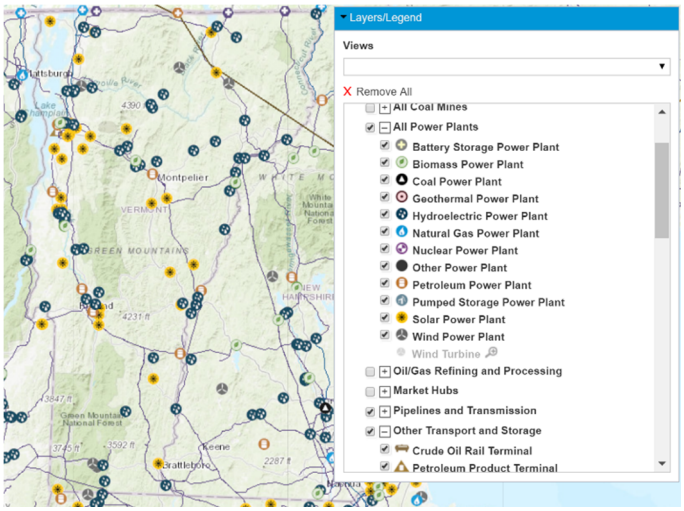

Figure 1 – Vermont's Energy Infrastructure [1]

Even though Vermont has no petroleum, natural gas, or coal reserves, nor production of these fuels, around 60% of the energy consumed is from petroleum. Fossil fuels are brought into the state entirely via truck and train. A crude oil pipeline from Portland, Maine to Montreal crosses through the state. However, the oil is not directly transmitted to the state. Vermont is the second-smallest natural gas consumer per capita in the country, with the only gas distribution pipeline being in the northwest near the largest city, Burlington. As part of ISO-NE, Vermont agreed to receive a decreasing share of its power from coal but is still dependent on out-of-state facilities during periods of peak demand.

Vermont's per capita energy consumption is one of the lowest in the nation, at 206 million BTUs, similar to other New England states. However, Vermont has slightly higher petroleum consumption per capita than the national average. As shown in Figure 2, much of the petroleum is consumed by transportation, the largest sector of energy consumption in Vermont (38.5% in 2016). Granted, the state does have more than 160 public electric vehicle (EV) charging stations and over 2,300 EVs.

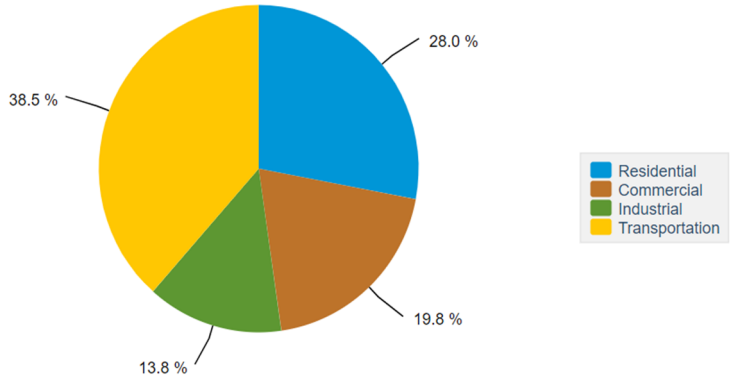

Figure 2 – Vermont Energy Consumption by End-Use Sector, 2016

The Green Mountain State has an abundant natural energy resource in the form of wood. There is a Clean Energy Development Fund that is aimed at small-scale projects such as high-efficiency combustion of wood fuels from sustainable forest ecosystems. Vermont has one of the highest uses of wood heating in the U.S. with almost one in six homes heating with wood. Still, the vast majority of Vermonters heat with natural gas or oil, with around 60% using some form of oil or propane heat and an additional almost 20% using natural gas. Natural gas is attractive to consumers because it costs approximately 12% less than fuel oil and 49% less than propane, according to the Vermont Department of Public Service.

Efficiency Vermont, an energy utility, has contributed to the state ranking third in the nation for energy efficiency, according to the American Council for an Energy-Efficient Economy. They conduct energy audits and look at sources of heat loss in buildings and suggest more smart-metering of homes to improve energy efficiency and reduce costs.
In January 2017, Vermont eliminated the cap on how much of an electricity distributor's peak demand could be net-metered, allowing home owners to get more out of their domestic solar panels. Vermont is the only state in New England that regulates energy markets, with the sole investor-owned utility, Green Mountain Power serving 80% of Vermont. Likely in part due to prohibiting outside electric suppliers to compete in energy provision, Vermont has some of the highest electric rates in the nation, at around $0.17 per kWh in 2017.

CONDITION, OPERATIONS AND MAINTENANCE

In a 2012 project called eEnergy Vermont, the Vermont Electric Power Company (VELCO), Vermont's unique, transmission-only company, along with distribution companies such as Vermont Electric Cooperative (VEC), deployed advanced metering infrastructure (AMI) to most Vermont residences, increased grid automation through upgrades and installation of new automated controls, and began conducting consumer behavior studies to assess time-of-use and peak-time rebate programs. In addition, IBM and VELCO rolled out a 17-terabit-capable dark fiber optic network, connecting 65 substations in Vermont and reaching 70% of Vermont's towns.

In all, VELCO manages 738 miles of higher voltage transmission lines as well as 55 substations, switching stations, and terminal facilities. Vermont law and Public Service Board Order require VELCO to plan for Vermont's long-term electric transmission reliability, including providing an updated plan every three years. VELCO also coordinates closely with local distribution utilities during the preparation of the plan to identify relevant issues and share information about study findings. The 2015 plan included a load forecast that reflects several recent changes affecting the electric grid, including the retirement of traditional base load generation, an increase in renewable energy, increased energy efficiency and demand response, and newer technology trends such as heat pumps and electric vehicles. The 2015 load forecast

projected a lower peak demand than the 2012 forecast; however, the plan identified potential system reliability issues in the Connecticut River area and the Central Vermont area. The reliability issues will likely need to be mitigated through rebuilding the Coolidge-Ascutney 115 kV line and 46 kV lines and the Coolidge-Cold River 115 kV line.

A VELCO subsidiary, Vermont Electric Transmission Company (VETCO), operates the Vermont portion of the Phase I Québec–New England HVDC Interconnection, a high-voltage direct current transmission line that passes through Vermont's Northeast Kingdom and transmits power from Canada to Vermont and other New England states. Companies such as Green Mountain Power, Vermont's largest consumer-facing utility, maintain the lower voltage, subtransmission and distribution lines. The not-for-profit, independent system operators in New England who are authorized by the Federal Energy Regulatory Commission (FERC) and ISO New England (ISO-NE), operate, plan, and administer all the power lines that supply Vermont utilities, as well as those in the other New England states.

Though fracking is banned in Vermont due to environmental concerns, the state continues to develop its natural gas infrastructure, allowing natural gas pipelines to pass into and through the state. The 41-mile, Vermont Gas Addison Natural Gas Pipeline, a controversial project for environmental activists, was finished on April 12, 2017 for a total cost of $165 million. According to Vermont Gas, this extension may serve as many as 4,000 families and businesses in Addison County. The company dropped the second and third phases of this project as costs and opposition to the project escalated.

RESILIENCE AND PUBLIC SAFETY

Extreme weather events are impacting Vermont more frequently, with at least eight federally declared weather disasters occurring since 2011. The extreme weather trends threaten the safety of Vermont's communities and the reliability of its infrastructure. To help mitigate the risk associated with extreme weather, VELCO, IBM, and a collaboration of dozens of in-state and regional partners developed the Vermont Weather Analytics Center (VTWAC) which delivers advance weather forecasts up to three days ahead, precise to one square kilometer. VTWAC has demonstrated safety and reliability benefits including strengthening emergency response coordination and enabling more accurate, site-specific customer updates. VTWAC is also being used to make the grid more resilient by improving operations, planning, and demand management. With a growing dependence on technology to operate and monitor the energy grid, constant vigilance is required to protect the reliability of the grid from cyberthreats. VELCO has a robust system in place to ensure the security of the grid, and in response to recent cyberattacks aimed at the U.S. power grid including Vermont's Burlington Electric utility, VELCO has reportedly taken appropriate actions to identify and resolve any vulnerabilities.

FUTURE NEED AND FUNDING

As of 2015, the Vermont Renewable Energy Standard (RES) requires 75% of retail electricity sales in Vermont to come from renewable sources by 2032, ultimately eliminating most petroleum use. This 35% jump would require significant upgrades to the transmission infrastructure, whether these renewables come from in or out of state. Vermont also has a goal to have 90% renewable energy overall, with 80% renewable energy in transportation, by 2050. Achieving this goal will require a drastic shift in the state's transportation and natural gas infrastructure, as well as adjusting the grid to accommodate the new, almost entirely renewable capacity.

