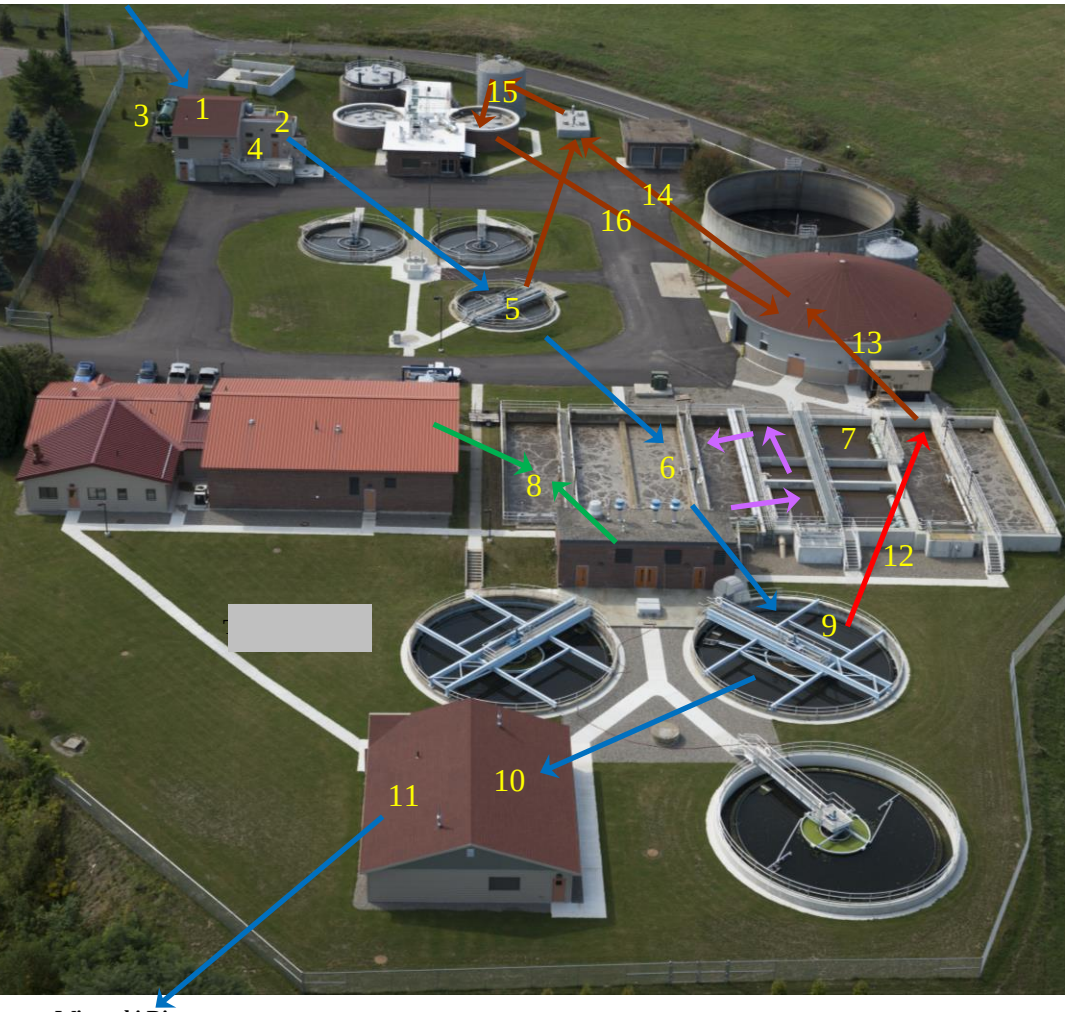
SOUTH BURLINGTON
AIRPORT PARKWAY
WATER QUALITY FACILTY

30 SB Pumpstations plus 9 Colchester Pumpstations



Winooski River

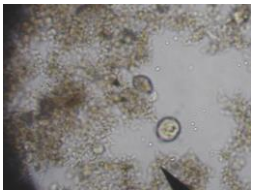
1. **Fine 6 mm Band Screen/Wash Press**: Paper/plastic/rags are screened, washed, compressed and sent to the landfill
2. **Grit Chamber**: Sand and Rocks are settled out by a reduction in the Influent velocity and air diffusion, dewatered, pumped into a bin and sent to the landfill
3. **Septage Receiving**: Septage unloaded into tank that is pumped into influent flow; 54% of Vermonters are on septic systems
4. **Odor Control**: Ferrous chloride added to reduce odors/minimize corrosion
5. **Primary Settling Tanks**: Primary solids are settled out by a reduction in Influent velocity; solids to Pre-Feed Tank →
6. **Aeration Tanks**: BOD/TSS are further reduced by bacteria/single cell organisms in the mixed liquor (aerated at >2.0 mg/L O_2)
7. **Anoxic/Anaerobic Tanks**: Biological Nutrient Removal by mixing primary effluent with recycled denitrified (no nitrate) mixed liquor in tanks with no oxygen causing (luxury) uptake of phosphorus
8. **Chemical Addition**: Alum is pumped into the Aeration Tanks where it precipitates out Phosphorus and Sodium Hydroxide is added for pH adjustment →
9. **Secondary Clarifiers**: Secondary Solids are settled out in the Clarifiers
10. **Filters:** Secondary Effluent passes through 10 micron filters
11. **Ultraviolet Disinfection (UV)** The Secondary Effluent passes through 254 nanometer wavelength UV causing DNA thymine dimers, disrupting reproduction
12. **Return Activated Sludge** (RAS): Secondary Solids are pumped from the bottom by the RAS pumps and returned to the Aeration Tanks →
13. **Waste Activated Sludge** (WAS): A certain percentage of the RAS is pumped by the WAS pump to Rotary Drum Thickener
14. **Thickened Waste Activated Sludge** (TWAS): is pumped to a holding tank and then to Pre-Feed Tank →
15. **2-PAD System:** Pre-Feed Tank batches every 6 hours to the Thermophilic Digester (135 F) then to the Mesophilic Digesters (95 F) digesting the solids/producing methane that supplies the boilers and a 65kW microturbine for electricity generation
16. **Digested Solids:** Pumped (3%) to 1,000,000 gallon holding tank and then centrifuge to produce (21%) Class A Solids

