Preliminary Engineering Report for

WASTEWATER TREATMENT PLANT EVALUATION

DANVILLE, VT

June 5, 2024

60% DRAFT

Submitted to:
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1 PROJECT PLANNING AREA

The Project Planning area is within the Town of Danville, Caledonia County, Vermont. The focus of this Preliminary Engineering Report (PER) is the Town of Danville's Wastewater Treatment Facility located at 406 US Route 2 East, Danville, VT. The wastewater collection system for the facility serves the Town of Danville's village area.

The wastewater collection system is comprised of approximately 11,350 linear feet (LF) of gravity collection sewer and manholes, and three wastewater pump stations with 2,120 LF of 2 1/2" and 3" force main. The bulk of the collection system is original to the 1983 system construction, including the Railroad Street pump station. Three expansions to the system were constructed in the early 1990's to serve the Larrabee development, the Sugar Ridge development, and a nursing home east of the WWTF. The Sugar Ridge and nursing home expansions each included construction of a duplex submersible pump station. The service area of the collection system covers an area of approximately 0.42 square miles or 265 acres.

Although the specific focus of this report is the wastewater treatment facility at 406 US Route 2 East the entire collection system will be considered when evaluating future flow and loading projections. Figure 1 in Appendix A provides an outline of the service area and notes the location of key wastewater infrastructure.

1.1 ENVIRONMENTAL RESOURCES

If any recommendations include expansion of the WWTF site into currently undeveloped areas existing environmental resources must be considered. Even without an expansion of the existing footprint of the facilities, is emphasized that control of the liquid and solid byproducts of the facility are critical to mitigating negative impacts to the receiving waters of the Water Andric, or to the sites receiving the facility's sludge. Effluent limitations and monitoring requirements referenced herein are as provided by the Facility's NDPES permit, No. VT0100633.

1.2 GROWTH AND POPULATION TRENDS

A review of the census data for the period 1990 – 2020 shows a slight increase in the Town of Danville's population with the current population exceeding previous estimates of growth. The most recent census data for the Town indicates a total population of 2,335 residents, exceeding published growth projections by approximately 87 residents. This is most likely attributed to growth in rural areas resulting from the COVID-19 pandemic in 2019 and 2020.

Although census data for the Town provides a useful metric, the wastewater collection service area is more closely represented by the village area and the census designated place (CPD). In 2010 the CDP had a population of 383 residents, increasing to 385 in 2020, with the most recent estimates indicating a population of 416 residents.

Considering the historical population data, and the sewer system service area, there is the possibility that the wastewater collection system could be expanded into currently unserved areas, or into future developments. There are currently 9 undeveloped lots in the Larabee development between US 2 and Walden Hill Road that are approved for connection to the wastewater system. The allocation for these undeveloped lots is 3,780 gallons per day. Additional infill beyond these lots is possible within the sewer service area.

1.3 COMMUNITY ENGAGEMENT

The Town of Danville was established in 1786 and is governed by a selectboard who are responsible for managing the municipal services within the Town including the department of public works, emergency services, and wastewater services. The selectboard is made up of 5 elected members serving either a 3-year, or 1-year term. The Town also staffs a selectboard assistant. Public selectboard meetings are held on the first and third Thursdays of each month at the Danville Town Hall.

1.4 EXISTING FLOW

Currently the wastewater treatment facility serves approximately 160 connections categorized as indicated by Table 1-1below.

Table 1-1: Town of Danville Wastewater Connections

Description	Units Per Category	Connections per Category
Apartment House (per unit)	34	10
Base Commercial (per unit)	20	18
Beauty Shop (per chair)	4	2
Church (per unit)	2	2
Grocery/Mini-Mart (per unit)	1	1
Health Center (per unit)	3	3
Office Space (per unit)	6	4
Restaurant (per Seat)	133	5
School w/caf & gym (per student)	485	1
Single Family (per unit)	115	109
Senior Housing (per unit)	19	2
Service Stations (per unit)	1	1
Non-food retail (per unit)	2	2
Total Sewer System Connections		**160**

Based on monthly effluent flow data reported by the facility for the period January 2018 through October 2023, the average daily flow through the facility is 0.035 MGD, approximately 58% of the 0.060 MGD design flow of the facility.

For the period January 2018 through June 2023 the highest maximum day flow was 0.087 MGD. In July of 2023 a maximum effluent flow of 0.132 was recorded as a result of an unusually wet July which resulted in significant flooding throughout the State, and damage to the Water Andric flow monitoring station.

1.5 PROJECTED FLOW

Between 2010 and 2020 the Village population grew from 383 to 416 which represents a rate of growth of less than 1 percent per year. If the growth rate from 2010 to 2020 is projected for the next 20 years, the population would be approximately 488 or an increase of 72 residents. It is expected that some of this increase would be due to development of housing on already approved lots, as noted above, and therefore the estimated flow from those lots it not considered separately. At a per capita estimated wastewater use of 70 gallons per day, this would increase the flow to the wastewater treatment plant by 5,040 gallons. This increase in flow is within the existing plant capacity and available hydraulic reserve. Should specific projects be pursued in Town with greater contribution to the wastewater treatment facility, they will need to be reviewed on a case-by-case basis to confirm capacity in the system exists and identify any collection or treatment system impacts the project may have.

2 EXISTING FACILITIES

2.1 COLLECTION SYSTEM

As previously discussed, the bulk of the collection system was constructed along with the wastewater treatment facility in the early 1980's. Construction is of modern means and methods and utilizing industry standard materials which today are still well within their expected useful lifespan.

The gravity portion of the collection system is comprised of approximately 47 precast concrete manholes, PVC gravity sewer main, and ductile iron gravity sewer main. In addition to the gravity sections of the system, three duplex submersible pump stations are located at local low points with associated PVC force mains. Evaluation of the collection system condition and associated pump station was not included as part of the development of this report, but the collection system was thoroughly inspected by R. Allyn Lewis, P.E. in 2003 and noted to be in excellent condition. A map of the collection system is included in Appendix A.

In 2003, the pump stations were also inspected. Recommendations for improvements of the Railroad Street station were made, but the Sugar Ridge and Nursing Home pump stations were noted to be in very good condition. Pump stations are critical to sustainable operation of the collection system and should be inspected regularly. It is typical for controls, monitoring systems, and pumps to be upgraded every 10 – 15 years. Considerations should also be made for emergency operation in the event of a power outage by providing the ability to connect standby generator power, or through available wastewater storage in the wet well or adjacent tankage.

2.2 WASTEWATER TREATMENT FACILITY

2.2.1 HEADWORKS

The existing headworks infrastructure is comprised of an open channel containing a rock/grit trap, a 1-1/2" manual bar screen, a Parshall flume, and diversion valves for flow control to lagoon #1 or lagoon #2.

It is noted that the facility does not seem to have a significant problem with the functionality of the headworks and that the manual bar rack is reported to be adequate to prevent excessive accumulation of wipes and rags in the lagoons. The manual bar screen is cleaned daily, and there are no concerns with the current condition of the channel or the screen structure. Although the flume is installed for flow measurement, a level sensor is not installed, and influent flow is not normally recorded at the facility.

2.2.2 Aerated Lagoon System

The Danville WWTF contains two lagoon ponds of identical size which can be isolated to provided independent, individual, or series operation. Each lagoon is of inverted trapezoidal shape with a sidewall slope of 1 foot vertical on 3 feet horizontal. The base of each lagoon is approximately 137 feet long by 36 feet wide. At maximum water depth the lagoons are approximately 238 feet long by 140 feet wide. Each lagoon cell is lined with a 36 mil Hypalon reinforced plastic liner covered with sand and crushed stone. Below the liner each lagoon contains an underdrain system to maintain consistent foundation conditions.

Lagoon #2 can be divided into two sections by a floating baffle to create two individual cells. During normal operation the lagoons are operated in series and the lagoon #2 baffle is utilized to create cell #2 and cell #3. Cell #3 is provided with less aeration and mixing to allow final settling and clarification of the system effluent.

Each lagoon contains Environmental Dynamics, Inc. FlexAir advanced membrane diffuser systems for aeration and mixing. The diffusers are located within each lagoon with cables and connected by HDPE aeration piping fed from the blowers in the main control building. The existing diffusers were installed as part of an upgrade in 2001 to replace the original LaSaire diffusers.

Aeration is provided by two Gardner Denver positive displacement 10 hp blowers in the main control building. One of the blowers is original to the facility and has been rebuilt, and the second blower was replaced in 2016. One blower is utilized at a time and the blowers are alternated to balance wear. A VFD has been installed on the lead blower allowing for a speed reduction to optimize performance and provide a power usage cost savings.

The lagoon levels and discharge flows are controlled by Vulcan telescoping valves contained in the control structure PMH 3. These valves can be operated independently to control the water level in each lagoon and the flow from each lagoon to the disinfection chamber. Although the valves are original, they are operable and in fair condition.

In 2021 excessive weed growth was observed in lagoon #2 causing frequent cleaning of the lagoon's telescoping effluent valve and the UV system. The operator was unable to determine the cause at that time, but this issue has not occurred since.

2.2.3 Ultraviolet Disinfection

After biological treatment and clarification in the lagoons the wastewater flows through the effluent control valve structure, PMH 3 and into the ultraviolet disinfection system. The system is housed underground in a tri-level concrete access structure. The structure is comprised of access stairs, and landings, for safe operator access and inspection. In the center of the structure is an opening that passes through all levels and the roof that can be utilized to remove and replace equipment to the lower level.

On the lower level of the disinfection building are housed two UV systems in parallel. The systems are Aquafine Corporation RBE-8 with individual control panels. The UV systems were upgraded in 2004, but the existing units and panels are showing signs of wear. Wastewater flows through one of the two UV units where disinfection of the effluent takes place before the flow moves into an open effluent trough with v-notch weir. Located above the weir is a level transducer to monitor and record effluent flow.

Effluent piping in the UV building is PVC and contains PVC isolation valves for each of the UV units.

2.2.4 SLUDGE MANAGEMENT

Sludge levels in the lagoons are monitored and sludge is removed infrequently in a bulk process. Historically, sludge has been stabilized with the application of lime and transported to local farm fields for land application. The land application process has taken place through coordination with the Town of St. Johnsbury. Since the last sludge removal evolution in 2002, St. Johnsbury has discontinued their land application program as a result of accumulated PFAS/PFOA.

In 2022 sludge depths were utilized to estimate the total volume of sludge to be removed. The volumes are as noted below:

- Cell #1 – 153,560 gallons
- Cell #2 – 38,048 gallons
- Cell #3 – 54,406 gallons

It was noted that in 2002 approximately 140,000 gallons of liquid sludge was removed from lagoon/cell #1.

2.2.6 CONTROL BUILDING

The control building contains the maintenance and storage garage, office, laboratory, blower room and mechanical equipment. The control building is a small structure that does not have full-time use. The building overall has been well maintained however, much of the electrical and HVAC equipment in the building is original and is recommended for replacement in the review completed by Engineering Services of Vermont, LLC.

2.3 FLOW, WASTE STRENGTH, AND PERFORMANCE

2.3.1 ORIGINAL DESIGN CRITERIA & PERMIT LIMITS

Table 2-1 below is provided to summarize the original design criteria of the facility based on the 1981 WWTF O&M Manual by Dufresne Henry. Original flows and loadings were based on a per capita method of a facility serving 672 persons with BOD loading of 0.17 lb/person/day and TSS loading of 0.20 lb/person/day.

Table 2-1: WWTF Design Criteria

Item	Design Year Conditions
Average Daily Flow (ADF)	0.060 mgd
Peak Flow	0.192 mgd
Biochemical Oxygen Demand (BOD_5)	115 lbs/day – 230 mg/L
Total Suspended Solids (TSS)	135 lbs/day – 270 mg/L

Notes:
1. Flows and loadings are as provided in the 1981 O&M Manual for the Danville WWTF.

Table 2-2 below provides a summary of the permit requirements as outlined by the facility's authorization to discharge under Permit No. VT0100633 dated September 30, 2021. In accordance with the permit the Town is authorized to discharge to the Water Andric effluent that is in compliance with the limitations presented below.

Table 2-2: NDPES Permit Requirements

Effluent Characteristic	Average Monthly	Weekly Average	Maximum Day	Instantaneous Max
Flow	0.060 MGD	-	-	
Ultimate Oxygen Demand (UOD)	As necessary to meet the Vermont Water Quality Standards			
Biochemical Oxygen Demand (BOD_5)	30 mg/l (15 lbs/day)	45 mg/l (22.5 lbs/day)	50 mg/l	
BOD_5 Removal	≥85%			
Total Suspended Solids (TSS)	30 mg/l (15 lbs/day)	45 mg/l (22.5 lbs/day)	50 mg/l	
TSS Removal	≥85%			
Settleable Solids				1.0 mL/L
E. Coli		-		77 colonies/100ml
pH	Between 6.5 and 8.5 SU			

Notes:
1. Limitations are as provided by the Town of Danville NDPES Permit # VT0100633, amended effective date January 17, 2018.

In addition to the limits presented in Table 2-2, effluent monitoring and reporting for Total Phosphorus (TP), Total Nitrogen (TN), Total Kjeldahl Nitrogen (TKN), Nitrate + Nitrite (NO_x), and Ammonia (NH_3) is required.

In accordance with the discharge authorization the facility must also monitor the streamflow in the Water Andric daily from June 1st through September 30th of each year. The effluent flow must then be adjusted as necessary to not exceed allowable discharge volume as defined in the NDPES permit. The calculation for allowable flow considers the effluent BOD_5 concentration, effluent TKN concentration, and base flow of the receiving water. To account for restricted flow periods, the lagoons were designed with approximately 21 days of additional storage beyond the normal operating level of the lagoons.

2.3.2 Flow

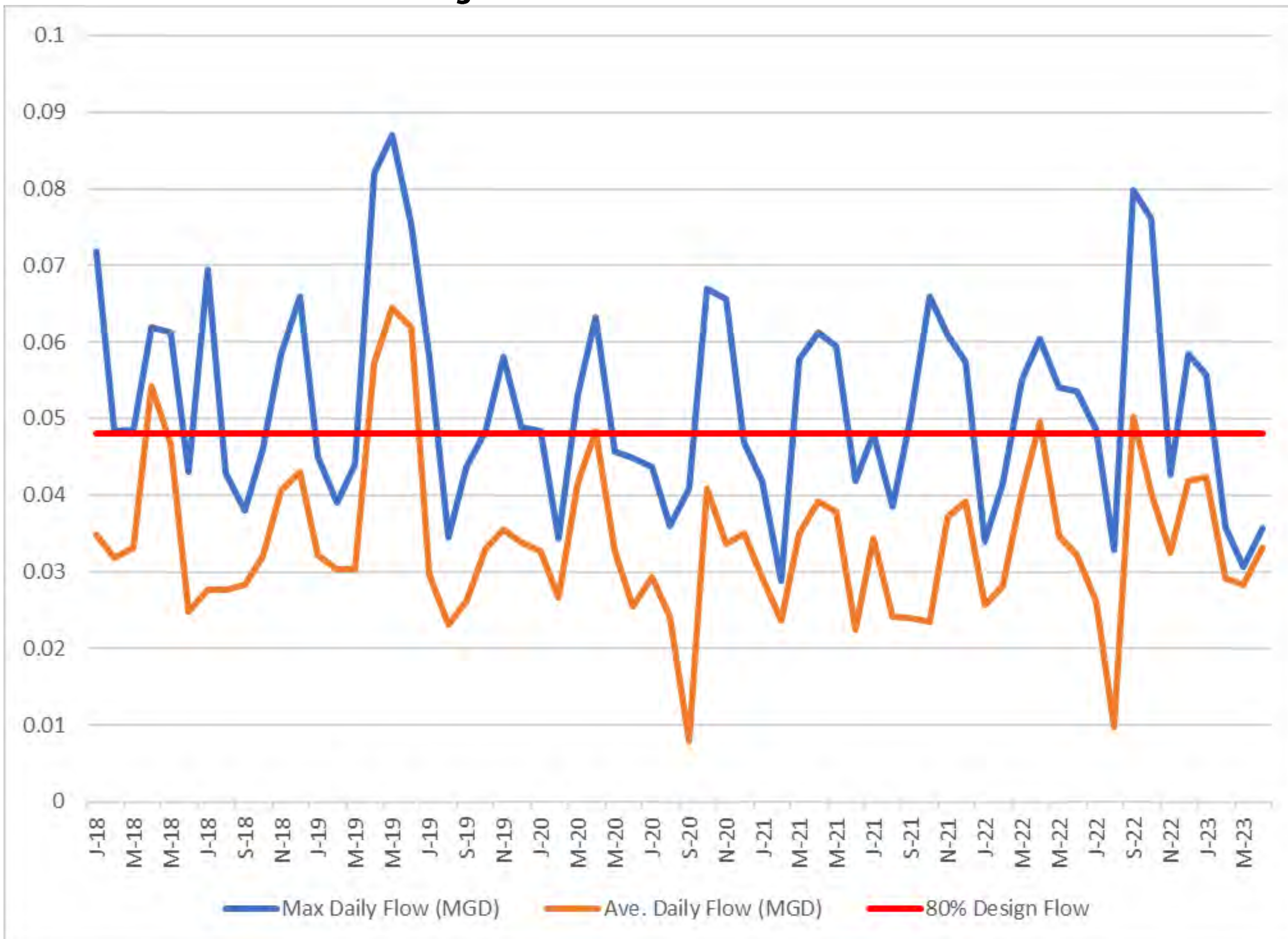
Although the headworks is equipped with a Parshall flume, a meter is not installed in the flume and the influent flow is not monitored or recorded. The Town is in the process of obtaining equipment to measure the influent flow. Only effluent flow is monitored and recorded using the v-notch weir in the disinfection chamber effluent trough. Figure 2-1 below provides a summary of the facilities average monthly and maximum monthly flow for the period January 2018 through June 2023. For this period, the average daily flow is 0.034 MGD, roughly 57% of the design ADF of 0.060 MGD. During the review period, the highest daily flow observed was 0.087 MGD in March of 2019. The installation of influent flow monitoring equipment will provide more a more accurate picture of flow into the plant.