The Energy Action Network 2017 Annual Report identifies 10 key drivers that need to be implemented by 2025 to meet the RES targets including replacing 60,000 fossil fueled vehicles with electric vehicles, installing 25,000 efficient wood heat systems, and installing 60,000 cold climate heat pump systems. These aggressive goals will be needed to face the growing threat of climate change, and to meet greenhouse gas emission reductions. The state's Greenhouse Gas Inventory

monitors emissions and in 2005 Vermont set greenhouse gas reduction goals of 50% below 1990 levels by 2028 and 75% reduction by 2050. Although Vermont is using more renewable energy, greenhouse gas emissions have increased 4% since 1990, which is far short of the pace needed to achieve the reduction goals. The effects of climate change can be seen in Vermont, with the number of heating degree days decreasing while the number of cooling degree days increases. In other words, fewer Vermonters are starting up their fireplaces and more are turning up their ACs.

To meet Vermont's aggressive greenhouse gas emission reductions and clean energy production targets, new large-scale wind and solar projects will be needed. The Coolidge Solar Project, Vermont's largest solar array project at 20 MW, began commercial operation in December 2018. Randolph Center Solar has proposed a similar 20 MW array in Randolph, Vermont. In addition, three major 20 MW solar projects may be in the works in southern Vermont for the summer of 2019.

In addition, Vermont needs to continue to invest in transportation programs. Vermont has an electric vehicle supply equipment (EVSE) grant program with about $2.4 million available to expand its network of charging stations. Recipients will be selected through an application process and funds will be distributed over multiple years until they are fully invested. Additional programs and funding will be needed beyond 2027 when the EVSE grant program is anticipated to end.

RECOMMENDATIONS TO RAISE THE GRADE

Vermont has a reliable backbone of over 60 hydroelectric dams, has achieved large gains in non-hydroelectric renewable energy production including wind and solar, and is set to continue the trend of generating its own renewable energy. It has a well-connected transmission system and smart grid. However, the state needs to focus on its consumer pricing, domestic consumption, and transportation systems. To improve its energy infrastructure grade, Vermont should implement the following recommendations:

- 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 in the home and on the road.
- Provide consumers with further incentives that 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.

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ROADS C+

SUMMARY

In 2017, the Vermont transportation network included 14,174 total miles of local and state roadways, 806 miles of the National Highway System, 2,709 miles of State Highway System, and 139 miles of Class 1 town highways. The Vermont Agency of Transportation (VTrans) has prioritized maintenance of state roadways, and the percentage of miles in good and fair condition has grown since 2013. The state also experiences little congestion. However, future needs are significant. By one measure, the state currently only has approximately two-thirds of the funding it needs to maintain its assets in a state of good repair. Increasingly severe winter storms are also challenging for regular highway system operations and maintenance. Fortunately, VTrans recently developed a Transportation Resilience Planning Tool (TRPT), a web-based application designed to help integrate climate risk and transportation resiliency into the agency's planning process for a more resilient network.

BACKGROUND

Vermont's highway system provides access to homes, employment, shopping, agriculture, tourism and recreation. To keep Vermont's roadways running smoothly, projects are prioritized and ranked based on a number of criteria, including cost-per-vehicle mile, project momentum, and more.

In 2017, the transportation network included 14,174 total miles of local and state roadways, 806 miles of the National Highway System, 2,709 miles of State Highway System, and 139 miles of Class 1 town highways. To keep traffic moving smoothly and efficiently, the state-owned system also includes 157 traffic signals and 1,100 roadway lights.

CAPACITY

Vermont's roadway network, unlike some states, does not have a capacity problem. The State of Vermont is predominantly rural, including many areas of low-population density. Chittenden County is the only designated urban area. Because of this, the primary mode of transportation for the majority of Vermonters is private vehicle travel. The highway system is one of the most important components of Vermont's transportation network. Nationally, Vermont ranks 48th in State-controlled highway mileage, just above Hawaii and Rhode Island, with 2,629 miles according to the 23rd Annual Highway Report. In 2016 Vermont ranked sixth in peak hours spent in congestion per auto commuter. Figure R1 to the right shows how each state ranks, with green showing the least amount of delay per commuter and red showing the most amount of delay. Residents spent an average of 8.42 hours in congestion, considerably better than the national average of 34.95 hours, according to the Reason Foundation. Maine and New Hampshire ranked 12th and 30th, respectively, with Maine drivers spending an average of 10.51 hours on congestion (tied with Alabama) and New Hampshire averaging 19.93.

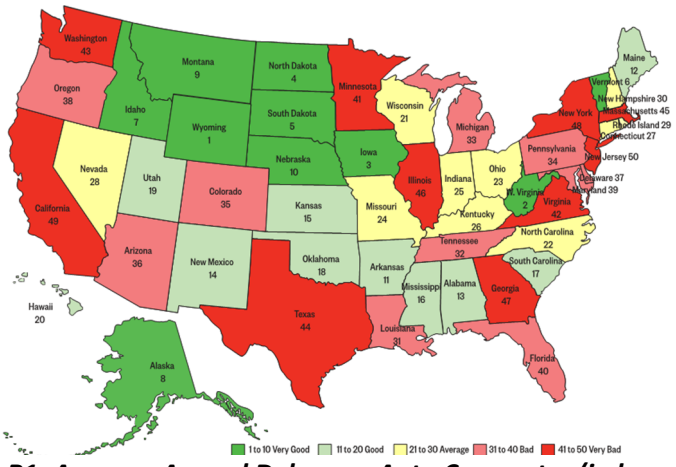

Figure R1: Average Annual Delay per Auto Commuter (in hours), 2016

While Vermont is not challenged by congestion, it does encourage car-pooling. VTrans operates 30 state-owned lots and has assisted in the development of over 62 municipal lots.

Located conveniently in the I-89, I-91, and US 7 corridors, these lots offer commuters the option to park a car and either share a ride with a carpool or vanpool, or board one of the public transit system bus routes.

CONDITION

Vermont's highway system is an expansive network of continuously degrading infrastructure. Harsh weather conditions experienced throughout the state result in roadways needing constant repair. In addition to harsh conditions, many of the roadways were constructed in the 1920-30s when the National Highway System was constructed and in the 1960s-70s when the interstate system was constructed. As this system ages and reaches its useful life, much of it needs to be replaced, or requires major rehabilitation to extend its useful life.

The VTRANS Highway Safety and Design Annual Report uses automated surveys, conducted annually, to determine pavement conditions across the state.

Good: 43% in 2017 (*up from 38% in 2013*)

- Like new pavement with few defects perceived by drivers
- Composite pavement condition index 80-100

Fair: 28% in 2017 (*up from 22% in 2013*)

- Slight rutting, and/or cracking, and/or roughness become noticeable to drivers
- Composite pavement condition index 65-79

Poor: 18% in 2017 (*down from 19% in 2013*)

- Multiple cracks are apparent, and/or rutting may pull at the wheel, and/or roughness causes drivers to make minor corrections
- Composite pavement condition index 40-64

Very Poor: 11% in 2017 (*down from 21% in 2013*)

- Significant cracks may cause potholes, and/or rutting pulls at the vehicle, and/or roughness is uncomfortable to occupants. Drivers may need to correct to avoid defects
- Composite pavement condition index 0-39

This level of detailed information is not currently available for local roads in Vermont, however in the future we hope to be able to include it in the Report Card.

OPERATION & MAINTENANCE

The Maintenance and Operations Bureau employs over 500 individuals who maintain infrastructure for the benefit of the traveling public. Vermont must plan and budget for winter maintenance costs. During the Winter of 2016-2017, Vermont's total cost of winter maintenance was $36.8 million. This can be broken down into categories based on materials. During that time, 131,000 tons of salt, 6,000 cubic yards of sand, and 2.7 million gallons of liquid salt were used to treat Vermont's state-owned public roads. In 2017 there were a total of 78 winter maintenance events, up from 61 in 2016. A winter maintenance event is an event in which three or more districts are engaged in activities requiring plowing, salting, or sanding.

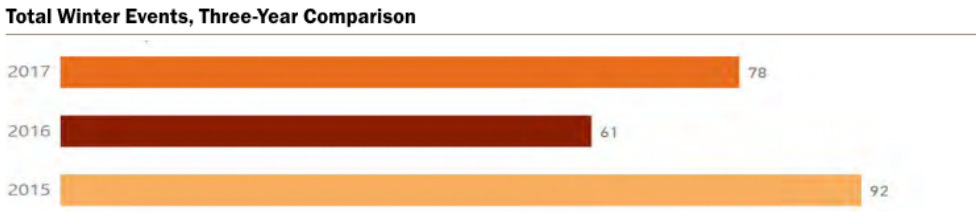

Figure 1: Source: Vermont Agency of Transportation 2018 FACT BOOK and Annual Report

The figure above shows a three-year comparison of total winter events. The figure below depicts the total state lane miles plowed for the winter of 2016-2017 as compared with the previous year and 5-year average.