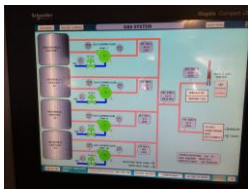
HISTORY

1967 Primary facility constructed. BOD/TSS removal approximately 50%. Chlorine gas disinfection.
1987 Secondary treatment added. BOD/TSS removal over 90%.
1994 Chemical feed upgrade. Sodium Bisulfate added to reduce chlorine residual in river.
2011 $28 million upgrade including UV disinfection instead of chlorine gas, Biological Nutrient Removal (BNR) system (Modified University of Cape Town system), 10 micron microfiltration, 2PAD Anaerobic Digestion system producing Class A Biosolids, 65 kW capstone microturbine for electricity production. BOD/TSS removal over 99%; Grade 5 Facility (Vermont DEC highest level)

	DESIGN	EFFLUENT 2015		
Average Daily Flow	3.25 Million Gallons per Day (MGD)		1.8 MGD	
Peak Hourly Flow	7.92 MGD		**Limit**	**2015**
Organic Loading	6,880 lbs per day BOD	BOD:	30 mg/L	2 mg/L
	6,880 lbs per day TSS	TSS:	30 mg/L	1 mg/L
	1,375 lbs per day TKN	TP:	0.8 mg/L	0.2 mg/L
	8 mg/L Total Phosphorus (TP)	E. coli:	77/100 ml	2/100 ml

Average percent of Winooski Flow = 0.15% (Winooski 2015 Avg. Flow = 1,845.0 cfs; AP = 2.8 cfs)
6,250 connections. Airport Parkway Facility replacement cost is estimated at $55-$60 million.

The South Burlington Airport Parkway (AP) Wastewater Treatment Facility was constructed in 1967. Many similar sized cities in the United States built comparable facilities during this period. Before the 1960's most municipal sewer systems in the United States emptied into rivers, lakes or the oceans. Even in large cities like New York City, the sewer system was completed by 1900 but most treatment facilities were not built until after World War II. In the South Burlington sewer system, sewage flows into a series of progressively larger pipes until it reaches the two wastewater treatment facilities. The South Burlington system carries wastewater and storm runoff in separate pipes with South Burlington having the first Stormwater Utility in Vermont. Only about 800 U.S. cities still rely on combined systems, the majority, over 20,000 municipalities, have separate systems. The South Burlington system consists of 99 miles of City sewer (not including laterals) which relies on gravity for movement, although 30 pumpstations help where the topography is difficult.