Based on the data presented in the Danville Wastewater Treatment Facility operation and maintenance manual the peak hourly flow is 192,000 gallons per day, equating to a peaking factor for peak hourly flow and average daily flow of 3.2. The data reviewed indicates a maximum day to average day peaking factor of approximately 2.5. Both of these factors are considered within the typical range for a plant of this type and size.

As noted by the special conditions section, paragraph A, 5 of the NPDES permit, once a facility reaches 80% of its design flow or design loading capacity for 90 consecutive days, additional studies of capacity, expansion, or optimization can be required by the State to ensure sustainability of the facility to reliably meet the permit limitations. During the review period April 2019 through June 2019 monthly ADF exceeded the 80% for 92 consecutive days. Since that period, the monthly average daily flow has only exceeded the 80% threshold three times, none of which were consecutive. The 2019 data was due to an unusually wet spring combined with significant snowmelt. During this three-month period, 15.85 inches of rain fell at the facility equating to approximately 644,916 gallons of direct rainfall collected by the lagoons. Over 92 days, which is approximately 7,010 gallons per day. Deducting this direct rainfall average from the ADF would pull many of the days in April and May below the 80% threshold. Based on the facility performance, and the additional storage capacity provided within the lagoons, capacity is not currently considered an issue under existing flow and loading conditions.

When determining the available reserve hydraulic capacity at the facility, the 80% design ADF threshold of 0.048 MGD is compared to the average flow for the review period of 0.034 MGD. The resulting difference is an estimated 14,000 GPD of available hydraulic reserve capacity at the facility.

Figure 2-1: WWTF Effluent Flow



2.3.3 Biochemical Oxygen Demand (BOD_5)

For the review period January 2018 – June 2023 the average BOD_5 loadings were 73.5 lbs/day, which is approximately 64% of the design capacity of 115 lbs/day. It is noted that the average influent BOD_5 concentration is 262 mg/l, which is slightly higher than what would be considered typical for municipal wastewater influent strength. Expected influent BOD_5 concentrations for municipal wastewater are 200 – 250 mg/l. The higher strength observed in Danville is likely attributed to several food preparation facilities including restaurants and a deli. It is also noted that there is no significant trend attributed to influent waste strength, however and the average levels remain consistent with historical data.

The facility consistently meets the permit limitations for effluent BOD_5 strength. During the review period, the average effluent strength was 8.3 mg/l, with an average 96.4% removal rate. The lowest percent removal rate observed in the data period was 85.8%.

BOD_5 and TSS influent concentration, effluent concentration, and percent removal are illustrated in Figures 2-2, 2-3, and 2-4.

2.3.4 TOTAL SUSPENDED SOLIDS (TSS)

For the review period January 2018 – June 2023 the average TSS loadings were 65.4 lbs/day, which is approximately 48% of the assumed design capacity of 135 lbs/day. It is noted that the average influent TSS concentration is 228 mg/l, which is within the expected range for municipal wastewater influent of 200 – 250 mg/l.

During the review period, the average effluent concentration was 5.61 mg/l, with an average 96.9% removal rate. The lowest percent removal rate observed in the data period was 88.1%.

BOD_5 and TSS influent concentration, effluent concentration, and percent removal are illustrated in Figures 2-2, 2-3, and 2-4.

Figure 2-3: Average Monthly Influent BOD & TSS Concentrations

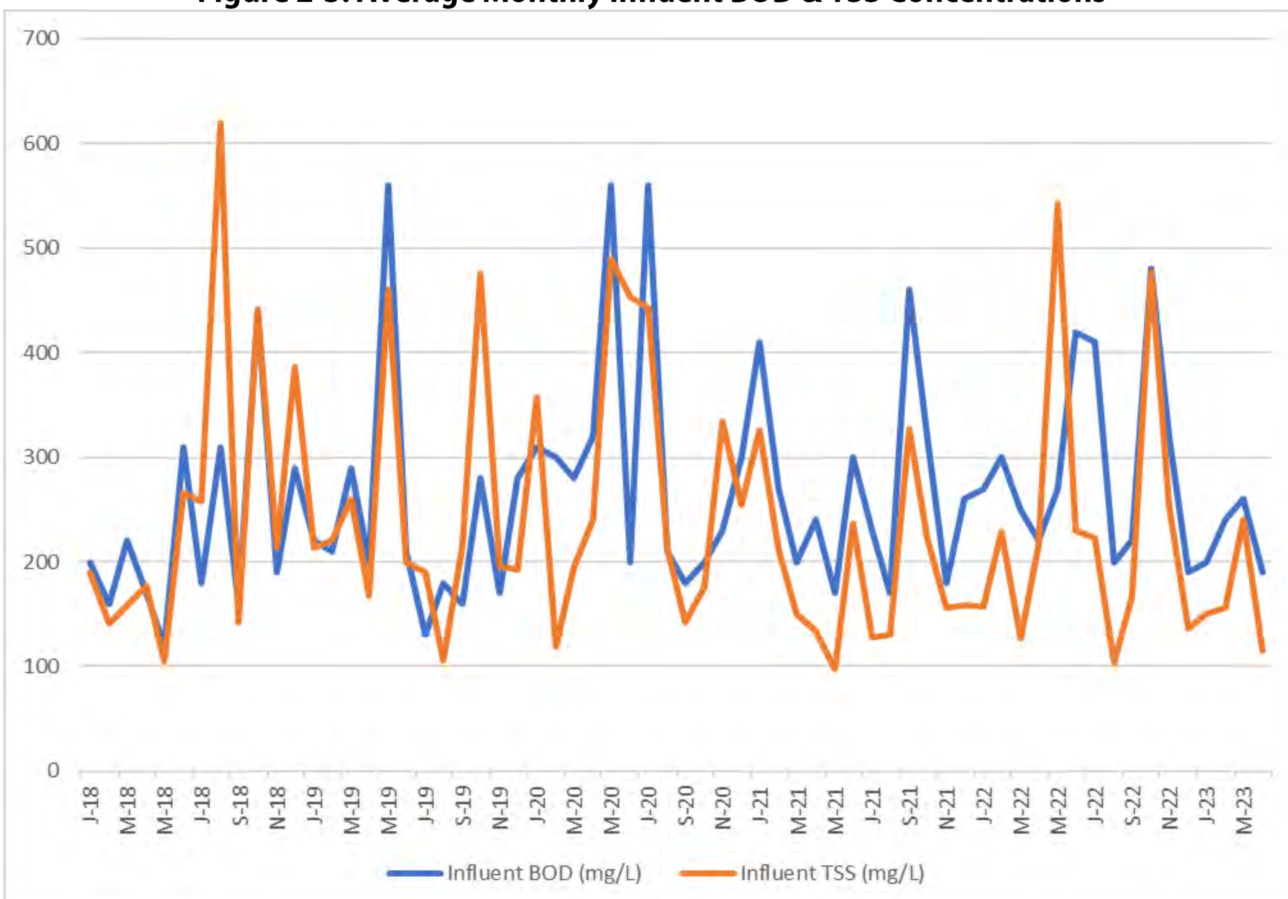


Figure 2-3: Average Monthly Effluent BOD & TSS Concentrations

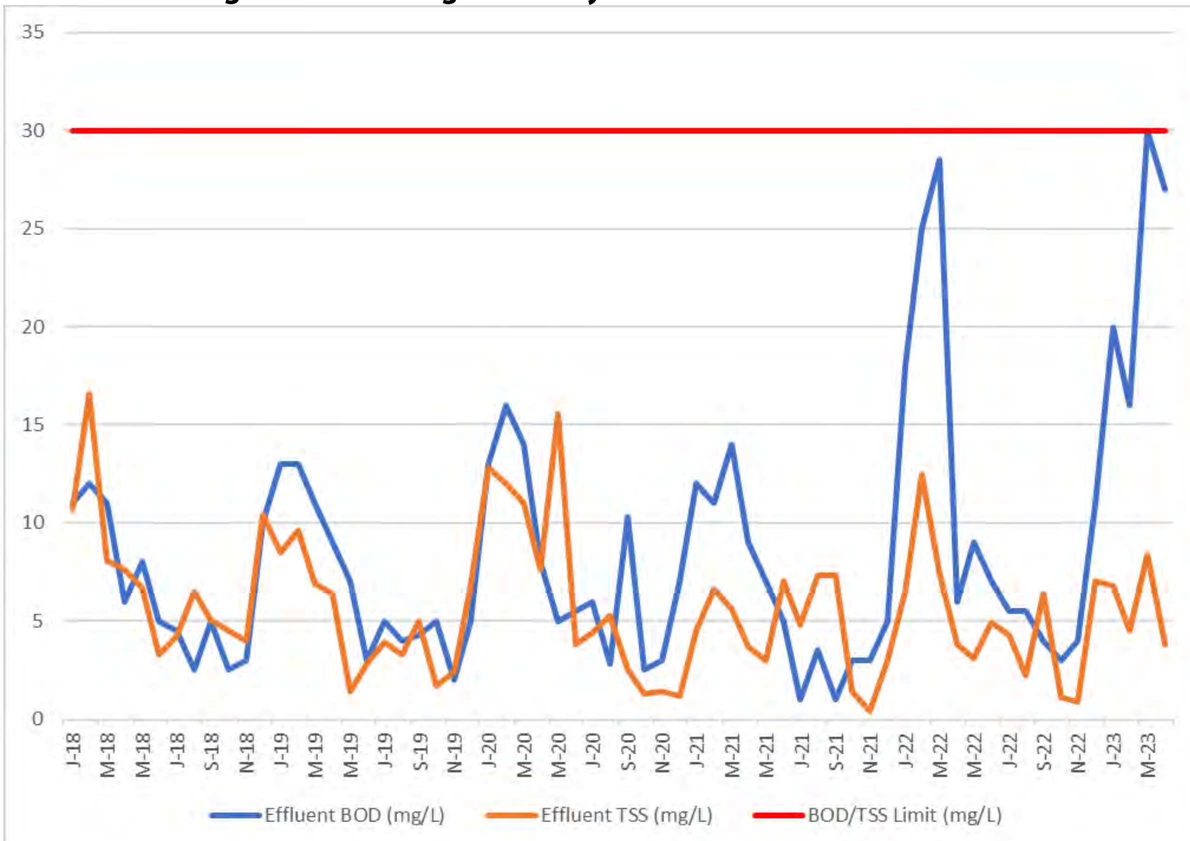
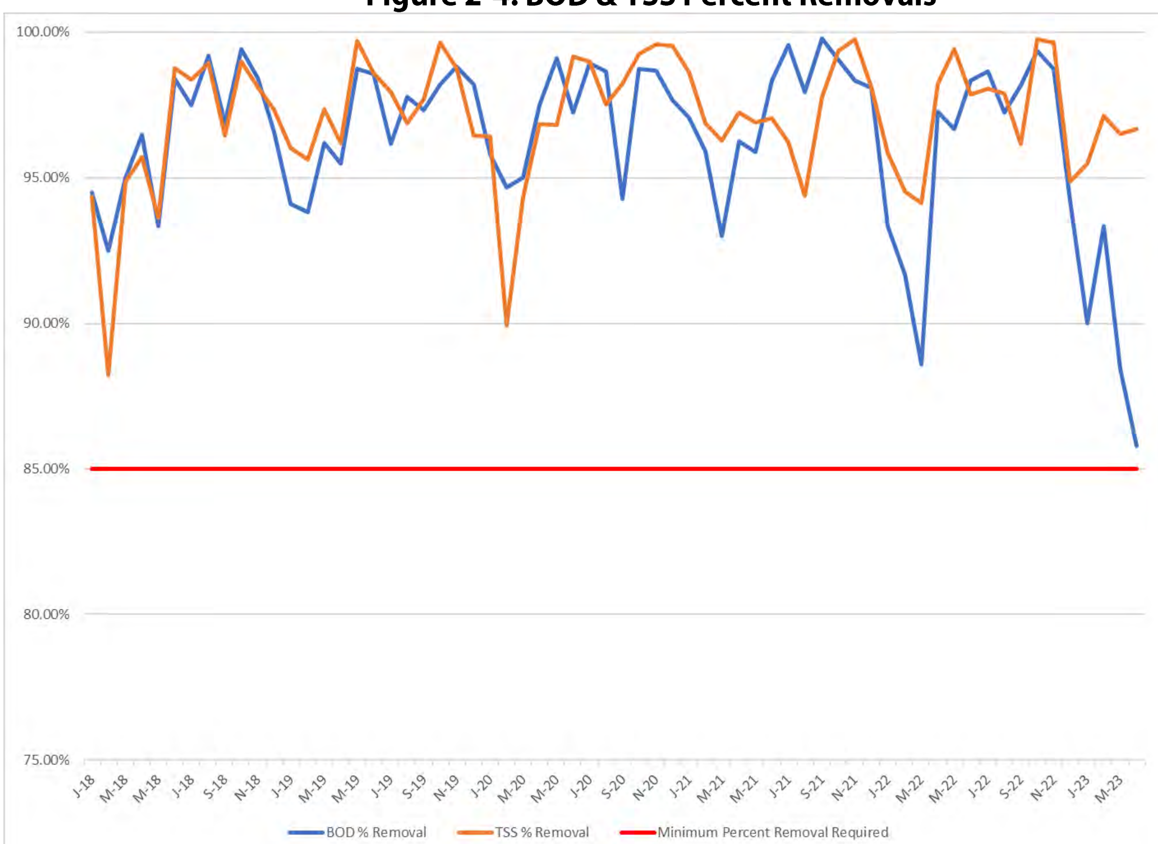