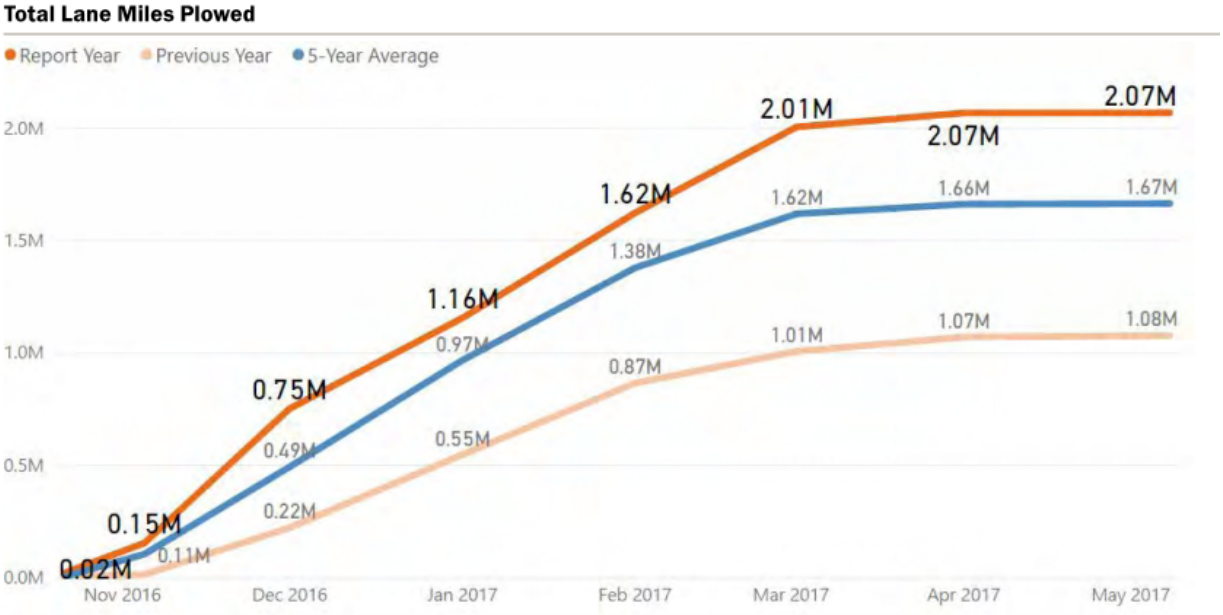

Figure 2: Source: Vermont Agency of Transportation 2018 FACT BOOK and Annual Report

In addition to winter maintenance, the Vermont Agency of Transportation completes a variety of other routine maintenance activities. VTrans provides a link on their website to VTransparency, an interactive GIS web map which allows the public to see where maintenance is taking place, as well as the activity being completed. The map can be accessed at https://vtrans.vermont.gov/vtransparency. This up-to-date information includes tree-cutting, mowing, stormwater/drainage work, snow and ice control, and patching - all of which are crucial to keeping Vermont roadways safe. This link also provides information on current construction activities throughout the State, including paving, bridge rehabilitation, guardrail replacement, construction of new sidewalk, installation of pavement markings, and other important maintenance activities.

FUNDING

The operations and maintenance of Vermont's transportation systems is funded through federal, state and local sources that are largely based on taxes from gasoline and diesel sales. Vermont's gasoline and diesel taxes are 30.72 cents and 32.0 cents, respectively, while, while those for some of the surrounding states are: New Hampshire 23.83 and 23.83 cents, New York 24.9 and 23.15 cents, Massachusetts 24 and 24 cents and Maine 30.0 and 3.2 cents respectively. Gasoline and diesel user fees are not indexed to inflation, and as a result, spending power has decreased over time. Additionally, gasoline consumption in Vermont has declined consistently since 2005 because of reduction in vehicle miles traveled (VMT), state investments in smart growth programs, transit, rail, park-and-rides, carshare programs, the growth of hybrid and electric vehicles, and federal fuel economy standards. According to a 2012 study published by the state legislature, the declining motor vehicle fuel consumption will compound a $240 million transportation funding gap over a decade.

Below are brief summaries of current funding sources that are based on motor vehicle fuel taxes and sources other than motor vehicle fuel taxes, which will be sufficient enough to maintain the State's transportation system to account for the declining motor vehicle fuel taxes and likely replace motor vehicle fuel taxes in the long run:

Revenue based on motor vehicle fuel taxes

- **Federal transportation funds**: For the State Fiscal Year (SFY) 2016, about 55% of the $616.1 million transportation budget is derived from federal funding sources. The majority of the funds ($337 million) is derived from the Highway Trust Fund (HTF), which is serviced by taxes on gasoline and diesel sales. However, dwindling revenues and the impact of inflation threaten the long-term solvency of this fund. The HTF is supplemented with funds from the Federal funding risk center on transportation reauthorization.
- **State fuel taxes (gasoline and diesel taxes, and assessments):** Most of the remainder of Vermont's annual transportation budget (38%) is comprised of State gas and diesel tax revenues, purchase & use taxes, and motor vehicle fees. Meanwhile, State gas and diesel taxes are also becoming less effective due to the decline in overall vehicle miles traveled and increases in fuel efficiency. While VMT is on the rise since 2015/2016, it was declining between the years 2003 and 2014, according to the 2018 Vermont Long-Range Transportation Plan.

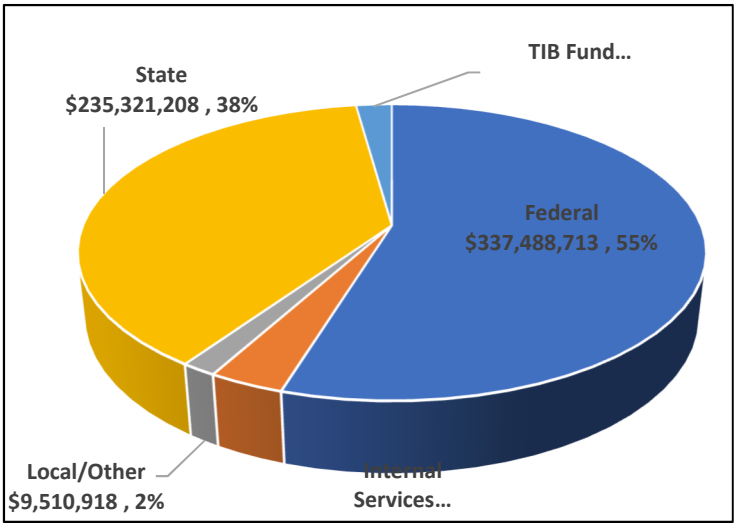

Figure 3: Sources of Transportation Funds in Vermont, SFY16
Source: VTrans Budget & Fiscal Management Section

- **DMV registration and other fees:** DMV motor vehicle fees account for the second highest share of state transportation revenues at $80.1 million, or 28% of total T-Fund revenues. DMV fees consist of a variety of fees for vehicle registrations, licenses, permits and endorsements. In contrast to gasoline taxes, these fees have held steady and increased in the past decade, assisted by periodic fee adjustments to ensure they kept pace with inflation.
- **Vehicle purchase and use taxes:** P&U taxes totaled $64.8 million, or 23% of total T-Fund revenues. P&U taxes are assessed at 6% of the cost of a vehicle; 4% is allocated to the T-Fund and 2% to the Education Fund. Revenues have generally increased since 2005, aided by increasing vehicle sales.

Revenue Based on Existing Fees

- **Vehicle Inspection Fees:** The state charges $5 flat rate for inspection stickers to licensed inspection stations. This generated nearly $3 million in revenues in the 2015 fiscal year. Every $1 increase in sticker fees will yield approximately $0.7million in additional funding.
- **Vehicle Rental Tax:** A 9% tax is assessed on vehicle rentals. An allocation of 6% is made to the T-Fund and 3% is allocated to Education Fund. This fund generated over $4 million in the 2015 SFY, with approximately $2.8 million allocated to the T-Fund. This fund will generate about $0.4 million for every 1% increase in the tax, if the entire increase is allocated to the T-Fund
- **Department of Motor Vehicle Fees:** DMV fees generated $80 million in revenue in SFY 2015. The potential in these fees is high, and a 1% raise in fees will result in about $0.8million in revenue.
- **Heavy Vehicle Registration Fees:** Heavy vehicles (those 55,000 lb. or higher) pay more DMV fees. These fees range from $1,441 to $4,375, and a $1 increase on the average, will generate about $5,000 in revenue.
- **Truck Gross Vehicle Weight Registration Fees:** Truck registration fees that are based on self-reported vehicle weight rather than gross vehicle weight can generate an additional $3.5 million in revenue by shifting to a gross vehicle weight registration.
- **Light-Duty Diesel-Gasoline Vehicle Registration Fee Parity:** Gasoline-powered light-duty vehicles pay more registration fees than similar diesel-powered vehicles. Raising the diesel-vehicle registration fees to achieve parity will generate about $0.4million in annual revenues.
- **Vanity Plate Fees:** Vanity plates are a component of DMV fees, and generated approximately $1million in revenue for the 2015 SFY, but the revenue potential is low.
- **Safety Violation Fees:** Safety violation fees generated about $4million in revenue for the T-fund in SFY 2015. The revenue potential is low, and a 1% increase would generate nearly $0.4million extra revenue.
- **Purchase & Use Taxes:** P&U taxes generated approximately $64.8million in SFY 2015. Two-thirds of this goes to the T-Fund and one-third to the Education Fund. The revenue potential is high and every 1% increase could generate approximately $16million additional revenue.
- **Reduction in P&U Allocation to Education Fund:** One-third of P&U revenues are allocated to the Education Fund, totaling about $32.4 million in SFY 2015. Each 1% reduction in P&U funds for the Education Fund will generate about $0.3million for transportation.
- **Reduction in Transportation Fund Allocation to the Department of Public Safety:** Approximately $22.7 million in T-Funds were allocated to the Department of Public Safety (DPS) in SFY 2015. Each 1% reduction in DPS allocation will generate about $227,000 for the transportation Fund.

FUTURE NEED

The 2018 Vermont Long-Range Transportation Plan (LRTP) is the policy document that serves as a framework, guiding transportation decision-making and investments over the horizon of the next 20 years, and covers all modes of travel. VTrans also maintains subject and transportation mode-specific plans or "modal" plans, which have their individual cycles, are more focused, and address the implementation of programs and projects that serve the vision.

Within the time frame of the LRTP, the State's transportation system is anticipated to face many challenges, such as adequate and sustainable funding levels to support maintenance operations, the interaction between land development and the transportation system, highway safety and an aging population, flat population growth, highway related water quality issues, and increasing frequency and severity of extreme weather events. Nevertheless, the future of

transportation improvements will center on smart technologies. Vehicle automation is promising to increase highway safety and may increase mobility for vulnerable users, including the aging population. Meanwhile, intelligent transportation systems are already increasing the efficiency of traffic signals and incident management.

Vehicle Miles Traveled (VMT) in Vermont increased an average of 2% per year from the 1990s to 2000s - peaking in 2003 at 7.9 billion - and then declined to a low of 7 billion in 2014. The VMT begun to rise again, but slightly, in 2015 and 2016.

According to the 2018 Transportation Asset Management Plan, the annual infrastructure gap between total transportation system needs and revenue ranged between $230 and $250 million during the five-year period between 2014 and 2018. This gap represents the funding for basic needs – essentially maintaining the existing system. Furthermore, the asset sustainability index (ASI), which is the amount of available funds divided by the amount of infrastructure needs, is 0.67. This means the State has approximately 2/3 of the funding it needs to maintain its assets in a state of good repair.

In 2008, the Agency of Transportation's statewide paving budget was just over $56 million. Over the next 10 years, paving expenditures were increased to just under $90 million annually. This sustained investment is being maintained for the 2018 and the proposed 2019 fiscal year.

Vermont has made significant progress in highway safety in the past decade through aggressive goal setting, infrastructure investments, outreach, education, and enforcement -and will continue to press towards safer roads. The proposed SFY2019 traffic and safety budget is approximately $17.3 million, with a slight increase projected for SFY2020.

Traffic congestion in Vermont is not as prevalent as in other more urbanized states. However, travel time reliability will continue to be monitored to identify, measure, and track the frequency and extent of unexpected delays in the system, and coordinate on responses to manage and alleviate the congestion.

Automobile usage is the dominant mode of travel, accounting for about 85% of all trips in Vermont. Travel needs in Vermont are also being met through a growing number of modes. There are multiple types of transit services including fixed-route, fixed-deviate route, commuter, demand response, health care and shopping shuttles, winter seasonal routes, ADA complementary transportation, special services for the State's elderly and disabled citizens, and intercity bus services. The State also partners with Amtrak to provide intercity rail service, and the State Aviation Program manages 90 runway lane miles at 10 state-owned airports in Vermont.

PUBLIC SAFETY

In 2006, Vermont implemented a Strategic Highway Safety Plan (SHSP) with a mission to minimize the occurrence and severity of crashes, the related human suffering, and the economic losses on the Vermont transportation network. The 2012-2016 SHSP Plan set an aggressive goal of a 10% reduction of major crashes by 2016. The objective was not only met, but exceeded, with an overall major crash reduction of 15% over the five-year period. The five-year rolling average from 2004-2015 shows a 25.7% reduction in overall major crashes. Despite the progress that has been made, there were approximately 325 major crashes between 2011 and 2015, with an average rate of 60 deaths per year. As of October 2018, there were a total of 51 vehicle fatalities reported on the VTransparency Public Information Portal. Targeting a reduction of major crashes will continue to be a primary goal, and the 2017-2021 SHSP goal is again to reduce major crashes in Vermont by another 10%. The Vermont fatality rate ranks fifth lowest in the nation based on the Reason Foundation's 23rd

Annual Highway Report, which is up from the 18th lowest ranking based on the Reason foundation's 20th Annual Highway Report.

The 2018 FACT BOOK and Annual Report, produced by the Vermont Agency of Transportation, outlined its 2017-2021 Strategic Highway Safety Plan Critical Emphasis Areas. One of the seven emphasis areas was age appropriate solutions, which included improving young driver safety (25 and younger) and improving older driver safety (65 and over). In 2017, the Vermont Highway Safety Alliance (VHSA) focused on young drivers. A two-day program was held to teach newly licensed teens necessary skills for safe driving, in which 200 teens participated.

RESILIENCE & INNOVATION

Many of Vermont roads are constructed along stream banks because of the hilly terrain, so they are susceptible to extreme weather events. In the aftermath of Hurricane Irene, VTrans developed a strategy for incorporating adaptive management, policies, and plans into every level of planning, design, operations, and maintenance. Those strategies continue to be reviewed.

Today, the Resiliency Vermont Network, a collaboration of organization in Vermont (including VTrans), are working to advance climate resilience by improving alignment, coordination, communication, and strategic impact across a range of issues related to climate resiliency. Furthermore, VTrans recently developed a Transportation Resilience Planning Tool (TRPT), which is a web-based application designed to help integrate climate risk and transportation resiliency into the agency's planning process for a more resilient transportation network in Vermont. The app identifies bridges, culverts and road embankments within a watershed that are vulnerable to damage from floods; estimates risk based on the vulnerability and criticality of roadway segments; and identifies potential mitigation measures based on the factors driving the vulnerability and criticality.

VTrans' asset management framework is designed to support policies and goals related to accountability, mobility, resiliency, safety, sustainability, and transparency. The state has a 2025 target for reducing energy use by 20%, increasing the share of renewable energy by 10%, and reducing GHGs emissions by 30% from 1990 levels. Annual targets are set for achieving these goals, and those targets are currently being met and even exceeded for reducing GHGs emissions. VTrans is also revamping its project prioritization system, such that it will be based on the "value" that the project provides for the taxpayers, using the following eight criteria: safety, asset condition, health access, environment, community, economic access, resiliency, and mobility and connectivity.

VTrans has a state transportation innovation council, which is a representative body of transportation stakeholders, and serves as a forum for initiating and overseeing the rapid deployment of innovative strategies and technologies to accelerate project delivery and to enhance project quality and effectiveness, with the goal of making the innovations routine practice. The council was created in 2010 to oversee the implementation of the Every Day Counts (EDC) Initiative. In 2013 the scope was broadened to include VTrans activities and projects associated with the Strategic Highway Research Program 2 (SHRP2) and the American Association of State Highway and Transportation Officials (AASHTO) Technology Implementation Group (TIG).

RECOMMENDATIONS TO RAISE THE GRADE

The Vermont Agency of Transportation has been responsible for the planning, development, implementation, and maintenance of the State's transportation infrastructure, with oversight from the Vermont Legislature. The overarching

goals of the agency include the following: Preserve, maintain, and operate the transportation system in a cost effective and environmentally responsible manner, and provide energy efficient travel options to Vermonters.

From 2004 to date, Vermont has seen over a 25% reduction in major crashes but losing 69 lives in 2017 means there is still much work to be done to improve traffic safety. Hence, the Vermont ASCE makes the following recommendations:

- Continue to reduce crash rates through the Safety Corridor program, which is a partnership between the Vermont Agency of Transportation and the Vermont Highway Safety Alliance.
- Continue the positive trend of increasing the percentage of roads in good and fair conditions.
- Continue to explore alternative sources for transportation funding, specifically to account for the declining motor vehicle fuel taxes and the impact of inflation.

  New revenue sources include:
  - **Vehicle Lease Fee,** can be imposed on all leased vehicles for transportation revenue. Based on SFY 2015 data, each $1 fee on leased vehicle would yield about $38,050 annually.
  - **Ad Valorem Fees:** Ad valorem or vehicle property fees are typically imposed annually during vehicle registration. This could generate about $147,028,364 annually, which is $66,918,334 increase over currently collected DMV fees.
  - **Auto Parts Tax Allocation to the Transportation Fund**: Sales of auto parts, accessories and tires could generate $4.85 million revenue annually from sales tax.
  - **Auto Insurance Taxes Allocated to the T-Fund:** Based on insurance statistics, a $1 tax added to insurance premiums would generate about $2.5 million annually.
  - **Bicycle Registration Fees:** Based on national statistical reports, an estimated 24,800 bicycles were sold in Vermont in 2015. This could have generated $24,800, if a $1 registration fee was imposed.
  - **Electric Vehicle Fees:** Based on electric vehicle registration records, Vermont can generate about $1,046 annually if a $1 registration fee is imposed on each electric vehicle. The amount will increase as the number of the electric vehicles increase.
  - **Vehicle Miles Traveled (VMT) Fee:** This is an alternative to motor fuel taxes, and is also called mileage-based user fee. Motor fuel use per mile of travel may decline as much as 50% over the next 25 years. VMT fees could be increased to generate more revenue, and for every $0.01 increase above the revenue neutral benchmark, a VMT fee would generate approximately $63,532,800.
  - **General Fund Revenues Allocation to T-Fund:** General funds are broad-based revenues that are not directly linked to transportation, but the state can allocate a portion for transportation. These funds totaled $1,378,753,727 in SFY 2015. The revenue potential is high and every 1% allocation would generate $13,787,538.
  - **Sales Tax Allocation to T-Fund:** The existing sales tax generated $229,900,000 in SFY 2015. A portion could be allocated to the T-Fund, and every 1% allocation will generate $2,299,000 additional revenue (Vermont Transportation Funding Options, 2016).
- Consider potential revenues increases based on existing fees that have high promise, such as vehicle inspection fees, vehicle rental tax, department of motor vehicle fees, purchase and use taxes, and other identifiable new revenue sources.
- Continue to pursue the state's goal of 10% electric powered vehicle fleet, and other efforts to reduce transportation related greenhouse gas emissions.
- Continue the partnership with local stakeholders to improve the public transit program, and also continue to develop the on-road bicycle plan.