Figure 2-4: BOD & TSS Percent Removals

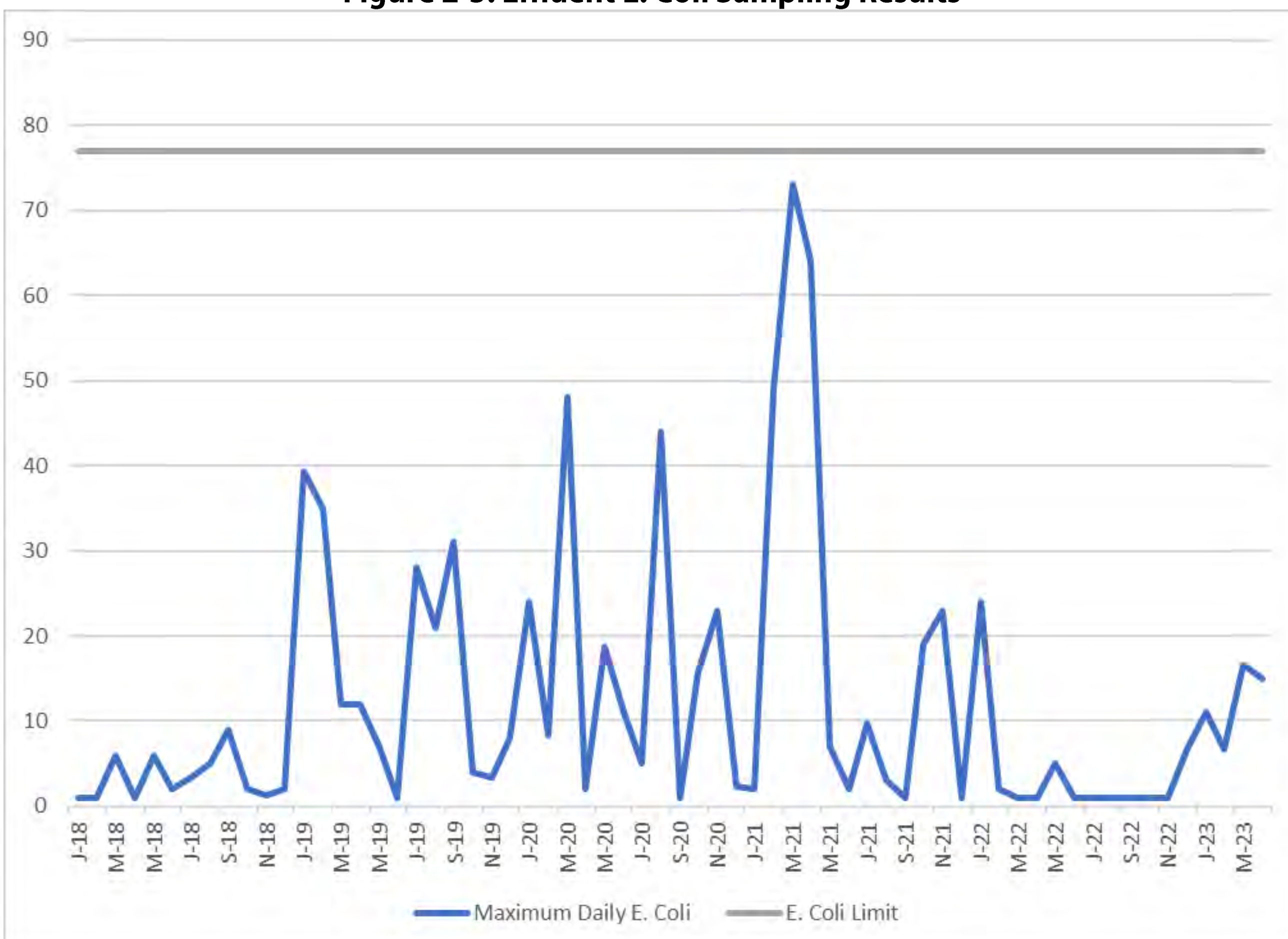


2.3.5 E. Coli

Effluent Escherichia Coli bacteria (E. Coli) counts are performed twice per month as a demonstration of the disinfection achieved by the facility. The NDPES permit includes an instantaneous maximum limit of 77 colonies per 100 mLs. Over the review period the average E. coli count was 11.8 colonies per 100 mLs, and the maximum observed count was 73 colonies per 100 mLs.

Figure 2-5 illustrates the effluent E. Coli performance of the facility showing the instantaneous maximum colony count permit limit.

Figure 2-5: Effluent E. Coli Sampling Results

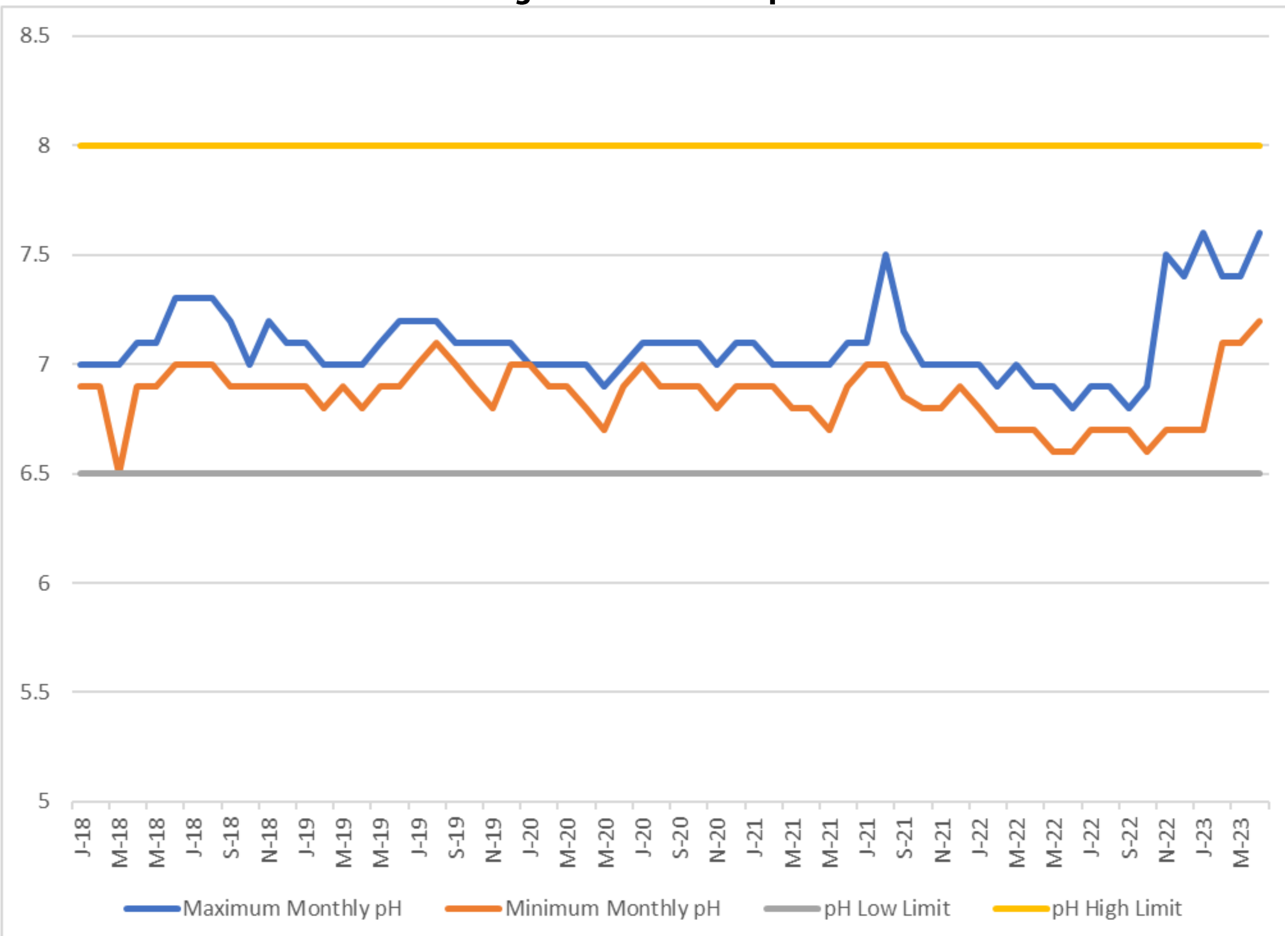


2.3.6 pH

Effluent pH is monitored with daily grab samples. The minimum and maximum pH for each month were reviewed and are shown on Figure 2-6 along with the NDPES permit limits of

6.5 and 8.5 standard units. As shown, there have been no permit exceedances in the data review period.

Figure 2-6: Effluent pH



2.3.7 Future Water Quality Limits

As part of this study, Randy Bean of RAB Consulting & Services reviewed the existing performance of the wastewater treatment plant against current and anticipated future water quality limits for ammonia and phosphorus. A summary of the findings is presented below. More detailed information is included in Appendix B.

The receiving water for the wastewater treatment plant discharge is the Water Andric which is classified as a "Small High Gradient" stream with the following characteristics.

Table 2-3: Water Andric Characteristics

Period	Critical Instream Flow (CFS)	Discharge Instream Waste Concentration
Summer 7Q10	0.60	0.1340
Winter 7Q10	0.93	0.0910
Summer 30Q10	0.74	0.1120
Winter 30Q10	1.30	0.0670
Summer Low Median Monthly	1.18	0.0732

The current ammonia and phosphorus discharges to the Water Adric were reviewed against water quality regulations.

Ammonia is a pollutant that impacts aquatic organisms. Temperature of the receiving water impacts sensitivity with higher temperatures and higher pH during the summer resulting in greater effects. Due to this, the Agency of Natural Resources has historically established summer and winter limits. A summary of the resulting instream ammonia concentrations and in-stream capacity of the Water Andric are presented in Table 2-4 below.

Table 2-4: Ammonia Discharge Concentrations

Period	Avg Effluent Ammonia Discharged (mg/L)	Avg Ammonia Mass Loading Discharged (lbs/day)	Chronic Assimilative Capacity in Water Andric (lbs/day)	Acute Assimilative Capacity in Water Andric (lbs/day)
Summer (June - Sept)	19.1	4.8	2.51	11.67
Winter (Oct-May)	21.5	6.2	13.11	42.02

As shown in Table 2-4, the Danville wastewater treatment facility meets the capacity in the Water Andric during the winter months but exceeds the chronic capacity during the summer months. Therefore, any planned upgrades to the facility should include some treatment for ammonia during the summer months.

Excessive phosphorus in surface water bodies, typically in the summer months, contributes to eutrophication, the overgrowth of aquatic plants, algae and bacteria. The current discharge of phosphorus in the Water Andric is not violating the Vermont Water Quality Standards or causing or contributing to eutrophication in the Water Andric at the current average day flows. However, when additional water quality standards such as the "EPA Quality Criteria of Water 1986" (aka Gold Book) are considered and the potential for increased flow, Phosphorus discharges may have an impact to the water quality in the Water Andric. Therefore, providing for future phosphorus treatment with any plant upgrades is recommended. Phosphorus data is shown below in Table 2-5.

Table 2-5: Phosphorus Discharge Concentrations

	At 0.030 MGD	At 0.060 MGD
Avg Total Phosphorus Concentration (mg/L)	3.29	
Avg Total Phosphorus Effluent Mass Loading (lbs/day))	0.87	
Average instream Total Phosphorus (mg/L)	0.125	2.41
Gold Book Recommended Standard (mg/L)	0.1	

Based on the current and future nutrient analysis by RAB Consulting, including ammonia and the option for future phosphorus treatment at the Danville Wastewater Treatment Plant is recommended.

2.4 EXISTING FACILITIES EVALUATION

An evaluation of the process systems at the Danville WWTF was performed in comparison to modern design criteria as outlined in the "Recommended Standards for Wastewater Facilities (2014 edition)", "TR-16, Guides for the Design of Wastewater Treatment Works" (2016 edition), and the Vermont Wastewater System and Potable Water Supply Rules (2020 edition).

The following subsections and narratives provide an overview of the adequacy and deficiencies of facility systems relative to noted key design criteria.

Functionality of subsystems are reviewed relative to the original design parameters of the facility, existing design parameters, and future design parameters. A summary of flows and loadings is provided by Table 2-6.

Table 2-6: Danville WWTF Flows and Loadings

Item	2023 Conditions	Original Design Conditions - 1981
Influent Flow		
Average Daily Flow (ADF)	0.034MDG	0.060 MGD
Peak daily Flow (PDF)	0.087MGD	---
Peak Hourly Flow (PHF)	---	0.192 MGD
Influent Loadings		
Biochemical Oxygen Demand (BOD_5)	75 lbs/day – 262 mg/l	115 lbs/day – 230 mg/l
Total Suspended Solids (TSS)	65 lbs/day – 228 mg/l	135 lbs/day – 270 mg/l

2.4.1 HEADWORKS

Equipment & Status Summary

The existing headworks system is limited to a single channel exterior to the main control building including a rock/grit trap, manually cleaned bar screen, and Parshall flume.

Operators report that the screen is cleaned daily, and the stone trap as required. There are no operational complaints or significant conditional issues with the headworks channel at the Danville facility. A summary of the design criteria, existing equipment and any deficiencies is included in Table 2-7 below.

Table 2-7: Headworks Equipment Evaluation

Equipment	Design Criteria	Existing Conditions	Deficiency
Screens (Manually Cleaned)	Clear openings of 1-2 inches	1.5-inch openings	None
	Slope of 30-45 degrees	30-degree angle	None
	Bypass provided	6-inch diameter bypass	None
Grit Removal	Placed based on effects of grit on downstream equipment	Stone trap	Adequate for existing process

Figure 2-7: Headworks Channel & Influent Sampler

2.4.2 Aerated Lagoon System

Equipment & Status Summary

The existing lagoon structure appears to be in good condition with no reported concerns associated with the aeration diffusers, piping, or lagoon liners. The blower systems function properly and appear in fair condition. The telescoping valves to control the lagoon levels are reported as operable and in good condition. At design average day flow and a 10-foot operating depth the lagoons have a hydraulic residence time (HRT) of 27 days and accommodate an additional 21 days of storage for dry weather flow periods. Under current average day flow conditions, the HRT is approximately 44 days. The additional storage is necessary to meet the NDPES permit ultimate oxygen demand (UOD) limitations based on the baseline stream flow of the Water Andric during the summer months (June 1st through September 30th). To meet this requirement, the UOD of the wastewater is calculated based on the most recent BOD_5 and TKN measurements. The wastewater UOD is them compared to the daily streamflow and if necessary, the facility effluent discharge is limited using the PVC ball valves in the disinfection vault to maintain stream health.

As discussed above, the secondary treatment provided by the lagoons has been consistently acceptable based on historical performance relative to permit limits.

Sludge depths have been monitored and recent measurements indicate approximately 155,000 gallons of sludge is present in lagoon #1, with an additional 95,000 gallons in lagoon #2. Sludge depths and volumes indicate that the Town should be planning for a significant sludge removal evolution in the next year or two. A summary of the design criteria, existing equipment and any deficiencies is included in Table 2-8 below.

Table 2-8: Lagoon Evaluation

Equipment	Design Criteria	Existing Conditions	Deficiency
Lagoon	Length to width ratio between 2:1 and 4:1	Length to width ratio is 3.8:1	None
	Minimum of two lagoons capable of parallel operation	Two lagoons provided	None
	Capable of isolation of any cell	Isolation possible	None
	Hydraulic Retention Time (HRT) of typically 20-40 days	Design HRT 27 days, at average day flow HRT is 44 days	None
	Aeration capable of providing 3 lbs of O_2 per lb BOD	Current system provides 4 lbs O_2 per lb BOD	None
	Freeboard 3 feet	Under peak flow, freeboard is approximately 7 feet. During storage, freeboard is approximately 3.1 feet	None
	Side slopes between 1:2.5 and 1:4	Side slopes are 1:3	None
	Depth of 10-20 feet	Operating depths are 10-14 feet	None
	Inlet piping at 1/5 - 1/3 total water depth but not less than 2ft above floor	Inlet piping is 2.1 ft above floor	None

Figure 2-8: Lagoon #2

Figure 2-9: Aeration Blowers & Discharge Manifold

2.4.3 Ultraviolet Disinfection System

Equipment & Status Summary

The existing UV disinfection systems have reached the end of their expected useful lifespan and are in need of replacement. Although they have maintained adequate performance as demonstrated by the e-coli sampling results of the facility, spare parts are difficult to find, and the control panels are showing significant signs of age.

Although the UV disinfection building is in fair condition, and access is reasonable with the use of stairwells and railings, the UV control panels are located on the lowest level and evidence of significant condensation causing corrosion is apparent. It is believed that the open effluent channel allows condensation to build up within the structure leading to corrosion of steel components including electrical conduit, fixtures, and handrails. A summary of the design criteria, existing equipment and any deficiencies is included in Table 2-9 below.