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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 and is the current Secretary of the Vermont Section of ASCE.

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SOLID WASTE B-

SUMMARY

In 2016, approximately 585,789 tons of municipal solid waste (MSW) was generated in the State of Vermont. Of that, about 211,152 tons of material were recycled or otherwise diverted from landfills or incinerators. That 36% diversion rate is relatively high when compared to the 30-36% percent diversion rate over the last 17 years. The statewide goal is to reduce the disposal of municipal solid waste from the current 5.18 pounds per person to 2.76 pounds per person, and to increase diversion rates to 50% by 2022. The Solid Waste Infrastructure Advisory Committee (SWIAC) determined that approximately $12 million was needed to meet the proposed state share of infrastructure investments estimated to implement these changes. Though progress has been statistically stagnant in years prior, Vermont is beginning to see indications of positive change in the diversion and disposal rates of MSW.

BACKGROUND

Vermont currently generates approximately 585,789 tons of municipal solid waste (MSW) per year. Approximately 64% of Vermont's MSW is either disposed of in Vermont landfills or hauled out of state for disposal. The remaining 36% of MSW generated in Vermont is recycled or otherwise diverted from landfills or incinerators. Vermont also generates and disposes of approximately 35,000 tons of materials that are 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 MSW based on a 2013 study prepared by DSM Environmental is presented in Figure 1.

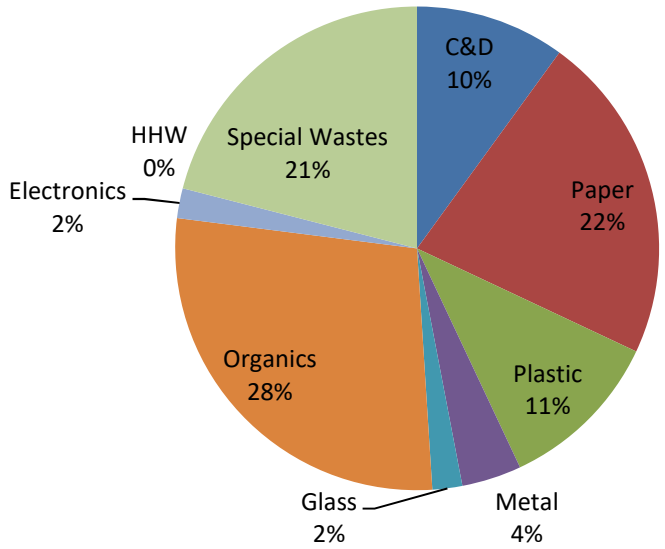

Figure 1: Vermont Residential Waste Disposal (2013)

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 (metal, glass, plastic, paper, etc.), food scraps, clean wood and leaf and yard debris. The Vermont Department of Environmental Conservation (VTDEC) anticipates that the MSW diversion rate will get to 47% by 2022 and anticipates reaching 66% as additional material-specific management programs are implemented (Figure 2).

CONDITION, CAPACITY & PUBLIC SAFETY

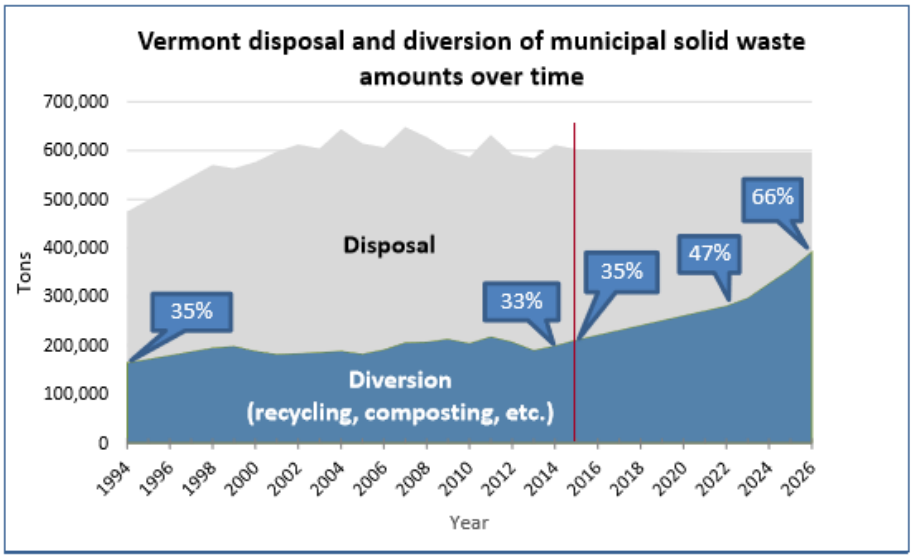

Figure 2: Vermont Disposal and Diversion Graph

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 December 2016, there are 10 facilities certified to compost materials, 13 permitted food scrap haulers, and 17 farm digesters.

Solid Waste Disposal

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. A permit has been issued for a 51-acre landfill expansion which will be built in multiple phases, with an overall life expectancy of 22 years. This proposed expansion will increase the airspace capacity in Vermont beyond 2020, which is when the current existing airspace is projected to be filled to capacity.

In addition to the Coventry, Vermont facility, there are two in-state unlined MSW landfills and one C&D landfill providing a limited amount of waste disposal capacity. In addition, about 16% of Vermont's waste (in 2016) was transported to Massachusetts, New Hampshire, New York, and Quebec, Canada 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.

Recycling

In 2016, Vermont diverted over 211,152 tons of MSW through recycling facilities, bottle redemption, direct to market economic recycling, scrap metal facilities, organics composting, and reuse facilities and programs. Act 148 (adopted 2012) and Act 175 (adopted 2014) are intended to increase the diversion rates of organics and C&D, respectfully; however, currently there are a limited number of facilities devoted to reuse and recycling of these materials.

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. Despite challenges to this program from volatile recycling markets, the amount of material recycled has increased steadily year over year. During the 2015 program year, 4.9 million pounds of electronics 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.

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.

In Vermont it is estimated that organic materials (food scraps, leaf and yard debris, etc.) make up almost a third of the solid waste disposed of in the state, or nearly 100,00 tons per year. 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.

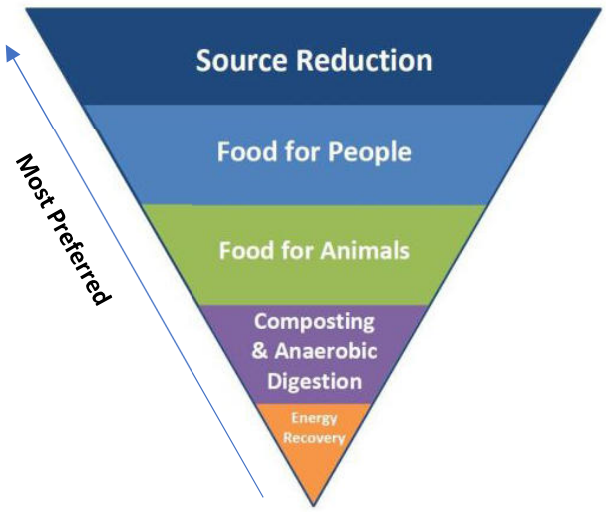

Figure 3: Vermont Food Recovery Hierarchy

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. 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. In 2016 leaf, yard, and clean wood debris were banned from the landfill and by 2020 all food scraps will be added to that list. In order to achieve this goal set by Act 148, F2P acts as an opportunity for the agricultural community to diversify their operations and/or reduce input costs.

FUNDING, FUTURE NEED, OPERATION & MAINTENANCE

Continued success of Act 148 implementation will require improved recycling infrastructure and services. There 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, therefore it will 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 Solid Waste Infrastructure Advisory Committee (SWIAC) determined that approximately $12 million would need to be raised to meet the proposed State share of infrastructure investments estimated to implement Act 148. This comes from the cost of building effective statewide infrastructure for recycling and organics management.

Economic incentives such as possible grant funding and a Solid Waste Service Fee (including trash, recycling, and organics) will 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 including C&D materials, 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 significant progress with ensuring that adequate landfill capacity is available for waste disposal, as landfills will continue to be a primary component of the state's solid waste management program for years to come.

RECOMMENDATIONS TO RAISE THE GRADE

- 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.
- Establish new hazardous waste disposal facilities to improve accessibility and convenience for every region of the state.
- Develop C&D collection, recycling, processing, and disposal infrastructure in underserved areas of the state.