Table 2-9: UV Disinfection System Evaluation

Equipment	Design Criteria	Existing Conditions	Deficiency
Ultraviolet Disinfection	Provide minimum UV dose at average and peak flows	UV system design flow is 100 gpm, plant peak hourly flow is 66 gpm	None
	Deliver design dose at peak flow with one module out of service	Two units, capable of treating 100 gpm, 30 mg/L TSS and 30 mg/L BOD to 77 counts of e. coli per 100 ml are provided.	None
	Backup electrical supply required	No standby generator but flow is stopped by a solenoid valve during power outages	A waiver may be required
	UV Intensity meter for each module	Each module has an intensity meter	None
	Alarm when UV intensity drops below 80% original output	Alarm provided when intensity drops below 80%	None
	Lamp status display	Lamp status display provided	None
	Sufficient exposure time provided during peak flow	Historical performance during normal flow conditions have shown adequate disinfection. Performance under peak flow conditions has not been analyzed.	Verification of adequate disinfection during peak flow conditions recommended.

Figure 2-10: UV Disinfection Systems & Control Panels

2.4.4 CONTROL BUILDING AND SUPPORT EQUIPMENT

Equipment & Status Summary

Although much of the facility's control building is original, the structures and systems have been well maintained. The buildings exterior has been refreshed recently with new paint and a new roof. The gravel access roadway and parking areas are maintained on a regular basis by the Town's Road crews.

Heating, ventilation, electrical and air condition systems were reviewed by Engineering Services of Vermont (ESV), a summary report is included as Appendix C of this PER. In summary, the electrical heating systems should be replaced, along with much of the ventilation system infrastructure. Significant electrical improvements should also be considered. ESV recommends replacement of both of the facility circuit panels, raceway replacement, lighting upgrades, the installation of a standby generator, installation of GFCI outlets, and the installation of emergency lighting in the blower room. It is also recommended that the autodialer alarm system be replaced and modernized to include more information as part of an alarm callout than just one general alarm signal.

The effluent v-notch weir and level transducer are in fair condition and operate reliably.

During the flooding in July of 2023 the Water Andric monitoring weir was buried in sediment. In February of 2024 the weir was relocated and dredged. The system remains in fair and operable condition but should be regularly dredged to maintain reliability.

Figure 2-11: Control Building

Figure 2-12: Electrical Service & Water Heater

Figure 2-13: Alarm Autodialer

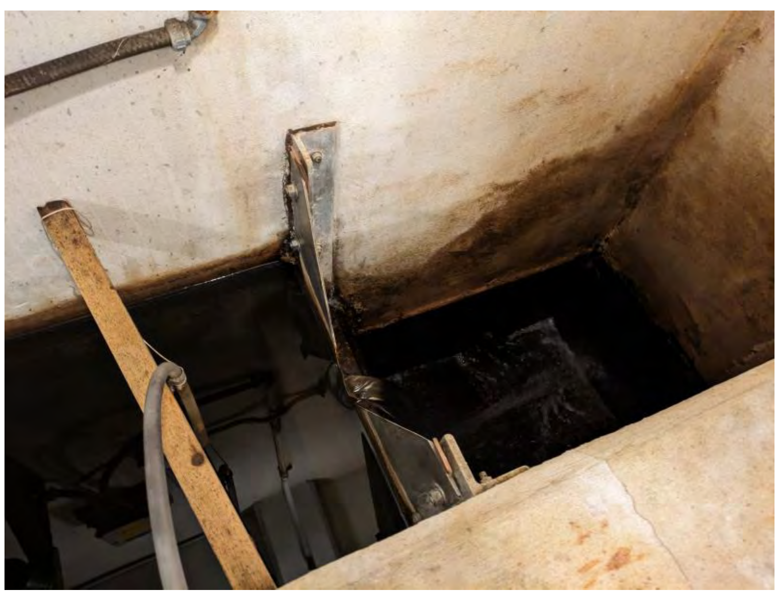


Figure 2-14: Effluent V-Notch Weir

2.5 FINANCIAL STATUS OF EXISTING FACILITIES

The Town of Danville collects revenue based on budgeted wastewater fund expenditures including contributions to long term maintenance or capital investment per user connection based on the rates established for each connection type, refer to Appendix D.

Based on the 2022-2023 town of Danville sewer budget, $92,446.00 of total revenue is projected to be collected, $79,196.00 through the collection of user fees. Expenditures are anticipated to total $84,246.00 leaving a net positive income to the sewer fund of $8,246.00. The income is normally transferred into seven accounts associated with the collection system, treatment facility, or sludge removal funds. At 2022 year end the accounts had a total balance of $152,000.88 of which $40,813.38 of this is dedicated to sludge removal.

There is no long-term debt currently associated with the Town's wastewater system.

There have not been any waste or energy audits recently performed to reference as part of this PER.

3 NEED FOR PROJECT

3.1 HEALTH, SANITATION, AND SECURITY

Maintaining the effective performance of the wastewater collection system and wastewater treatment facility is critical to sustaining environmental health. Without the sustainable performance of the collection system uncontrolled discharges of untreated wastewater could occur exposing the public and environment to unnecessary health hazards. Discharges of partially treated wastewater from the treatment facility can also cause a deterioration to the receiving water's stream health, ultimately impacting any ecosystems or recreation that depend on the resource.

During the development of this PER, the State of Vermont has indicated that the next NDPES permit issued to the Town for the wastewater treatment facility will include total ammonia nitrogen (TAN) limits to protect the Water Andric. It has also been indicated that a phosphorus limit may be considered in the future. A review of the current performance of the facility indicates that satisfactory TAN removal would not take place with the current lagoon process, and that a process revision is necessary to promote nitrification to convert TAN to nitrite and nitrate.

Any project recommending a process change to address TAN removal should also incorporate sludge removal from both lagoons. Although the sludge levels do not appear to be impacting the facility performance, they are considered high and should be lowered in the short term. Allowing the sludge blanket to continue to grow will lower the effective treatment volume in each lagoon, could short circuit the lagoons, and impact the facility's ability effectively treat for BOD and TSS.

3.2 AGING INFRASTRUCTURE

Although the WWTF and the collection system have functioned reliably since initial construction in 1983 many of the systems and components are original and should be considered for replacement based on their estimated useful lifespans.

The gravity portions of the collection system are in good condition. Modern materials and construction methods were utilized, and these materials have an estimated useful lifespan of 75 -100 years. The pump stations have been maintained regularly, but routine evaluation and improvements to controls, alarms, and pumps should be made on 10–20-year cycles.

At the wastewater treatment facility there are systems that have reached the end of their useful life that should be considered for replacement. The UV disinfection systems are in need of replacement and can no longer be reliably serviced. The blowers are original to the facility, and although one has been rebuilt and retrofitted with a VFD, consideration of a blower upgrade based on age should be made. Although the aeration diffusers were upgraded in 2006, significant improvements to aeration have been made over the past 20-years and replacement of the diffuser membranes should be considered. There are no known issues with other process equipment associated with age and condition (pipes, valves, headworks channel, lagoon structures, diversion structures).

The control building is in fair condition, but much of the HVAC and electrical systems are original and should be modernized. An electrical and ventilation upgrade should also be considered in the disinfection building where corrosion of electrical conduit and panels is visibly noted.

3.3 REASONABLE GROWTH

As discussed in section 1.2, the Town of Danville has experienced some growth both in population and in types of businesses served with an emphasis of food service. Based on flow the current facility runs on average at about 57% capacity, but based on BOD loading the current facility runs on average at about 65% capacity. The BOD influent strength is higher than the original design values utilized and as such there is a disproportionate available capacity when considering flow and loading. There is an estimated available hydraulic capacity of about 14,000 gallons per day in reference to the 80% design flow threshold specified in the NDPES permit. In terms of loading and referencing the same 80% design threshold there is only about 7,700 gallons per day of reserve capacity at the existing facility. In terms of new living units and assuming 210 gallons per day per unit, which leaves capacity for the system to expand to reliably serve an additional 36 living units.

Any additional commercial, industrial, or food processing facilities would need to be carefully reviewed to ensure that they can be reliably served by the current wastewater system.

When considering reserve capacity along with the proposed TAN effluent limits, a process modification should also review expansion of the treatment capacity to provide additional ability for the community to reasonably grow.

4 ALTERNATIVES CONSIDERED

4.1 ALTERNATIVE 1: DO NOTHING

Consideration of the do nothing alternative assumes that no significant capital investment is made at the wastewater treatment facility and the existing process, and operation would remain as-is.

There are several significant concerns associated with the do nothing alternative that make this alternative non-viable. They are noted in bullet form below:

- Both Lagoon #1 and Lagoon #2 are due to have sludge removed to restore the operating volumes and maintain adequate system performance.
- The existing UV disinfection system has reached the end of its useful life and can no longer be depended on for reliable performance.
- The existing lagoon treatment configuration is unable to reliably nitrify the wastewater. Without a process change or modification this plant will be unable to meet the proposed TAN limits expected to be implemented in the next NPDES permit.
- The current discharge is not reliably complying with the Water Quality Standards for instream ammonia during the summer months.

Because the do nothing alternative would not address the concerns noted above, it is not considered further.

4.2 ALTERNATIVE 2: PREVIOUSLY DEVELOPED ARC

Alternative 2 considers the installation of an anaerobic reactor cell (ARC) at the head end of lagoon #1 as previously developed in 2021 by the facility operators and Lemna Environmental Technologies (LET).

The ARC concept adds a covered cell with a hydraulic retention time of 2-3 days to the head of the lagoon where primary settling can take place, and anaerobic digestion of the settled sludge can also take place due to temperature control provided by the cover. This concept is not widely utilized but has been successfully implemented in cold weather climates throughout the country including in Maine, and in Hardwick, VT (2007).

The primary intent of the previous operations staff reviewing this alternative with LET was to continue to allow the plant's biological processes to remain effective at removing BOD in the presence of higher strength effluent. The ARC concept has been proven effective in Hardwick, and a similar design model was followed. In Hardwick, BOD removal in the ARC is approximately 50%, and TSS removal is approximately 75%. With the cover controlling temperatures, the solids digestion has shown an 83% reduction in sludge volumes. With such a large portion of the BOD and TSS being removed in a fixed area, sludge must be removed on a routine basis from the ARC but in theory larger sludge removal evolutions would be more infrequent.

With larger portions of the BOD removed in such a small area without utilizing oxygen, the remaining oxygen provided through the diffusers in lagoon #1 would be working to continue BOD removal, but also to nitrify the ammonia in the summer months when temperature does not stall the reaction.

Using 133 feet of baffle, and 1,508 square feet of cover an ARC with approximately 2.5 days of hydraulic retention time could be developed.

Since Alternative 2 would keep the overall hydraulic retention time of the system and would be expected to improve BOD and TSS removals, maintaining an ultraviolet disinfection system as opposed to transitioning to chlorine disinfection is viewed as the optimal disinfection alternative. Construction of new tankage for contact time and managing a new chemical and chemical feed onsite is not considered a better alternative when compared to replacing the UV infrastructure in the existing UV disinfection vault.

As part of any alternative implemented, the sludge accumulated in both lagoons should be removed, dewatered, and disposed of.

Figure 4-1 below illustrates the baffle and cover layout as developed and proposed by LET in 2021 for the Danville wastewater treatment facility operator.

Figure 4-1: Alternative 2 – ARC Layout

Table 4-1: Alternative 2
Total Project Cost Estimate

Item Description	Estimated Cost
Remove and Dispose of Sludge (Lagoon 1)	$47,400
Replace Diffuser Membranes	$4,500
Replace UV System	$118,000
Purchase and Installation of LEMNA Equipment	$114,000
Miscellaneous Work & Cleanup 25%	$56,800
Construction Cost	**$340,700**
Contingency (20%)	$68,200.0
Engineering	$78,400.00
Legal, Fiscal, Admin	$10,300.00
Total Project Cost Estimate	**$497,600**

Although this concept has been proven successful at other facilities, there are very few design references and guides for the implementation of an ARC, and it is difficult to guarantee performance due to a lack of empirically developed mathematical design equations. Little to no nitrification can be expected within the ARC, and without the ability to maintain temperatures throughout the winter in the rest of the lagoon with a complete cover, this alternative is not considered viable in itself to address the proposed TAN limits.

Combining this method with a complete covered system as reviewed in Alternative 4 however could prove effective based on the performance seen in Hardwick. If pursued, blower and diffuser upgrades should also be considered to improve delivery of oxygen and promote nitrification.

4.3 ALTERNATIVE 3: CONVERT TO A SEQUENCING BATCH REACTOR FACILITY

Alternative #3 considers the conversion of the facility from a lagoon facility to a Sequencing Batch Reactor (SBR) facility. At the existing site within the footprint of lagoon #1, new tankage to support an SBR facility would be installed including an aerated mixed pre-batch equalization basin, two SBR cells, and a waste sludge storage tank. In this configuration, lagoon #2 would be operated at the normal low water elevation and provide the post batch equalization volume and additional storage capacity for dry weather flows when the effluent flow may need to be throttled down based on the oxygen demand to protect the Water Andric.

The second lagoon would also allow for the flow to the UV chamber to be throttled to maintain a consistent flow through the systems separate from the batch discharge rate. This would enable the UV system to remain in its current configuration without needing to be upsized.

With the ability to adjust the aeration and batch times as necessary, it is estimated that the SBR facility could reliably provide effluent quality suitable to meet the existing permitting limits. The design of the SBR system is based on effluent concentrations of less than 24 mg/L BOD and TSS and less than 1.6 mg/L ammonia nitrogen and less than 19.2 mg/L total nitrogen. Because the nitrification reaction is temperature dependent, there may be cold weather periods where bypassing the influent equalization basin to preserve the wastewater temperature and promote nitrification may be desirable, but this flexibility would be provided in the design.

Unlike with the lagoon system, the installation of fine screening and grit removal before the reactors is necessary for a sustainable system. This would require construction of a headworks building, a mechanical fine screen, a grit removal system, and a grit washer/classifier. It is noted that the installation of a headworks facility would improve the quality of the sludge produced at the facility, but that any facility accepting the sludge would also pre-screen and grind the material.

A transition to an SBR facility would be a significant operational change, but most notably the waste sludge would need to be removed on a regular basis. Onsite aerated sludge storage would be constructed to store 2-weeks of process sludge, with the intent of the Town negotiating a weekly hauling contract with a local septage hauler, and a receiving facility.

An additional advantage provided by an SBR system is that the process can be continually modified by adjusting batch rates, times, and aeration. The system could be modified in the future to denitrify if a total nitrogen limit were to be enforced with a future permit.

Since the designed reaction would incorporate nitrification, significant alkalinity in the wastewater would be used up, and it is recommended that a chemical injection system be installed for pH neutralization within the SRBs.

Table 4-2: Alternative 3
Total Project Cost Estimate

Item Description	Estimated Cost
Remove and Dispose of Sludge (Lagoons 1 & 2)	$95,000
Remove Diffusers in Lagoon 1	$2,000
Replace UV System	$118,000
SBR System Purchase and Installation	$468,000
Fine Screening	$240,000
Grit Removal	$200,000
Headworks Building	$400,000
Sludge Storage Tanks	$20,000
SBR Tanks	$170,000
Equalization Basin	$100,000
Blower Replacement	$10,000
Chemical Feed System	$10,000
Construction Phasing	$102,000
Miscellaneous Work & Cleanup 25%	$308,600
Construction Cost	**$2,243,600**
Contingency (20%)	$448,800.0
Engineering	$476,900.00
Legal, Fiscal, Admin	$67,400.00
Total Project Cost Estimate	**$3,236,700**

4.4 Alternative 4: Cover Lagoon #1 and Implement Intermediate Treatment Zones

Alternative #4 considers the installation of a full cover system over lagoon #1 and the conversion of this lagoon to a complete mix – partial mix baffled system. The cover over the entire surface of lagoon #1 would create a less ambient temperature reliant environment where the nitrification reaction could be supported year-round.

The complete mixed portion of the lagoon would provide aggressive growth of heterotrophic bacteria to support BOD removal that can be predicably modeled. These bacteria are also utilized for ammonia removal once the BOD is depleted. Nitrifier growth will also occur within the complete mixed cell. The hydraulic retention time of the complete mixed cell would be 3.5 days under average flow conditions.