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STORMWATER D+

SUMMARY

Stormwater is runoff caused by rain events or snowmelt that must be collected and treated in a safe and efficient manner to ensure the safety of our roads, buildings, wastewater systems, waterbodies, and various forms of human transport. Stormwater management is vital to maintaining Vermont's resources, whether water quality, habitat, stream geomorphology, or flood protection. In 2015, Vermont passed Act 64, a new Clean Water Act (Act 64, an act relating to improving the water quality of State Waters). For the state to reach compliance as outlined by Act 64, it will be necessary for the state and its municipalities to invest $2.3 billion over the next 20 years. Revenues from funding sources already in place within that timeframe are projected at $1.06 billion, leaving an investment gap of $1.24 billion. As a small and largely rural state, Vermont 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

Demands on deteriorating and undersized stormwater infrastructure continue to grow in Vermont. As development increases and storms intensify, many communities are finding that they are not equipped to manage increased stormwater volumes. Much of the state's stormwater infrastructure is owned by Vermont's 255 municipalities. In the spring of 2002, the Vermont Legislature passed Act 109 to give Vermont municipalities the power to create stormwater utilities. While the United States boasts roughly 500 stormwater utilities, less than 10 Vermont communities have introduced one. Only 20% of towns have a town manager, and 200 of Vermont's town clerks and road crews are part time. The vast majority of Vermont's impervious cover, not including hydrologically connected road segments that now fall under the 2018 Municipal Roads General Permit (MRGP), is not permitted through the State's stormwater program. Private driveways and non-regulated roadways constitute approximately 20% of Vermont's impervious cover and generate significant untreated stormwater runoff.

However, Vermont is making measurable progress towards improving water quality. Twelve municipalities, The University of Vermont, and the Burlington International Airport are Municipal Separate Stormwater System (MS4) General Permit holders, and the State recently established the Transportation Separate Storm Sewer System (TS4) General Permit. Both General Permits 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. This general permit requires municipalities to inventory the condition of road segments and related drainage systems crossing or near waterbodies, and to implement a multi-year plan to improve roadway drainage infrastructure where it does not meet set performance standards. Reducing erosion from local roads will in turn reduce the volume of sediment and phosphorus transported to waterways. Vermont's Better Roads program is available to municipalities to provide technical support and grant application assistance for design and construction of roadway-related stormwater improvement projects.

Vermont is in the process of finalizing a new Stormwater Permitting Rule, which will incorporate a new General Permit to regulate sites that contain impervious cover greater than or equal to three acres that were constructed prior to Vermont's adoption of a stormwater permit program, or prior to the drafting of the 2002 Vermont Stormwater Management Manual.

Impervious cover on these properties is currently unregulated, and while drainage may be adequate, it was commonly designed and built before modern understanding of the water quality and peak flow-related impacts of stormwater runoff. Under the new rule, permittees will be required to meet the stormwater management standard for redevelopment included in the 2017 Vermont Stormwater Management Manual Rule and Guidance—or pay an impact fee if the standard cannot be fully met.

Over the past five years, there has been increased and building emphasis across Vermont on implementation of Green Stormwater Infrastructure (GSI) practices and utilization of Low Impact Development (LID) techniques wherever feasible. Together, these practices aid in reducing stormwater runoff and its associated pollutants by capturing and infiltrating it as close to the source as possible through decentralized treatment practices. Some of these GSI projects are being targeted by or for private land owners, often through the efforts of watershed stewardship organizations.

OPERATION AND MAINTENANCE

Proper operation and maintenance is critical for systems to achieve desired function and design capacity. Stormwater infrastructure is only required by the State for projects that create more than an acre of impervious cover, or that, if an acre of impervious surface already exists, expand existing impervious cover by more than 5,000 square feet. 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: 1) it creates funding to assist in maintaining Vermont's stormwater program and 2) it makes the owner 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. 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. In particular, 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.

PUBLIC SAFETY

Lake Champlain has been a public safety priority as the largest waterbody in the state. In the northern and southern portions of Lake Champlain, warm, shallow water combines with elevated phosphorus levels to create a habitat that allows blue-green algae to flourish. According to the New York Department of Health, 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. The re-establishment in 2016 of a Total Maximum Daily Load (TMDL) for phosphorus in Vermont's portion of the Lake Champlain basin, and resulting changes in stormwater management across all sectors implemented through Act 64 are intended to combat these safety concerns.

Increased flooding, erosion, and channel destabilization also present a public safety concern. The average annual precipitation in Vermont has increased 1.5 inches per decade since 1960, and four of the five years with the most precipitation have occurred since 1995. As is the trend nationwide, improvements in stormwater infrastructure have not

kept pace with the rapid rate of climate change. Much of Vermont's municipal infrastructure was not designed to treat stormwater runoff of this magnitude. In cities like Burlington and Rutland, wastewater collection systems with combined sewer inputs can be overwhelmed by runoff from intense storms. The combined sewer collection systems have safety releases that prevent sewage from backing up into homes and business, and combined inflow from overwhelming the wastewater treatment plants. The overflow structures, however, release mixed sanitary wastewater and stormwater into rivers or Lake Champlain.

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. Revenue from funding sources already in place within that time frame are projected at $1.06 billion, leaving a total investment gap of $1.24 billion. On an annual basis, that means it will cost $115.6 million to reach compliance as outlined by Act 64, of which $53.2 million is accounted for in existing revenue, leaving an additional funding need of $62.4 million.

While some projects may be paid for with the Clean Water State Revolving Loan Fund (SRF) or its associated new loan forgiveness program, Vermont is still working to identify funding sources to secure the necessary long-term funds. The state is currently allocating funds through efforts like the MRGP Grants in Aid, Ecosystem Restoration Grants, and the Better Roads Program. Two hundred of Vermont's towns have taken advantage of the MRGP Grants in Aid Program and received technical assistance and advice from professionals as to how they can reduce stormwater related erosion and work towards MRGP compliance. The extent of the need is expected to be high but will not be known until towns create implementation plans to bring the roads into compliance, which are not due until 2020.

RESILIENCE

For most Vermont residents, one event sticks out in memory. In September 2011, Tropical Storm Irene delivered as much as 11 inches of rain and caused $733 million in damage, including damage to 2,400 roads, 800 homes and businesses, and 300 bridges. This storm, coming on the heels of shoreline flooding on Lake Champlain in the spring and major storm events that impacted southern and central Vermont in May of the same year, was a wake-up call to protect against future devastation. Flooding caused damage to areas 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. The state has since produced updated maps that account for fluvial erosion hazards in addition to inundation and passed new laws that improved flood preparedness and response. The state also created new resources, including websites for better warning and information systems, as well as assistance to municipalities to buy out flood-prone homes to decrease future disaster relief spending. Municipalities have also taken steps to limit development in floodplains, including the passing of local ordinances preventing placement of fill in designated floodplains.

INNOVATION

The 2017 update of the Vermont Stormwater Management Manual emphasizes GSI and LID techniques to reduce runoff and utilize a more naturalized approach to stormwater management. GSI includes a range of soil/water/plant systems that intercept stormwater and treat it by infiltrating, evaporating, and/or detaining and slowly releasing to mitigate stormwater's negative effects on closed drainage infrastructure and water quality. Examples of GSI include infiltration chambers, bioretention, gravel wetland filtering practices, green parking, permeable pavement/pavers, planter boxes,

and urban tree planting. The Agency of Natural Resources estimates that the phosphorus load from new development will be reduced by 70% on average through this new approach, emphasizing the goals of Act 64.

RECOMMENDATIONS TO RAISE THE GRADE

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

- Establish a state budget mechanism to help reduce the constant conflict between short-term and long-term needs.
- Establish scale-appropriate clean water utility programs that provide a consistent and dedicated revenue stream for stormwater management improvements and maintenance.
- Establish a statewide system that inventories the size, condition, capacity, and capital needs of all public and privately-owned stormwater assets that is easily accessible.
- 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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WASTEWATER D+

SUMMARY

Vermont processes over 15 billion gallons of wastewater annually in its 92 municipal direct discharging permitted wastewater treatment plants (WWTPs) used by half the state's population, and even more in its soil-based wastewater treatment systems, such as septic systems, used by the other half. The WWTPs and septic systems, along with piping networks and pumping stations, make up Vermont's wastewater infrastructure. Many of these systems are in need of expensive upgrades, especially in communities with combined sewer systems, where overflows pose potential for public safety concerns, and in WWTPs required to meet new phosphorus standards. In 2015, the passage of Vermont's Clean Water Act focused available resources toward addressing impaired waters across the state. As a result of this higher prioritization and concerted efforts by the state, increased state and federal dollars, including an increased Lake Champlain Basin Program award, the funding gap between what wastewater infrastructure needs and what revenues provide was reduced.[1] In 2017, the Vermont Treasurer's Clean Water Report estimated an average annual gap, between wastewater infrastructure need and available revenues, of $13.7 million for each of the next twenty years, to upgrade and maintain Vermont's municipal wastewater direct discharge infrastructure.