After the complete mix zone, the flow would enter the partially mixed zone with a hydraulic retention time of 9.6 days where further biological treatment will occur for BOD, TSS, and ammonia removal. Also, in this cell the solids will begin to settle and will undergo anaerobic digestion over the floor of the lagoon.

For improved reliability of the nitrification reaction and ammonia removal a polishing reactor would be added between the two lagoons. In this polishing reactor suspended media would be utilized to create an ideal environment for nitrifying bacteria. The flow through this reactor would be aggressively aerated through floor mounted diffusers so that the ammonia removal process could be reliably depended on year-round.

Using the complete mix, partial mix system with a polishing reactor, the ammonia concentrations of the effluent would not be expected to exceed 2.0 mg/L and the phosphorus effluent concentration is expected to be under 1.0 mg/L. To provide adequate oxygen supply and mixing the blower would be upgraded to 15 hp, and new diffusers installed in lagoon #1.

To accommodate the cover in lagoon #1, the water surface elevation would need to be fixed and this lagoon would no longer be available for storage during dry weather periods. Noting the improved nitrification reaction, it is emphasized that ultimate oxygen demand (UOD) of the effluent which contributes to the allowable discharge volume of the facility would be significantly reduced, and the storage volume in lagoon #1 would no longer be necessary to protect the effluent receiving water.

If future phosphorus limits were to be implemented, removal could also be achieved by adding alum at the polishing filter and baffling off a settling area in lagoon #2 for the alum sludge. This sludge would need to be removed on a semi-regular basis which would increase the operational burden of the facility.

It is also noted that the nitrification reaction utilizes available alkalinity in the wastewater, and that pH stabilization may be necessary with the addition of sodium hydroxide.

Similar to as reviewed in Alternative #2, the transition to chlorine disinfection is not viewed as a viable alternative. Replacement of the UV system in place is the most desirable disinfection alternative considering the extended hydraulic retention times provided by the lagoon system.

During construction, the sludge from both lagoons would be removed, new air diffusers added, and new blowers installed to increase the oxygen rate to the lagoons to improve nitrification.

One disadvantage of this proposal is that the lagoon cells could no longer operate independently as separate treatment ponds and would need to be operated in series from Lagoon #1 to Lagoon #2. Careful consideration would need to be made regarding maintenance of the lagoon systems to maintain operation without 100% process redundancy for ammonia removal. Plumbing to allow for bypass of Lagoon #1 temporarily as is currently used during sludge removal would be maintained to allow for maintenance operations.

The figure below represents the complete mixed, partial mixed covered system as provided by LET. Also shown are baffles and mixers in lagoon #2 associated with phosphorus removal if required.

Table 4-3: Alternative 4
Total Project Cost Estimate

Item Description	Estimated Cost
Remove and Dispose of Sludge (Lagoon 1)	$47,400
Replace Diffuser Membranes	$4,500
Replace UV System	$118,000
Purchase and Installation of LEMNA Equipment	$482,500
Chemical Feed System	$10,000
Lagoon 1 Temporary Bypass Piping and Pumping	$20,000
Miscellaneous Work & Cleanup 20%	$130,500
Construction Cost	**$812,900**
Contingency (20%)	$162,600.0
Engineering	$187,300.00
Legal, Fiscal, Admin	$24,400.00
Total Project Cost Estimate	**$1,187,200**

During design, piping would need to be incorporated to allow for flow to continue to be received during periods of cleaning and maintenance of Lagoon #1 so that flows could be directed to Lagoon #2 temporarily then pumped back to the head of the system after maintenance is complete.

Figure 4-2: Alternative 4 – Covered Lagoon Layout

4.5 CONTROL BUILDING, HVAC, ELECTRICAL IMPROVEMENTS

Coupled with any selected alternative there are electrical, mechanical, and HVAC improvements that should be implemented within the main control building and UV disinfection space. These recommendations are as provided by Engineering Services of Vermont and can be viewed in Appendix C. A summary table of the recommended improvements and the associated costs is provided below.

Table 4-4: Mechanical, Plumbing and Electrical Upgrades Cost Estimate

Description	Construction Cost
Mechanical & Plumbing	
New Bathroom Electric Strip Heater	$500
Cold Climate Heat Pump	$12,000
New Bathroom Exhaust Fan	$1,000
New U.V. Building Exhaust Fan and Dampers	$7,000
New Process Room Exhaust Fan & Thermostat	$5,000
Remove Process Room Transfer Fan and Duct	$1,500
New Hot Water Heater	$5,000
New Eyewash & Mixing Valve	$2,000
New Lavatory, Water Closet, & Shower	$6,000
Mechanical & Plumbing Subtotal	$40,000
Electrical	
New Circuit Breaker Panels & Blower #2 VFD	$18,000
Raceway, Boxes, and Supports Improvements	$7,500
GFCI Outlet Installations	$700
GFCI receptacle at condensing unit	$200
GFCI receptacle on dedicated circuit at sampler	$700
Replace interior lights with LEDs	$7,000
Correct water source for UV Lighting	$2,000
Provide Illuminated Exit Signs	$500
Provide emergency lighting in blower room	$500
Replace exterior lighting with LEDs	$700
Motion sensor flood light	$500
Replace Process Alarm System	$12,000
Provide Internet Access	$300
Electrical Subtotal	$50,600

The installation of a liquid propane (LP) standby generator and automatic transfer switch could also be considered to power the process and building systems during a power outage. It is noted that the facility currently ceases to pass effluent during a power outage and that influent flow just gets stored, but a generator could power the process equipment and maintain the heating and ventilating systems in the event of an outage. Estimated costs for a 40kW LP generator is $75,000.

5 SELECTION OF AN ALTERNATIVE

5.1 GENERAL

As discussed in Section 3, the Danville Wastewater Treatment Facility faces both aging infrastructure and permit nutrient limits that require upgrades to the existing process and equipment. To address this need, three alternatives were developed. Alternative 1, do nothing is not considered.

- Alternative 2: Install a new chlorination and control building and finished water storage tanks, while maintaining the existing tank for raw water storage.
- Alternative 3: Reconstruct the existing tank to maintain one cell for raw water storage, while using the remaining space for chlorination and control and installing new finished water storage tanks.
- Alternative 4: Install a new chlorination and control building and finished water storage tanks and demolish the existing tank and building.

Costs associated with each alternative are presented in Section 4, non-monetary considerations associated with each alternative are also discussed in Section 4.

5.2 ALTERNATIVE COMPARISON

The most appropriate way to evaluate the different alternatives in terms of economic value is through a life cycle cost analysis, **Table 5-1** compares Life Cycle Costs for the three alternatives over a 25-year period. As shown Alternative 2 has a higher annual operational cost because it provides the most space to heat. Alternative 3 is the least expensive annual building maintenance cost because it includes the cost to replace roofs and siding of structures to remain.

Table 5-1: Storage and Treatment Life Cycle Cost Comparison

Item	Alternative 2	Alternative 3	Alternative 4
Construction Cost	$180,000	$182,000	$215,000
Tank Inspection (10, 15, 20 & 25 year)	$8,000	$8,000	$8,000
Chemical Feed Pump Repl. (10 & 20 year)	$1,500	$1,500	$1,500
Roof Replacement (25 year)	$4,500	$3,600	$2,000
Siding Replacement (20 year)	$4,400	$4,200	$3,700
Annual Heating Costs (over 25 years)	$0	$6,250	$0
Net Present Worth	$204,650	$205,550	$235,575

Notes:

1. Total construction costs were developed in **Section 4**.
2. Annual electrical costs included in Power and Communications alternatives.
3. Salvage value assigned for all alternatives is $0 based on industry experience.
4. All costs presented in **Table 5-1** are in present day dollars projected over 25-years.
5. Short lived assets are identical for all alternatives, so costs have been excluded.
6. Heating costs are based on propane heating cost of $3.359/gallon and were calculate using US National-Oceanic and Atmospheric Administration published Normal Heating Degree Days.

5.3 ALTERNATIVE SELECTION

Selection Matrix

To incorporate non-monetary factors a selection matrix was created as shown in **Table 5-2**. In this selection tool, we have assigned different weighting factors between 10 and 5 based on the importance of the various parameters and local preference. A parameter with a weighting factor of 10 is most important and a weighting factor of 5 is the least important parameter. The various alternatives are then ranked between 10 and 1 with 10 being the alternative that exhibits the best characteristics related to a certain parameter. The alternative with the highest score represents the "best" alternative.

Table 5-2: Evaluation Criteria for Alternatives

#	Parameter	Weight	Remarks
1	Life Cycle Cost	10	Are there significant differences in the life cycle costs to complete the project?
2	Construction Cost	10	Are there significant differences in the construction costs to complete the project?
3	Permit Compliance	10	Does the system have the ability to meet current and anticipated future permit nutrient limits?
4	Sustainability	9	Is a particular alternative more or less likely to provide expansion further into the future?
5	Ease of Operation	8	Are there significant differences in how the treatment systems are operated or maintained? Is one easier to operate and maintain than the other?
6	Public Acceptance	6	Will customers serviced by the system be satisfied with the end result?
7	Constructability	6	Are there differences in the project's construction impacts and time to complete?

Storage and Treatment

Although Alternative 2 provides a more economical solution, there are non-economic factors that must also be considered. Alternative 2 has the smallest site impact, while Alternative 3 removes the existing tank completely, which may need repair or replacement in the near future. Based on the parameters indicated in **Table 5-3** above, we have prepared **Table 5-4** as a selection matrix for the alternatives to address the Storage and Treatment deficiencies in this project.

Table 5-3: Evaluation Matrix for Storage and Treatment Alternatives

			Alt. 2		Alt. 3		Alt. 4	
#	Weight	Parameter	Rank	Score	Rank	Score	Rank	Score
1	10	Life Cycle Cost	10	100	9	90	6	60
2	10	Construction Cost	10	100	10	100	6	60
3	10	Permit Compliance	10	100	10	100	10	100
4	9	Sustainability	9	81	9	81	7	63
5	8	Ease of Operation	6	48	8	64	8	64
6	6	Public Acceptance	6	36	6	36	6	36
7	6	Constructability	6	36	2	12	6	36
TOTAL			443		432		361	

As shown in the evaluation matrix above, Alternative 4 provides the best overall solution. This evaluation considers monetary and non-monetary factors, and it is understood that budgetary constraints, funding options, and local preferences may also factor in the Fire District's decision.

6 PROPOSED PROJECT

Once an alternative is recommended by Section 5, Section 6 will be utilized to further define the recommended project including considering the schedule, permit requirements, total project costs, and funding strategies.

7 CONCLUSIONS AND RECOMMENDATIONS

Section 7 will be utilized to restate the content of the PER and the PER recommendations in summary format. If necessary, additional emphasis will be provided as it relates to key design criteria. This section may also be utilized to highlight any data that could impact the recommendation if it were to be found to be inaccurate or changing.

Appendix A

Wastewater System Map

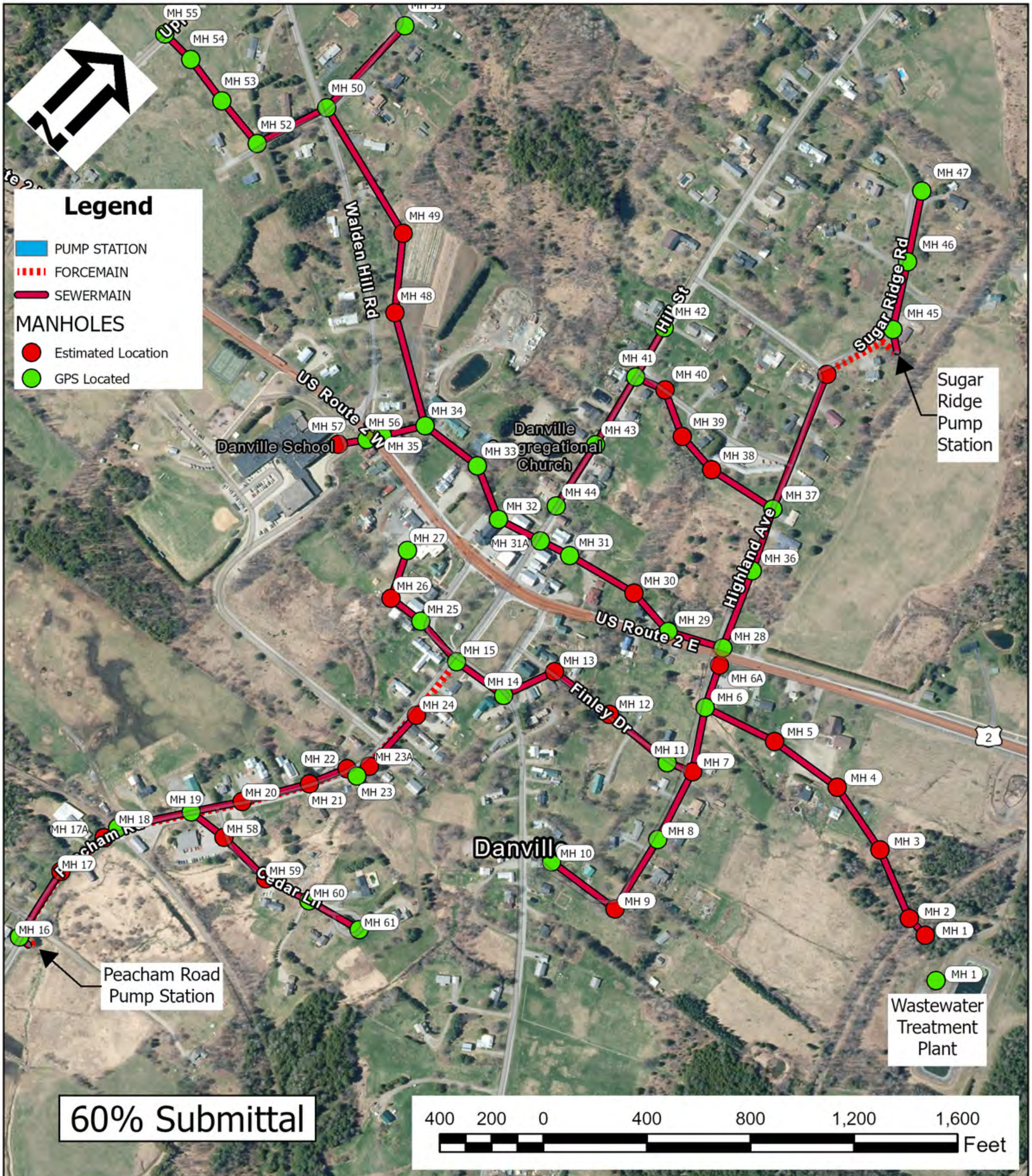


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FIGURE 1

EXISTING WASTEWATER COLLECTION MAP

DANVILLE, VERMONT

PROJECT NO. 3123007

PROJECT MJR. AJD

SCALE AS SHOWN

DATE JUNE 7, 2024

Appendix B

Nutrient Analysis

To: Andrea Day, Dufresne Group Consulting Engineers
From: Randy Bean, RAB Consulting & Services LLC
Date: May 30, 2024

RE: Danville Wastewater Treatment Facility Ammonia & Phosphorus Assessment

As requested, I have investigated the total nitrogen ammonia (ammonia) and total phosphorus discharged from the Danville Wastewater Treatment Facility (WWTF) and potential NPDES Discharge Permit issues.

Danville WWTF

The Danville WWTF discharges to the Water Andric. The WWTF is an aerated lagoon facility consisting of two treatment lagoons and ultraviolet light disinfection. The design flow of the WWTF is 0.060 MGD (60,000 gpd), annual average. Currently the WWTF has an annual discharge of ~0.033 MGD, approximately 55% of the design flow.