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[2]. The Federal Clean Water Act (CWA) includes provisions such as the National Pollutant Discharge Elimination System that permits specific discharges into the nation's waterways[3]. These national efforts are supported by state-specific regulations, including Vermont's Clean Water Act of 2015[4], and 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[5]. The federal CWA established a Water Quality Standards program where states designate the uses of water bodies within their areas of authority, and establish water quality criteria based on the existing characteristics of the body of water[4]. Total Maximum Daily Loads (TMDLs) are established for each pollutant, specific to the water body, by the state and the Environmental Protection Agency (EPA), if the water quality standards are exceeded.

CONDITION & CAPACITY

Vermont's wastewater infrastructure has three primary components; the WWTPs, the piping system that carries wastewater to the WWTPs, and decentralized, on-site systems. In addition to the 92 municipal WWTPs, there are other pretreatment facilities that discharge to those plants and other WWTPs. In total there are 174 WWTPs in Vermont, as of April 2018, with active permits[6]. Vermont's WWTPs average daily flows are 46.2% of the permitted hydraulic capacity. Much of the piping infrastructure system that supports Vermont's wastewater systems predates its WWTPs, and is up to 100 years old, with some even older exceptions.[6] VT DEC's Facilities Engineering Division assumes that most non-PVC (polyvinyl chloride) pipes will reach the end of their useful life within the next 20 years. This assumption is based on the consistent reports by facility operators of significant infiltration associated with asbestos cement and vitrified clay pipes.[7] Most WWTPs were built between the 1960s-1970s, using funds from, and in compliance with, the federal CWA. Vermont's most recent municipal plant was built in the late 2000s.

About 50% of the state utilizes smaller decentralized units, such as septic systems.[8] These smaller systems do not have direct discharges to waters of the state, and therefore are not required to obtain NPDES permits, although they are managed by the VT DEC Regional Office Program to protect public health, safety, and welfare. If these systems fail, they can contribute to surface water pollution due to surfacing effluent. There were 339 permitted replacements in 2017, and 445 in 2016.

WWTPs that routinely exceed 80% of permitted hydraulic capacity, are expected to submit a plan, that may include a recommendation for an upgrade, but doesn't need to. However, most WWTPs operate at about 50% to 60% of their design flows. The unused hydraulic capacity helps meet other treatment needs, such as providing capacity for high strength wastes from industries. Smaller facilities, with capacities of less than half a million gallons per day (< 0.5 MGD), throughout the state are almost always operating at or below 50% of their treatment capacity, with the smallest of those facilities operating at significantly lower percentages[7]. Some of this excess capacity is due to WWTPs being designed and built to allow room for future expansion (a need for many Vermont towns), but recouping the costs of any improvements or upgrades to these smaller facilities with excess capacity, mean less affordable rates.

FUNDING, OPERATION & MAINTENANCE (O&M)

The passage of Act 64 of 2015, and compliance with the state's Combined Sewer Overflow (CSO) rule of 2016, has called for greater investments from the four major pollution source sectors – municipal wastewater treatment facilities, agriculture, developed lands, and natural resources such as forestry and land management. For wastewater infrastructure, potential funding sources are loans and grants.

The State provides loans through the Clean Water State Revolving Fund (CWSRF), Vermont Pollution Control State Revolving Fund, and the Vermont Planning Advance Program; and grants via the Vermont Pollution Control Grants and the Clean Water Fund (CWF) (created via Act 64: Vermont Clean Water Act). See Figure 1 for a snapshot of the 2018 funds awarded by basin.[9] Vermont obtains capital for the CWSRF through annual federal capitalization grants, state match (from the capital bill), and repayments from previously awarded loans. Additionally, there is general funding for the CWF. The CWF has provided some funding for asset management plans and optimization plans. The United States Department of Agriculture (USDA) also provides loans via USDA Rural Development Water and Environmental Loans and Grants.[10]

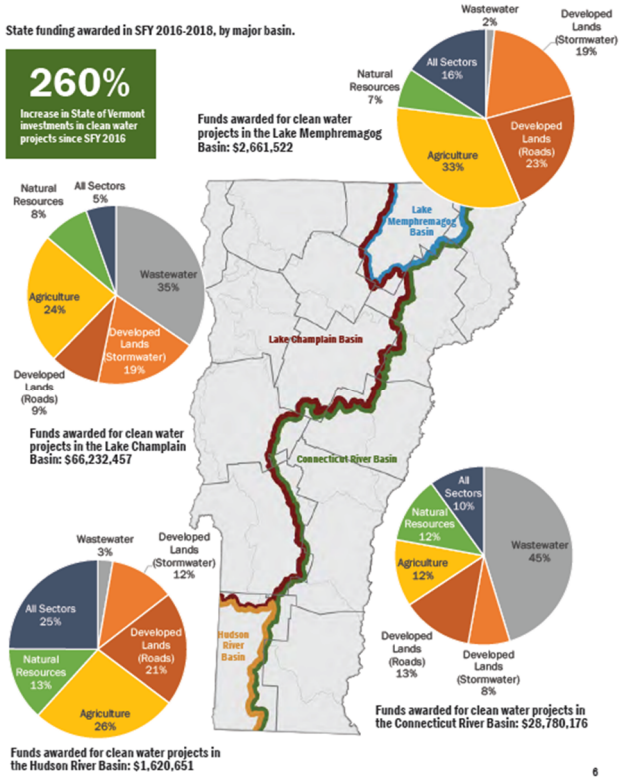


Figure 1: 2018 state funds awarded by basin under this Clean Water Fund

Municipalities generate revenue for capital improvements and operations and maintenance by setting their own rates for water, wastewater, and stormwater users. The average water + sewer rates for Vermont communities is $164 per quarter based on 2016 rates[11], with approximately $94/quarter, for sewer alone. An estimate of these rates for 2019 are shown in Figure 2[12]. However, these rates do not cover the full cost of service, thus requiring municipalities to apply for loans, or seek our grants. Some municipalities use funds from their grants or local sales tax to fund some clean water needs.

The VT DEC has a database called the Wastewater Inventory that stores all monitoring results, violations, inspection reports, contact information, plans, and much more. In some instances, violations that involve replacing a part of the treatment process, and hence greater costs, may have to be engineered, and require the municipality to take on substantial loans, and go through the bond process.

In addition, the VT DEC also maintains a separate enforcement database. As these two data sets are not synchronized, finding statewide data on operation and maintenance gaps and needs of the WWTPs and related infrastructure is difficult.

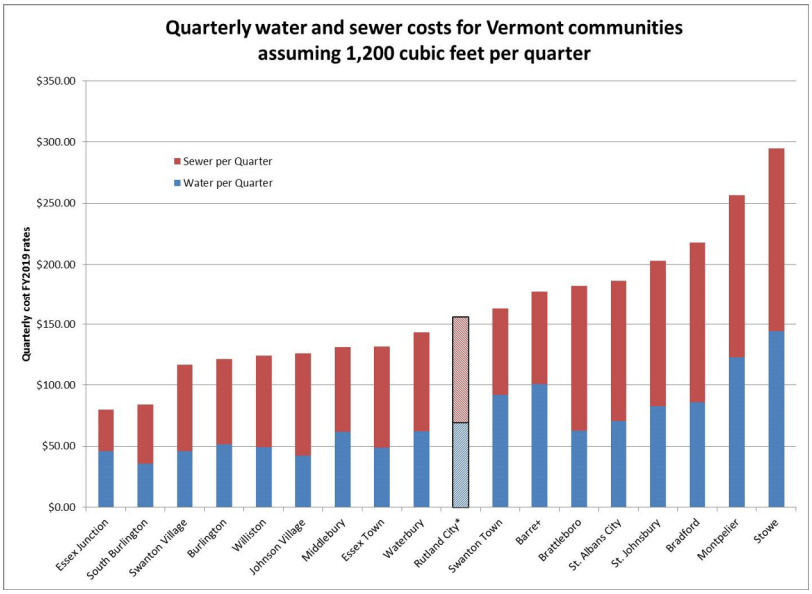


Figure 2. Quarterly water and sewer costs for VT communities in 2019 (City of Rutland, 2019).

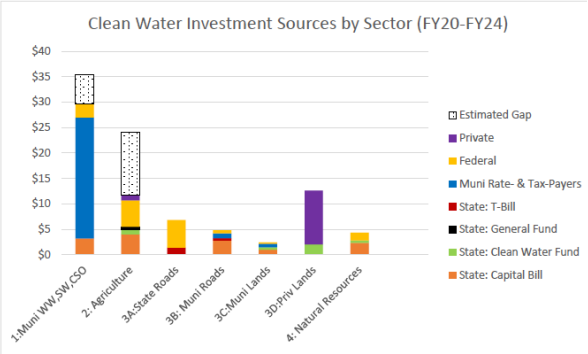
Smaller municipalities do not have the ability to self-finance clean water projects, therefore they rely heavily on CWSRF / USDA Rural Development (RD) funding.

FUTURE NEED

A six-member working group was established "to develop recommendations for equitable and effective long-term funding methods to support clean water efforts in Vermont", under section 26, of Act 73, passed by the General Assembly, in 2017 to address Vermont's long-term funding needs. Data generated for the Act 73 Report included a projection of costs and revenues from FY 2020 through FY 2024 (Figure 3 a) and show that the greatest costs are associated with the wastewater and stormwater sectors. The state requires each of Vermont's 92 WWTPs to go through engineering evaluations every 20 years to determine necessary refurbishments and upgrades. It should be noted that not all improvements are implemented in response to a "20-year evaluation." For example, in 2018, Burlington passed a $30 million bond to cover immediate WWTP needs and other clean water issues in the City. This translates to an approximately $64 annual increase per ratepayer once the projects are completed.[13] An additional example, is the planned upgrade of the Bartlett Bay WWTP in South Burlington (last upgraded in 1999), which is estimated to cost South Burlington approximately $8 million-$10 million.[ii] Vermont works with municipalities to provide funding for refurbishment and upgrade projects at WWTPs, including upgrades to meet new permit limits. In Vermont, TMDLs were adopted for Lake Champlain in 2016, and Lake Memphremagog in 2017, requiring annual phosphorus reductions of 34% and 23% to the two lakes, respectively. The 2016 Lake Champlain TMDL specifies allowable phosphorus loads, or waste load allocations (WLA), expressed as metric tons per year (mt/yr), for each of the 59 WWTPs that discharge to the lake's watershed. The new TMDLs for total phosphorus

could limit the successful permitting of a new or increased direct discharges from WWTPs. However, where new community wastewater systems are needed, new soil-based wastewater systems may be the only permittable solution.

It is anticipated that CWSRF and USDA-RD loans will be used to meet these and other wastewater infrastructure needs. These dollars, while "available" cannot be considered "free" money, considering that municipalities must get voter approval to bond, to avail themselves of these loans, and are responsible for repayment. This factor is a major strain on the municipalities, especially if voters reject ballot measures to obtain necessary loans, and the lack of funding prevents the communities from making necessary upgrades, retrofits, and repairs. The state treasurer's report also looked at clean water revenues and costs, over a 20-year horizon, as compared to the Act 73 report's five-year horizon. A comparison of the funding gaps projected in these two reports is shown in Figure 3 b. Neither the treasurer's report nor the Act 73 report considered staffing and O&M costs.[15] For the municipal infrastructure sector, using a 20-year timeframe, the treasurer's report projected annual average costs of $43 million, revenues of $30 million, and a gap of $13 million. The Act 73 report, using a 5-year timeframe, projected annual average costs of $35 million, revenues of $29 million, and a gap of $6 million. In order to close these funding gaps, utilities will need to increase rates to cover the cost of operations, maintenance, and capital needs.



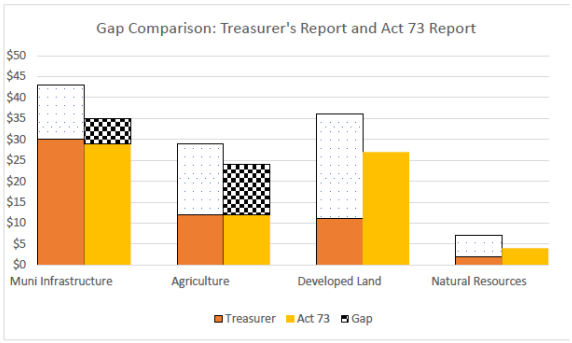


Figure 3. a. Clean water investments by sector; and b. Comparison of funding gaps between the Act 73 report and the Treasurer's report

In terms of assessing Vermont's future wastewater infrastructure, Congress has not provided funding to do the Clean Watersheds Needs Surveys recently, and Vermont is now overdue to perform this survey, and currently lacks relevant CWNS data to show the statewide aggregated need. VT DEC's Facilities Engineering Division (FED), is working on a statewide inventory of wastewater system needs and, once completed, the assessment should provide a clearer picture of the state's needs.[7]

Considering the millions of dollars invested in WWTFs over the years, it is imperative that these investments be protected, otherwise, it is a public health violation waiting to happen.

RESILIENCE

In the aftermath of Tropical Storm Irene of 2011, Vermonters from across the state rallied and collaboratively developed a "Roadmap to Resilience" with 23 recommendations, including recommendations on prioritizing water and wastewater investments.[16] The resilience-driven investments are important in the context of projections of increased precipitation for our region, and the corresponding increases in CSOs. Vermont's 2017 Forest Action Plan noted that the state's annual precipitation is projected to see an increase of 10% by the end of the century, with more frequent and short duration, high intensity rainfall events.[17] This poses a burden on WWTPs,[14] and related infrastructure, especially in communities with combined sewer systems. Additional resilience calls are in the context of the almost 4,000 climate refugees predicted to be concentrated in the Chittenden county area[18], posing a strain on not

just wastewater infrastructure, but other sectors as well. Vermont's State Hazard Mitigation plan (SHMP) of 2018, considers this hazard of sufficient importance to account for it in the next (2023) SHMP.

INNOVATION

A number of innovations of Vermont's wastewater infrastructure are being driven by phosphorus TMDLs, resulting in treatment upgrades at WWTPs. For example, St. Albans City is progressing toward completing a $18 million upgrade and refurbishment project that will add a cloth disk filtration system. This system, the latest in cloth media advancements, is engineered to reduce phosphorus to 0.2 mg/l and possibly lower, making it effective technology for tertiary treatment for phosphorus removal in combination with chemical addition.[19] Many facilities are looking at optimization of their current infrastructure prior to high cost investments to meet the short-term need. Additionally, municipalities are looking towards pollution prevention options and have started surcharge fees to help incentivize pollution prevention. Some are diverting these wastes to composting facilities or other alternative facilities.[9]

In addition, according to the Agency of Agriculture, there are 16 operating manure methane digesters generating electricity and heat in Vermont.[9] Organizations such as Vermont Rural Water Association and Vermont Energy Investment Corporation (VEIC), are working with Vermont's Wastewater Program, to facilitate technical assistance related to optimization of nutrient removal and energy efficiency at wastewater treatment facilities. Diffused air floatation units that remove the phosphorus from separated manure effluent can help make phosphorus a marketable commodity in other markets outside of impaired watersheds. However, development of markets, pricing structures, and issues around storage and transportation will still need to be addressed.

Finally, a "clean water innovation hub" is being considered for Vermont, which involves the creation of a new, third-party, independent and transparent institutional structure or "hub" to support innovation, in achieving the state's clean water goals.

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 funding to safeguard performance of critical infrastructure, and protecting the investments made over time are vital to ensure public health and safety. Fifteen communities in Vermont have combined sewer systems, which cause CSOs during periods of heavy rainfall. The State has proactively started issuing a 1272 Order (which requires the development of a long-term control plan, to manage CSOs, and meet Vermont's WQS) prior to issuing certain NPDES permits, to help municipalities manage frequent CSOs. With mandatory reporting, there is more public awareness of the issue.

RECOMMENDATIONS TO RAISE THE GRADE

Overall, Vermont's wastewater infrastructure is aging, and in need of repairs, retrofits, and upgrades. Whether a municipality is addressing a CSO, trying to meet the phosphorus TMDL, or protecting its prior investments (roughly $100 million for municipal wastewater treatment infrastructure, $24 million in grants under the Ecosystem Restoration Program and $26 million in grants and technical assistance to farmers over a decade through 2017)[20], loan-based funding poses a major burden. Ballot measures and debt considerations for ensuring sound wastewater infrastructure to protect community and ecological health compete with other critical community needs, including the opioid crisis, affordable

housing, education, and others. From FY 2020 through FY 2024, the projected average annual borrowing for wastewater infrastructure in Vermont is $24 million, as noted in the Act 73 report. Concerted efforts are needed to ensure that a systematic needs survey is performed to prioritize the next set of implementation actions, and to provide zero interest loans, or grant funding to protect and maintain critical infrastructure. Innovative solutions and practices must be applauded and advanced, and collaborations, partnerships, and technologies that are building community resilience in the wastewater sector must become common and mainstream. Therefore, Vermont ASCE assigns a grade of D+ to the state's wastewater infrastructure, and recommends the following:

- Congress should provide funding to do the Clean Watersheds Needs Surveys. Vermont is now overdue to perform this survey, therefore no updated CWNS data are available to show the statewide aggregated need.
- Vermont's utilities must be able to set rates to cover the full cost of service, including operation, maintenance, and capital needs.
- The state's WWTF inventory and asset management efforts should be applauded and supported to ensure needed upgrades that are driven by resilience and innovation.
- The ongoing innovation efforts in Vermont's WWTPs being pushed by the phosphorous TMDLs, should be promoted and emphasized.
- Collaborative partnerships must be encouraged and supported to ensure long-term and sustainable management of wastewater infrastructure.

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George is a licensed engineer in the State of Vermont and is currently working as a Project Manager at McCain Consulting, Inc., providing civil engineering and land use planning services across Central Vermont. George has over a decade of experience in engineering design and project management, specializing in on-site solutions for residential & commercial land development projects. George graduated with a master's degree from the University of Vermont, Bachelor's Degree from Clarkson University, and has been active on the Board of Directors for the Vermont Section of ASCE since 2007 including serving as President from 2016-2017. George was recognized as Vermont's 2015 Vermont Young Engineer of the Year

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ABOUT ASCE – VERMONT

The Vermont Section of ASCE was originally founded 1955 and represents around 370 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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