Receiving Water

The Water Andric is the receiving water for the Danville WWTF discharge. The Water Andric has been categorized a "Small High Gradient" stream by the Agency of Natural Resources and has the following characteristics:

Critical Instream Flows

Summer 7Q10 Flow:	0.60 CFS
Winter 7Q10 Flow:	0.93 CFS
Summer 30Q10 Flow:	0.74 CFS
Winter 30Q10 Flow:	1.30 CFS
Summer Low Median Monthly Flow:	1.18 CFS

WWTF Discharge (0.060 MGD) Instream Waste Concentrations (IWC) at Critical Flows

Summer 7Q10 IWC:	0.134 (13.4%)
Winter 7Q10 IWC:	0.091 (9.1%)
Summer 30Q10 IWC:	0.112 (11.2%)
Winter 30Q10 IWC:	0.067 (6.7%)
Summer Low Median Monthly IWC:	0.0732 (7.32%)

Ammonia

Ammonia is a pollutant which exerts acute and chronic toxic effects on aquatic organisms, mostly fish, in a receiving water. It can also contribute to increased eutrophication in a receiving water. The effects of ammonia in receiving waters are directly correlated to the instream water temperature and pH. Specifically, the higher the instream temperature and the higher the pH, the more sensitive a receiving water is to the effects of ammonia.

Therefore, during summer periods ammonia is a much greater pollutant of concern. In addition, some species of fish are much more sensitive to ammonia than others. The EPA "Aquatic Life Ambient Water Quality Criteria For Ammonia – Freshwater 2013" (EPA Ammonia Criteria) accounts for this variability in deriving instream ammonia criteria.

The Vermont Water Quality Standards (VWQS) incorporates, by reference, the EPA Ammonia Criteria for deriving the assimilative capacity for ammonia in waters in Vermont and for developing permit limitation in NPDES Discharge Permit. Appendix C of the VWQS effective November 15, 2022, mandates that ammonia instream capacity and criterion be derived based on 30Q10 flows.

Historically the Agency of Natural Resources (ANR) has established summer and winter ammonia limitations in NPDES Discharge Permits to account for this seasonal variability in the effects of ammonia plus to account for the variability in summer and winter stream flow conditions.

With respect to the Water Andric, at the point of discharge of the Danville WWTF, based on Table 5a Page 44 of the EPA Ammonia Criteria document, during summer stream conditions, at an instream temperature of 25° C and pH of 8.0, the acute instream ammonia criterion is 2.6 mg/l. Based on Table 6 Page 49 of the EPA Ammonia Criteria document, at the same instream temperature and pH with *Oncorhynchus spp* (rainbow trout family) present, the chronic instream ammonia criterion is 0.56 mg/l. Therefore, a discharge into a Water Andric at these summer field conditions cannot cause the instream ammonia concentrations to exceed 2.6 mg/l at acute conditions and 0.56 mg/l at chronic conditions. (See Spreadsheet)

Based on Table 5a Page 44 of the EPA Ammonia Criteria document, during winter stream conditions in the Water Andric, at instream temperatures of 0-14° C and pH of 8.0, the acute instream ammonia criterion is 5.6 mg/l. Based on Table 6 Page 49 of the EPA Ammonia Criteria document, at instream temperatures of 0-7° and pH with *Oncorhynchus spp* (rainbow trout family) present, the chronic instream ammonia criterion is 1.8 mg/l. Therefore, a discharge into the Water Andric at these winter conditions cannot cause in the instream ammonia concentrations to exceed 5.6 mg/l at acute conditions and 1.8 mg/l at chronic conditions. (See Spreadsheet)

With respect to the summer ammonia assimilative capacity of the Water Andric at 30Q10 flows and the Danville WWTF discharge, based on the summer instream ammonia criteria derived from the EPA Ammonia Criteria document and the summer 30Q10 IWC based on a 60,000 gallon per day discharge, the ammonia capacity of the Water Andric is 2.51 lbs/day at chronic conditions and 11.67 lbs/day at acute conditions. (See Spreadsheets)

Based on the winter acute and chronic instream ammonia criteria derived from the EPA Ammonia Criteria document and the winter 30Q10 IWC based on a 60,000 gallon per day discharge, the ammonia capacity of the Water Andric is 13.51 lbs/day under chronic conditions and 42.02 lbs/day under acute conditions. (See Spreadsheets)

Condition I.A.1 of NPDES Discharge Permit No. 3-1235 requires the Danville WWTF to monitor their effluent for ammonia once per month. The ammonia discharged from the WWTF was assessed from January 1, 2021, through March 31, 2024 (Study Period). (See Spreadsheet)

<u>Danville WWTF Study Period Average Effluent Ammonia Concentrations Discharged</u>

Summer (June – Sep) Average Effluent Ammonia Concentration:	19.1mg/l
Ammonia Effluent Concentrations range:	9.0 mg/l to 30.0 mg/l
Winter (Oct – May) Average Effluent Ammonia Concentration:	21.5 mg/l
Ammonia Effluent Concentrations range:	12.0 mg/l to 40.0 mg/l

<u>Danville WWTF Study Period Average Effluent Ammonia Mass Loading Discharged</u>

Summer (June – Sep) WWTF Average Flow:	0.028 MGD
Summer (June – Sep) Average Effluent Ammonia Mass Discharge:	4.8 lbs/day
Ammonia Mass Discharge range:	0.79 lbs/day to 12.01 lbs/day
Winter (Oct - May WWTF Average Flow:	0.035 MGD
Winter (Oct – May) Average Effluent Ammonia Mass Discharge:	6.2 lbs/day
Ammonia Mass Discharge range:	0.99 lbs/day to 9.47 lbs/day

Based on this data, it can be concluded that currently there is a reasonable potential for the assimilative capacity of ammonia in the Water Andric, at both acute and chronic conditions, to be exceeded by the discharge from the Danville WWTF during the summer period. Considering that the WWTF is currently discharging only ~50% of its permitted flow, this issue will become more problematic over time as flows increase.

Specifically, the assimilative capacity for ammonia of the Water Andric during the summer period is 2.51 lbs/day at chronic conditions and 11.67 lbs/day at acute conditions based on a 0.060 MGD discharge into the receiving water at summer 30Q10 flows. The ammonia discharged from the Danville WWTF into the Water Andric averaged 4.8 lbs/day and ranged from 0.79 lbs/day to 12.01 lbs/day with flow of 0.028 MGD during the summer study period. Consequently, it can be concluded that the WWTF discharge is currently exceeding the summer ammonia assimilative capacity of Water Andric and compliance problems will increase as WWTF's flow increases towards the permitted limitation.

In addition, acute Whole Effluent Toxicity Tests conducted on the Danville WWTF discharge on September 23, 2020, indicated toxicity on *Pimphales promelas* (Fathead minnows) at effluent concentrations greater than 25%. The *Ceriodaphnia dubia* (daphnia) tested showed no toxicity at any effluent concentrations. (See WET test results). While this WET concentration does not cause a violation of VWQS, considering there are no industrial sources within the Danville WWTF collection system, it is highly probable that the toxicity was caused by ammonia.

With respect to the winter period, based on the effluent ammonia data reviewed and the current flow discharge from the Danville WWTF, is not currently causing an instream exceedance of the assimilative capacity for ammonia in the Water Andric. The assimilative capacity for ammonia of the Water Andric during the winter period is 13.11 lbs/day at chronic conditions and 42.02 lbs/day at acute conditions based on a 0.060 MGD discharge into the receiving water at winter 30Q10 flows. The ammonia discharged from the Danville WWTF into the Water Andric averaged 6.2 lbs/day and ranged from 0.99 lbs/day to 9.47 lbs/day with an average flow of 0.035 MGD during the winter study period. Consequently, it can be concluded that the WWTF discharge does not exceed the ammonia assimilative capacity of Water Andric during the winter.

However, as the flow increases towards permitted limitations and the retention time in the lagoons decreases, which may impact the ammonia removal processes, the ammonia loading to the Water Andric from the Danville WWTF will increase.

Total Phosphorus

Total phosphorus is a pollutant which contributes to increased eutrophication in waters. Excessive total phosphorus cumulatively exerts its effects in a receiving water during the entire summer growing season (June through October) and typically needs warm water temperatures and significant sunlight to cause increased eutrophication. Therefore, the instream impacts of elevated phosphorus can vary on a case-by-case basis and can impacted by many variables in a watershed.

The VWQS incorporates the effects of the variability in Table 2 of Section 29A-306 which establishes numeric instream total phosphorus screening criteria that are to be applied at summer low median monthly flows. However, the VWQS also allows for compliance with the total phosphorus instream criteria to be demonstrated by nutrient response conditions downstream of discharges.

In addition, the "EPA Quality Criteria of Water 1986" (aka Gold Book) is used by ANR to provide instream criteria for some pollutants including phosphorus. The Gold Book recommends 0.1 mg/l instream criteria for Total Phosphorus, however this criteria is not supported for the control of eutrophication in riverine systems.

Condition I.A.1 of NPDES Discharge Permit No. 3-1235 requires the Danville WWTF to monitor their effluent for total phosphorus once per month. The total phosphorus discharged from the WWTF was assessed from the Summer period for phosphorus impacts (June through October) from January 1, 2021, through March 31, 2024. (See Spreadsheet):

Average WWTF Flow:	0.030 MGD
Average Total Phosphorus Effluent Concentration:	3.29 mg/l
Total Phosphorus Effluent Concentrations range:	2.1 to 4.7 mg/l
Average Total Phosphorus Effluent Mass Loading:	0.87 lbs/day
Total Phosphorus Effluent Mass Loading range:	0.33 to 2.07 lbs/day

Deriving the instream Total Phosphorus concentration based on the Instream Waste Concentration at LMM flows in the Water Andric, the design flow of the WWTF (0.060 MGD), and the average phosphorus loading (0.87 lbs/day) results in an average instream total phosphorus concentration of 0.241 mg/l which significantly exceeds the Gold Book recommended standard. (See Spreadsheet)

However, at the current discharge flow (0.030 MGD), the instream total phosphorus concentration in the Water Andric due to the Danville WWTF discharge is 0.125 mg/l, which is much closer to the Gold Book recommended standard. (See Spreadsheet)

In regard to the nutrient response to total phosphorus in the Water Andric, as part of ANR's water quality assessment program, instream macroinvertebrate sampling downstream of the WWTF discharge was conducted in the Water Andric in the early fall of 2010, 2012, 2015, 2017, and 2020. Except for the sampling in 2015, all the sampling results indicated full support of all biotic parameters. The 2015 sampling results indicated impairment due to eutrophication, but after an investigation by ANR at the request of the Town of Danville, the unsatisfactory results were directly correlated to the lack of maintenance of a stormwater basin treating runoff from the Route 2 improvement project which discharges upstream of the WWTF discharge. After the stormwater basin was properly maintained, the subsequent sampling in the Water Andric in 2017 and 2020 has indicated full support of all biotic parameters.

Therefore, based on these results it can be concluded that the current mass discharge of total phosphorus from the Danville WWTF is not causing or contributing to increased eutrophication in the Water Andric. However, the watershed appears to be sensitive to increases in phosphorus loading to the river and increases in discharges of phosphorus from all sources into the Water Andric should be controlled to the extent practical.

Conclusions

1. During the summer period, the current ammonia mass discharge from the Danville WWTF exceeds the assimilative capacity of the Water Andric, the EPA Ammonia Criteria, and the VWQS. This problem will increase as new users connect and the discharge from the WWTF increases towards its permitted flow. Therefore, any upgrade or expansion of the WWTF must address this issue. In addition, since there is a reasonable potential for the WWTF discharge to cause an exceedance of the assimilative capacity of the Water Andric and instream ammonia criteria during the summer, ANR, in all probability, establish a Total Ammonia Nitrogen effluent limitation during the summer as part of the permit renewal process. This will require modifications to the treatment process or the installation of new equipment at the WWTF to ensure compliance with the new ammonia effluent limitation.

2. During the winter period, the current ammonia mass discharge from the Danville WWTF is within the assimilative capacity of the Water Andric and complies with the EPA Ammonia Criteria and the VWQS. In addition, based on the ammonia effluent data collected from January 1, 2021, through March 2024, the discharge will not exceed the assimilative capacity of the Water Andric

or the requirements of the EPA Ammonia Criteria and the VWQS as new users connect and the discharge from the WWTF increases towards its permitted flow.

However, while there is not a reasonable potential for the WWTF discharge to cause an exceedance of the assimilative capacity of the Water Andric or the instream ammonia criteria during the winter, ANR will most likely continue the Total Ammonia Nitrogen effluent monitoring as part of the permit renewal process.

3. The current phosphorus mass discharge from the Danville WWTF is not causing or contributing to eutrophication in the Water Andric. Nonetheless, due to instream concentration of total phosphorus resulting from the WWTF's discharge and the nutrient response in the Water Andric from other discharges in the watershed it is highly probable that a measurable increase in the total phosphorus discharged from the Danville WWTF above current loadings would have a reasonable potential to cause an adverse impact in the receiving water. Therefore, any upgrade or expansion of the WWTF must address this issue and ensure that the discharge of total phosphorus in the discharge does not increase the mass loading into the Water Andric above current values. In addition, ANR will most likely continue the Total Phosphorus effluent monitoring as part of the permit renewal process and may add limitations which prevent the mass discharge of phosphorus from increasing above current loadings (aka "hold the load") during the summer.

Effluent Limitation Considerations

Any effluent limitations established by ANR as part of the permit renewal process should be carefully scrutinized to ensure that they have a proper scientific and legal foundation, are not overly restrictive, or place an unneeded burden on the Town of Danville.

Specifically, effluent limitations for ammonia and total phosphorus must be Water Quality Based Effluent Limitation (WQBELS) and directly correlate to the capacity of the Water Andric to assimilate the pollutant without causing a violation of instream criteria. They should be based on the derivation process put forth in the Vermont Toxic Discharge Control Strategy and the Wasteload Allocation Process. The limitations should be expressed as mass loading limitations and incorporate a "margin of safety" in their derivation. Concentration effluent limitations that are derived based on the design flow of a WWTF are overly restrictive and result in higher operational and maintenance costs when the WWTF is discharging at less than design flows. In addition, concentration-based effluent limitations would not correlate to the assimilative capacity of the Water Andric when the WWTF is discharging as less than design flows.

AMMONIA CAPACITY ANALYSIS - WATER ANDRIC

Summer Conditions

Receiving Water: Water Andric *Oncorhynchus present*

Stream Flow CFS 30Q10	*0.740*
Proposed Discharge Effluent Flow MGD	*0.060*
Instream Waste Concentration	0.112

Instream Ammonia Criteria from EPA 2013 Ammonia Criteria

Instream Acute Criteria - pH & Temperature Based
Page 44 Table 5a

pH	8	
Instream Temperature	25	
CMC w/ Oncorhynchus	***2.6***	**mg/l**

Instream Chronic Criteria - pH & Temperature Based
Page 49 Table 6

pH	8	
Temperature	25	
CCC	***0.56***	**mg/l**

Effluent Mass Discharge (lbs/day) to meet Instream Ammonia VWQS

Acute	Chronic	
11.67	***2.51***	**lbs/day**

Effluent Ammonia Concentration (mg/l) @ Proposed Flow (0.060 MGD)

Acute	Chronic	
23.32	***5.02***	**mg/l**

AMMONIA CAPACITY ANALYSIS - WATER ANDRIC

Winter Conditions

Receiving Water: Water Andric *Oncorhynchus present*

Stream Flow CFS 30Q10	*1.300*
Proposed Discharge Effluent Flow MGD	*0.060*
Instream Waste Concentration	0.067

Instream Ammonia Criteria from EPA 2013 Ammonia Criteria

Instream Acute Criteria - pH & Temperature Based
Page 44 Table 5a

pH	8
Instream Temperature	25
CMC w/ Oncorhynchus	***5.6* mg/l**

Instream Chronic Criteria - pH & Temperature Based
Page 49 Table 6

pH	8
Temperature	25
CCC	***1.8* mg/l**

Effluent Mass Discharge (lbs/day) to meet Instream Ammonia VWQS

Acute	Chronic	
42.02	***13.51***	**lbs/day**

Effluent Ammonia Concentration (mg/l) @ Proposed Flow (0.060 MGD)

Acute	Chronic	
83.98	***26.99***	**mg/l**

Danville WWTF Ammonia Loadings
January 2021 - March 2024

Sample Date	Flow (mgd)	Ammonia mg/l	Ammonia lbs/day
1/5/21	0.0342	22.0	6.28
2/2/21	0.0238	18.0	3.57
3/11/21	0.0289	18.0	4.34
4/6/21	0.0414	14.0	4.83
5/4/21	0.0342	13.0	3.71
6/1/21	0.0238	20.0	3.97
7/6/21	0.0289	30.0	7.23
8/3/21	0.0414	9.0	3.11
9/7/21	0.0191	18.0	2.87
10/5/21	0.0296	18.0	4.44
11/3/21	0.0439	24.0	8.79
12/7/21	0.041	14.0	4.79
1/22/22	0.0228	40.0	7.61
2/1/22	0.0208	29.0	5.03
3/1/22	0.0307	37.0	9.47
4/5/22	0.043	20.0	7.17
5/3/22	0.0361	14.0	4.22
6/7/22	0.0282	17.0	4.00
7/5/22	0.022	24.0	4.40
8/2/22	0.005	19.0	0.79
9/6/22	0.0239	20.0	3.99
10/4/22	0.0344	21.0	6.02
11/2/22	0.0329	25.0	6.86
12/7/22	0.0466	22.0	8.55
1/4/23	0.0467	21.0	8.18
2/8/23	0.0276	23.0	5.29
3/7/23	0.0275	25.0	5.73
4/4/23	0.0314	23.0	6.02
5/2/23	0.0363	17.0	5.15
6/6/23	0.0527	24.0	10.55
7/6/23	0.042	23.0	8.06
8/1/23	0.0313	13.0	3.39
9/5/23	0.0103	12.0	1.03
10/3/23	0.0099	12.0	0.99
11/1/23	n/s		
12/20/23	0.0476	23.0	9.13

Summer Ammonia Discharge

Date	Flow		NH3 mg/l		NH3 lbs/day	
6/1/21	0.0218		20.0		3.64	
7/6/21	0.048		30.0		12.01	
8/3/21	0.0324		9.0		2.43	
9/7/21	0.0191		18.0		2.87	
6/7/22	0.0282		17.0		4.00	
7/5/22	0.022		24.0		4.40	
8/2/22	0.005		19.0		0.79	
9/6/22	0.0239		20.0		3.99	
6/6/23	0.0527		24.0		10.55	
7/6/23	0.042		23.0		8.06	
8/1/23	0.0313		13.0		3.39	
9/5/23	0.0103		12.0		1.03	
Average	**0.0281**	**mgd**	**19.1**	**mg/l**	**4.8**	**lbs/day**

Winter Ammonia Discharge

Date	Flow	NH3 mg/l	NH3 lbs/day
1/5/21	0.0342	22.0	6.28
2/2/21	0.0238	18.0	3.57
3/11/21	0.0289	18.0	4.34
4/6/21	0.0414	14.0	4.83
5/4/21	0.0342	13.0	3.71
10/5/21	0.0296	18.0	4.44
11/3/21	0.0439	24.0	8.79
12/7/21	0.041	14.0	4.79
1/22/22	0.0228	40.0	7.61
2/1/22	0.0208	29.0	5.03
3/1/22	0.0307	37.0	9.47
4/5/22	0.043	20.0	7.17
5/3/22	0.0361	14.0	4.22
10/4/22	0.0344	21.0	6.02
11/2/22	0.0329	25.0	6.86
12/7/22	0.0466	22.0	8.55
1/4/23	0.0467	21.0	8.18
2/8/23	0.0276	23.0	5.29
3/7/23	0.0275	25.0	5.73

1/10/24	0.0503		19.0		7.97	
2/14/24	0.047		23.0		9.02	
3/13/24	0.044		23.0		8.44	
Average	**0.0327**	**mgd**	**20.7**	**mg/l**	**5.7**	**lbs/day**

4/4/23	0.0314		23.0		6.02	
5/2/23	0.0363		17.0		5.15	
10/3/23	0.0099		12.0		0.99	
11/1/23		n/s				
12/20/23	0.0476		23.0		9.13	
1/10/24	0.0503		19.0		7.97	
2/14/24	0.047		23.0		9.02	
3/13/24	0.044		23.0		8.44	
Average	**0.0351**	**mgd**	**21.5**	**mg/l**	**6.2**	**lbs/day**

Danville Wastewater Treatment Facility
Total Phosphorus Loadings
January 2021 - March 2024

Sample Date	Flow mgd	TP mg/l	TP lbs/day
1/5/21	0.0342	2.1	0.60
2/2/21	0.0238	3.2	0.64
3/11/21	0.0289	2.9	0.70
4/6/21	0.0414	2.4	0.83
5/4/21	0.0554	2.4	1.11
6/1/21	0.0218	2.2	0.40
7/6/21	0.048	4.6	1.84
8/3/21	0.0324	2.7	0.73
9/7/21	0.0191	2.1	0.33
10/5/21	0.0296	3.4	0.84
11/3/21	0.0439	3.8	1.39
12/7/21	0.041	4.6	1.57
1/4/22	0.0265	3.5	0.77
2/2/22	0.0208	3	0.52
3/1/22	0.0307	3.5	0.90
4/5/22	0.043	3	1.08
5/3/22	0.0361	3.7	1.11
6/7/22	0.0282	3.0	0.71
7/5/22	0.022	4.5	0.83
8/2/22	0.005	3.4	0.14
9/6/22	0.0239	2.3	0.46
10/4/22	0.0344	2.8	0.80
11/1/22	0.0342	2.9	0.83
12/6/22	0.0424	3.2	1.13
1/3/23	0.0457	4.0	1.52
2/7/23	0.0275	3.7	0.85
3/7/23	0.0275	4.2	0.96
4/4/23	0.0314	3.9	1.02
5/2/23	0.0363	3.2	0.97
6/6/23	0.0527	4.7	2.07
7/7/23	0.0393	4.3	1.41
8/1/23	0.0313	2.8	0.73
Sep	n/s		
Oct	n/s		
11/14/23	0.023	2.9	0.56

Summer Loadings

Sample Date	Flow MGD	TP mg/l	TP lbs/day
6/1/21	0.0218	2.2	0.40
7/6/21	0.048	4.6	1.84
8/3/21	0.0324	2.7	0.73
9/7/21	0.0191	2.1	0.33
10/5/21	0.0296	3.4	0.84
6/7/22	0.0282	3.0	0.71
7/5/22	0.022	4.5	0.83
8/2/22	0.005	3.4	0.14
9/6/22	0.0239	2.3	0.46
10/4/22	0.0344	2.8	0.80
6/6/23	0.0527	4.7	2.07
7/7/23	0.0393	4.3	1.41
8/1/23	0.0313	2.8	0.73
Sep		n/s	
Oct		n/s	
Average	**0.030**	**3.29**	**0.87**

12/5/23	0.019		3.8	0.60
1/10/24	0.0503		3.8	1.59
Feb		n/s		
3/12/24	0.044		3.9	1.43
Average	**0.033**		**3.34**	**0.94**

Calculated Instream Phosphorus Concentration (mg/l) criterion at Low Monthly Median stream flows

6/3/2024

PERMITTED DISCHARGE FLOW

Permittee	Design Flow MGD	Design Flow CFS	Receiving Water	Low Median Monthly CFS	LMM IWC	Effluent Phosphorus Concentration (mg/)	Instream Phosphorus (mg/l)
Danville	0.06000	0.09	Water Andric	1.18	0.073	3.30	**0.241**

CURRENT DISCHARGE FLOW

Permittee	Current Flow MGD	Current Flow CFS	Receiving Water	Low Median Monthly CFS	LMM IWC	Effluent Phosphorus Concentration (mg/)	Instream Phosphorus (mg/l)
Danville	0.03000	0.05	Water Andric	1.18	0.038	3.30	**0.125**

Potential Regulatory Issues

VWQS Instream Nutrient TP Screening Criteria — Section 29-A-306 Table 2 pg 29 — **Instream TP Criteria (mg/l)**

Water Andic: Classifaction B2/SHG — **0.012**

EPA 1986 "Gold Book Recommendation" — Pages 241-249 — **Instream TP Criteria (mg/l)**

0.1 mg/l

Monitoring Site Summary - River/Stream

Water Andric

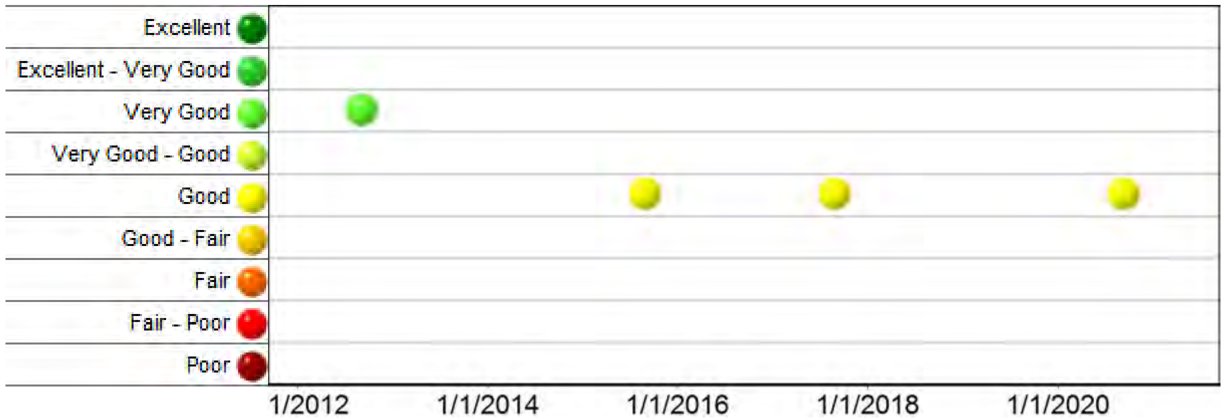
River Mile: 6.6

Located above Danville WWTF discharge. WQ sampled immediately below V-weir and above PVC discharge pipe. Bugs sampled above small V-weir impoundment in woods.

Danville, VT (44.41299, -72.12968)

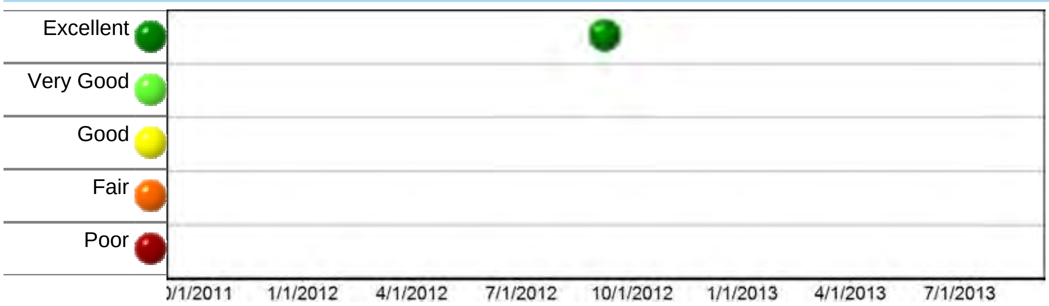
Macroinvertebrate Assessment

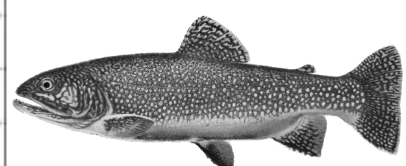
Macroinvertebrate population Assessments are a measure of the biological integrity of the macroinvertebrate community and an indicator of the health of the aquatic biota. (For More Details)



Fish Assessment

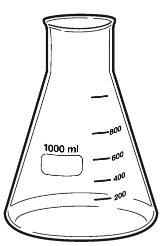
Fish populations provide a measurement of the general health of the aquatic biota. Since fish occupy the top of the food web their population integrates the conditions of lower community types. (For More Details)

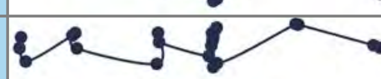
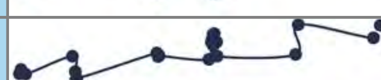




Water Quality Measurements

Chemical and physical parameters provide a “snapshot” of current conditions and are used to detect changes in water quality and to make determinations about a waterbody and its watershed. (For More Details)



Characteristic	Description	Trend	Max	Mean	Min
Chloride (mg/L)	At elevated values mostly from deicing		119.0	62.9	22.1
Conductivity (umho/cm)			744.2	527.5	264.6
Nitrogen (mg/L)	Nutrient that may fuel algae blooms		1.9	1.2	0.4
pH	Acidity		8.3	8.0	7.7
Phosphorus (ug/L)	Nutrient that may fuel algae blooms		156.0	26.9	6.0
Turbidity (NTU)	Measure of suspended sediment		48.7	3.2	0.0

Habitat Observations

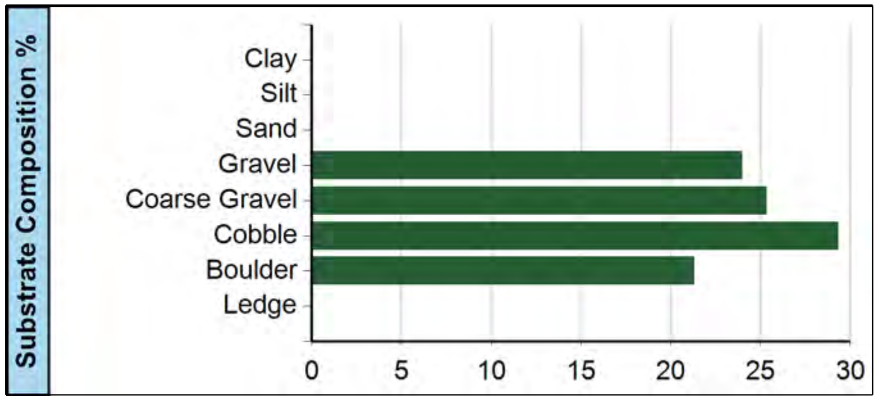
Observations on the physical condition of the waterbody can be useful in determining the habitat type present and if watershed stressors have degraded its ability to support a healthy community of aquatic biota. (For More Details)

Observation Date: 9/16/2020

Habitat Type: Riffle

Embeddedness Estimated %: 50

Canopy %: 45



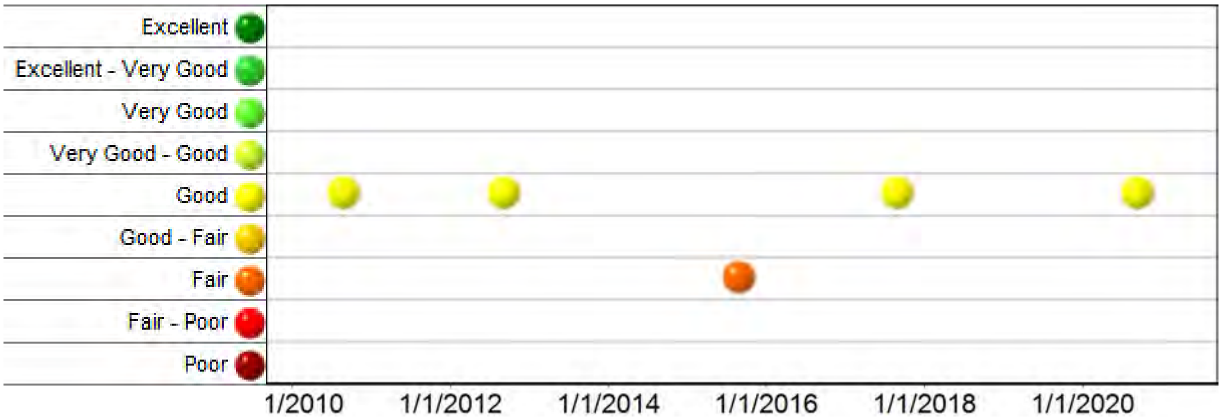
Monitoring Site Summary - River/Stream

Water Andric

River Mile: 6.5
Located below Danville WWTF.
Danville, VT (44.41238, -72.12876)

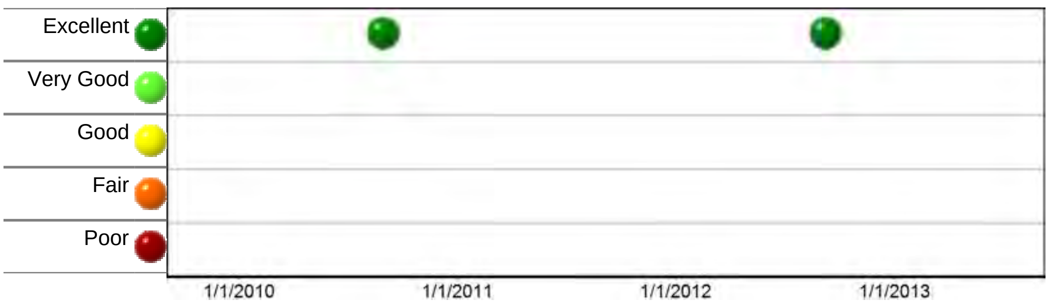
Macroinvertebrate Assessment

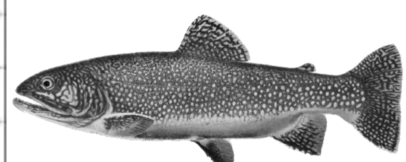
Macroinvertebrate population Assessments are a measure of the biological integrity of the macroinvertebrate community and an indicator of the health of the aquatic biota. (For More Details)



Fish Assessment

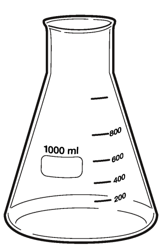
Fish populations provide a measurement of the general health of the aquatic biota. Since fish occupy the top of the food web their population integrates the conditions of lower community types. (For More Details)





Water Quality Measurements

Chemical and physical parameters provide a "snapshot" of current conditions and are used to detect changes in water quality and to make determinations about a waterbody and its watershed. (For More Details)



Characteristic	Description	Trend	Max	Mean	Min
Chloride (mg/L)	At elevated values mostly from deicing		119.0	68.9	22.4
Conductivity (umho/cm)			923.4	553.1	266.2
Nitrogen (mg/L)	Nutrient that may fuel algae blooms		3.2	2.0	0.7
pH	Acidity		8.3	7.9	7.6
Phosphorus (ug/L)	Nutrient that may fuel algae blooms		786.0	297.1	110.0
Turbidity (NTU)	Measure of suspended sediment		46.7	3.6	0.0

Habitat Observations

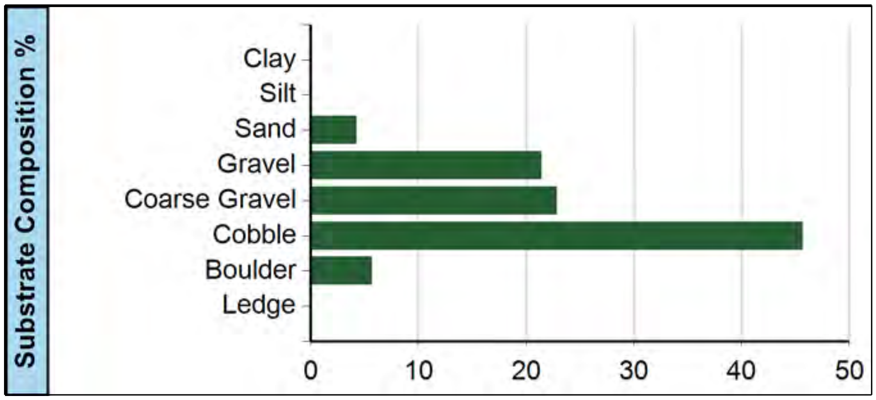
Observations on the physical condition of the waterbody can be useful in determining the habitat type present and if watershed stressors have degraded its ability to support a healthy community of aquatic biota. (For More Details)

Observation Date: 9/16/2020

Habitat Type: Riffle

Embeddedness Estimated %: 35

Canopy %: 75



Appendix C

Mechanical and Electrical Evaluation

Engineering Services of Vermont, LLC
Mechanical-Electrical Consulting Engineers

9 Washington Street
Rutland, Vermont 05701
802.855.8091

5430 Waterbury-Stowe Rd., 2nd Floor
Waterbury Center, VT 05677
802.882.8449

www.EngineeringVermont.com

Danville Wastewater Treatment Plant

Danville, Vermont
Mechanical, Electrical & Plumbing Systems Conditions Report

January 15, 2024

DIVISIONS 22/23 MECHANICAL & PLUMBING

1. General
    a. A site inspection was performed 12/13/2023 by Jerry L. Marshall, P.E., to inspect and evaluate the existing conditions, identify any deficiencies, and identify any potential opportunities to reduce operational costs.
    b. ESVT was provided with existing condition drawing dated May 1981 along with a Status and Condition of existing equipment dated 2022 from Dufresne Group.
2. Heating
    a. The U.V. Building is unheated, as all of the equipment in that space is in the Lower-Level Headworks & Disinfection space.
    b. The Maintenance Room in the operations building has a through the wall LP gas-fired empire heater that is aging but is still working.
    c. The Maintenance Room has an electric heater in the opposite corner of the room that exists and appears to be original. It is unclear if this heater is being used.
    d. The Office in the operations building has a through the wall LP gas-fired empire heater that is aging but is still working.
    e. The bathroom has a strip of electric resistance heating. It is unclear if this operational.
    f. <u>Recommendations</u>
        i. Thru the wall LP gas-fired heaters to remain.
        ii. New bathroom electric strip heater
            1. Magnitude of Cost - $500-$750
        iii. See below for discussion of adding a cold climate heat pump that can also be used for heating for the Office and Lab space.
            1. Magnitude of Cost – *See below*

3. Ventilation
    a. The U.V. Building has an existing original centrifugal utility exhaust fan located in the Lower-Level with 14" diameter ductwork extended above grade with gooseneck and insect screen. The fan is original and is to be replaced with new. The exterior gooseneck is to be cleaned and painted with an exterior paint.
    b. There are 2 associated make-up air intake 120V motorized dampers with connected 6"x18" ductwork that are wired to the exhaust fan starter. These are original and should be replaced with new.
    c. The existing bathroom exhaust fan shall be removed and replaced with new 2-speed Panasonic exhaust fan that runs at low speed continuously and will ramp up to high speed when a switch is turned on.
    d. There is a centrifugal upblast exhaust fan on the roof above the process pump/blower room. There is a cooling only thermostat that is to activate this exhaust fan if the room temperature achieves 90degF. There is an associated outdoor air intake with motorized damper that shall open when the exhaust fan is energized. This is system original and is to be replaced with new.
    e. The process pump/blower room has a supplemental exhaust fan that "transfers" air from the process room to the adjacent office space if this room needs supplemental heat. It is unclear if this system is operational. Additionally there does not appear to be a ducted path to be able to recirculate that air back to the process room.
    f. <u>Recommendations</u>
        i. Replace the bathroom exhaust fan with a new Panasonic exhaust fan to run off a switch.
            1. Magnitude of cost - $750 - $1,000.
        ii. New U.V. building exhaust fan and dampers.
            1. Magnitude of cost - $6,500-$7,000.
        iii. New process room exhaust fan and 120v cooling only thermostat.
            1. Magnitude of cost - $4,500 - $6,000.
        iv. Remove Process room transfer fan and all associated ductwork.
            1. Magnitude of cost - $1,000-$1,500.
4. Air Conditioning
    a. The U.V. building has no air conditioning.
    b. There is an existing air handling unit with DX coil, electric heating coil (noted on original drawings), outdoor air connection (with motorized damper), supply air distribution to the Lab and Office space, return air from the office space,

refrigeration liquid and suction lines and an associated outdoor condensing unit. Based on discussions with facilities, this appears to not be operating.

c. <u>Recommendations</u>

    i. Replace the existing air handling unit and outdoor condensing unit with a cold climate outdoor heat pump and an associated indoor fan coil unit. This will provide HVAC for the Office and Lab space. Note: the existing through the wall LP gas-fired heater shall remain as a back-up.

        1. Magnitude of cost - $10,500-$12,000.

5. Plumbing

a. The U.V. building has two plumbing wall hydrants which are original and appear that they are in working order.

b. The lab has sink with hot/cold faucet and vacuum breaker. This is in OK condition and shall remain.

c. The existing hot water heater is in poor condition and shall be replaced with new. The new water heater shall be a 50-gallon hybrid heat pump water heater with new isolation valves, check valves, thermostatic mixing valve, and all other accessories for a complete installation.

d. The existing lavatory and faucet shall be removed and replaced with a new wall mounted lavatory with concealed arm support, stainless steel stops, p-trap with insulation kit and sensor single hole faucet with ASSE mixing valve for temperature adjustment below.

e. The existing toilet shall be removed and replaced with new universal height, 1.28 gpf, handle on approach side with open front seat with soft close cover, waxless seal and johnnie bolts.

f. The existing shower shall be removed and replaced with new 36”x36” shower with new shower head, control valve and rough-in valve.

g. There is an existing hand- held eyewash mounted adjacent to the lab sink that should be replaced with new.

h. <u>Recommendations</u>

    i. New hot water heater and accessories as defined above

        1. Magnitude of cost - $4,500 - $5,500.

    ii. Provide a new deck mounted swivel emergency eyewash with an ASSE 1071 thermostatic mixing valve.

        1. Magnitude of cost - $1,850 - $2,500.

    iii. New lavatory, water closet, shower as defined above.

        1. Magnitude of cost - $6500 - $8,000.

DIVISIONS 26/27/28 ELECTRICAL

1. General

   a. A site inspection was performed 12/13/2023 by Claus Bartenstein, P.E., to inspect and evaluate the existing conditions of the facility electrical power systems, identify any deficiencies, and identify any potential opportunities to reduce operational costs.

   b. ESVT was provided with existing condition drawing dated May 1981 along with a Status and Condition of existing equipment dated 2022 from Dufresne Group.

2. Electrical Service and Distribution

   a. Electrical service is 120/208V 3 phase, with wiring routed underground from a pole top bank of transformers terminating in a 225 Amp main circuit breaker panel. A 100 Amp sub-panel located in the garage is fed from the main panel.

   b. Capacity of the electrical service is 81 KW. Peak demand for the building, as obtained from Green Mountain Power is reported to be 11 KW which equates to 31 Amp at 208V 3 phase.

   c. The circuit breaker panels are aging. The main 225 Amp panel is a circuit breaker panelboard with motor starters for the two blowers integral to it. The panel is a product of FPE (Federal Pacific Electric). The circuit breaker panel in the garage is a standard main lug panelboard and is also FPE. FPE products have been found to be unreliable and the company was sold off decades ago after falsifying UL Listings of some of their equipment.

   d. Blower #1 is powered through a separate variable frequency drive (VFD) and the motor starter in the main panel is abandoned with only the circuit breaker being used.

   e. There is no generator providing back-up power for the building.

   f. <u>Recommendations:</u>

      i. Replace both circuit breaker panels with new and provide a VFD for blower #2.

         1. Magnitude of Cost – $16,000 - $20,000.

      ii. Provide a 40KW stand-by power LP gas fired generator for the building including service rated automatic transfer switch.

         1. Magnitude of Cost - $66,000 to $75,000.

            a. Does not include LP gas, assumed to be provided by gas supplier.

3. General Power

   a. Wiring methods generally appear appropriate for the different spaces in the facility.

b. Some of the raceways, couplings and supports in the lower levels of the Effluent (UV) Building are severely corroded to the point of disintegration.

c. Ground fault protection of receptacles is missing throughout the facility.

d. No service receptacle exists at the condensing unit.

e. There is no receptacle in the sampling hut requiring extension cords to be run from the Control building.

f. Recommendations

   i. Repair/replace corroded raceways, couplings and supports in the Effluent Building. Inspect all electrical connections for corrosion and repair/replace as necessary.

      1. Magnitude of Cost - $5,000 - $7,500.

   ii. Replace standard receptacles with GFCI type, where necessary

      1. Magnitude of Cost - $600 - $750

   iii. Provide a service receptacle (GFCI, weather proof cover) at condensing unit.

      1. Magnitude of Cost - $175 - $250

   iv. Provide a receptacle (GFCI, weather proof cover) at sampling hut on dedicated circuit. Wiring routed underground to building.

      1. Magnitude of Cost - $500 - $750

4. Lighting

a. The lighting systems are original to the circa 1980 construction and show their age. The luminaires are generally in fairly good condition. Interior luminaires are linear fluorescent, T-8 and T-12 lamps, mix of magnetic and electronic ballasts. Fluorescent and LED replacement lamps have been installed in lamp holders. Lighting controls are typically manual switches.

b. The lighting in the Effluent Building is enclosed and gasketed lamp holders. There are a few of these with the glass globe filled with water. *See photo to right.*

c. No exit signage exists in the building. All egress doors are required to be marked with internally illuminated signage, with battery power.

d. No emergency lighting exists in the building. The only space requiring emergency lighting is the space containing the main panel (blower room), per our Code review.

e. Exterior building mount luminaires are HID wall packs controlled via switch inside the building.

f. The Operators had relayed that it would be helpful to have motion sensor lights on the exterior of the building to illuminate the front of the building when they arrive after dark.

g. Recommendations

   i. Replace all interior lighting with new LED light source luminaires. Provide automatic lighting controls in all spaces to meet the requirements of the State Energy Code.

      1. Magnitude of Cost – $5,000 - $7,500

   ii. Investigate and correct source of water in raceways serving the Effluent Building lighting and correct to eliminate water collection in the luminaires.

      1. Magnitude of Cost - $1,000 - $2,500

   iii. Provide internally illuminated exit signage at all egress doors.

      1. Magnitude of Cost - $400 - $500

   iv. Provide emergency lighting in the blower room.

      1. Magnitude of Cost - $400 - $500.

   v. Replace all exterior lighting with full cut-off, LED light source wall pack luminaires with integral photocells.

      1. Magnitude of Cost – $500 - $750

   vi. Provide motion sensor-controlled flood lighting to the front of the building.

      1. Magnitude of Cost - $250 - $500

5. Process Alarm System

   a. The Sensa Phone process alarm system is antiquated. The system calls out that there is an alarm, but the Operators do not know what the problem is, big or small, until they arrive on-site.

   b. Recommendations

      i. Complete replacement of the process alarm system to send signal offsite.

         1. Magnitude of Cost - $10,000 to $15,000.

6. Telecommunications

   a. There is no internet at the facility, presently. There is no cellphone service at this location. The Operators relayed that it would be much more efficient to perform their work with internet service and Wi-Fi in the building.

   b. Recommendations

i. Provide internet access with present telecom service provider along with wireless access in the Control Building.

1. Magnitude of Cost - $250 - $350

Appendix D

Rates

Code	Description	Type	Method	Unit	Min Chg	Min Usage	Peak Season	Base Chrg	Lower Bound	Rate
SAH	Sewer Apartment House	Flat	Standard		0.00	0				165.000000
SBB	Sewer Inn/B&B per unit	Flat	Standard		0.00	0				41.250000
SBC	Sewer Base Commercial	Flat	Standard		0.00	0				165.000000
SBK	Sewer Bank per Employee	Flat	Standard		0.00	0				9.900000
SBS	Sewer Beauty Shop Chair	Flat	Standard		0.00	0				108.900000
SCH	Sewer Church	Flat	Standard		0.00	0				165.000000
SGR	Sewer Grocery/Mini-Mart	Flat	Standard		0.00	0				275.550000
SHC	Sewer Health Center	Flat	Standard		0.00	0				275.550000
SLB	Sewer Library	Flat	Standard		0.00	0				145.200000
SLD	Sewer Laundramat Machines	Flat	Standard		0.00	0				275.550000
SOF	Sewer Office Space	Flat	Standard		0.00	0				54.890000
SPO	Sewer Post Office	Flat	Standard		0.00	0				54.890000
SPT	SEWER PORTABLE TOILET	Flat	Standard		0.00	0				275.550000
SRT	Sewer Restaurant Seats	Flat	Standard		0.00	0				9.900000
SSC	Sewer School w/caf. & gym	Flat	Standard		0.00	0				9.900000
SSF	Sewer Single Family	Flat	Standard		0.00	0				165.000000
SSH	Sewer Senior housing	Flat	Standard		0.00	0				107.250000
SSS	Sewer Service Stations	Flat	Standard		0.00	0				275.550000
SST	Sewer Non-Food Retail	Flat	Standard		0.00	0				54.890000
STG	Sewer Town Garage	Flat	Standard		0.00	0				110.000000
STO	Sewer Town Office	Flat	Standard		0.00	0				165.000000