The AP facility constructed in 1967 was a primary system that settled out some of the solids and then chlorinated the primary effluent before it was discharged into the Winooski River. It removed approximately 50 percent of the TSS and BOD from the influent. In 1987, the facility was upgraded to secondary biological treatment. Sodium bisulfate injection into the effluent was added at that time to remove the chlorine residual in the effluent. This negated any effect the chlorine could have on aquatic life in the Winooski. In 2011, the facility was upgraded again to a Biological Nutrient Removal (BNR) system, a Modified University of Cape Town system with 10 micron microfiltration, 2PAD Anaerobic Digestion system producing Class A Biosolids and a 65 kW Capstone microturbine for electricity production from the methane gas produced. This is enough electricity to power 83 South Burlington homes. In 2011 ultraviolet light disinfection was also introduced. It is much safer than the dangerous chorine gas used previously. AP currently removes over 99 percent of the TSS and BOD before the effluent is discharged which unfortunately is far cleaner than the Winooski River that receives it. For example, in 2015 the TSS in the Winooski River averaged 143 mg/L, AP effluent averaged less than 2 mg/L. E. coli averaged 240 colonies per 100 mL in the Winooski River (2014 most recent data/ closest sample location near Montpelier) and AP effluent averaged 1 colony per 100 mL in 2014.

Airport Parkway is a state of the art biological treatment facility. It processes all the wastewater received from over half of South Burlington (657 million gallons in 2015) as well as leachate from the closed South Burlington landfill, septage from local septic tanks and the majority of the Colchester wastewater flow. Allen-Bradley PLC's (Programmable Logic Controllers) control most processes interfaced through SCADA (Supervisory Control and Data Acquisition) computers. This facility is a biological treatment facility and thus is "alive" and must be constantly monitored for proper operation. There are two main processes for solids reduction. The first are aeration tanks where aerobic bacteria breakdown solids that enter the tank. Large turbo blowers provide oxygen to keep these tanks at the optimal level. The second are anaerobic digesters that contain anaerobic bacteria that also reduce solids. A byproduct of this process is methane gas which is used to heat the facility and power the microturbine to produce electricity.

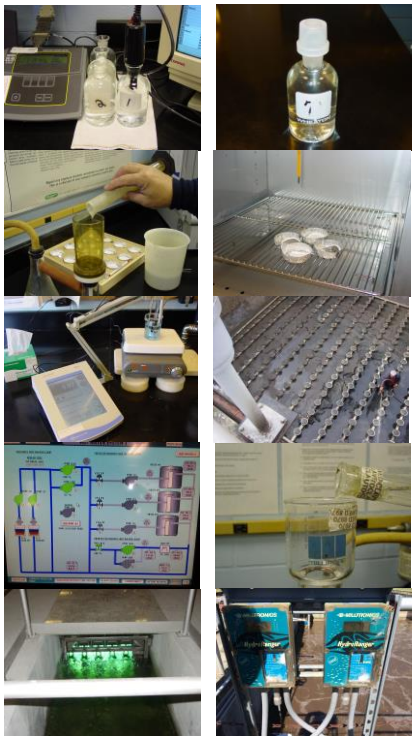
Airport Parkway is a State of Vermont Grade 5 facility (the highest level). The addition of Alum along with the BNR system reduces the approximately 60 lbs of phosphorus received by the facility daily to approximately 2 lbs. This is important to the health of Lake Champlain, as phosphorus is a nutrient that encourages algae production.

In addition to the Airport Parkway facility staff also operates the Bartlett Bay facility. This is an advanced 1.25 MGD Kruger Process facility with UV disinfection and 10 micron filtration located off route 7 next to the Magic Hat facility.

The laboratory does constant monitoring of the processes and makes any adjustments that are necessary. The laboratory does testing for pH, settleable solids, total suspended solids, total solids, total volatile solids, phosphorus, BOD, e. coli, ammonia, nitrate, nitrite, transmittance, alkalinity, temperature, turbidity and collects samples for metals, enteric viruses, Helminth ova, PCBs and Whole Effluent Toxicity testing (fish viability). The laboratory operators are certified analysts and the laboratory undergoes yearly federal testing of all permit tests for accreditation.

The facility operators must undergo testing to be licensed by the state with yearly class requirements. Vermont State Operator levels are Grade 1 progressing to Grade 5. The staff of seven consists of three Grade 5 operators, one Grade 4, two Grade 3 operators and one operator in training to oversee two advanced facilities and thirty (twenty-eight sewage/two landfill) pumpstations. Daily actions and decisions dictate the quality of the effluent. The Operators are "boots on the ground" environmentalists and true guardians of the Winooski River and Lake Champlain.

GLOSSARY OF TERMS



BOD (Biochemical Oxygen Demand): Test for the "strength" of wastewater where 300 mL of sample water is stored in a dark chamber, sealed, at 20º C for 5 days and the amount of oxygen used by the organisms is then analyzed.

TSS (Total Suspended Solids): Test for the amount of suspended solids in a sample of water. A set quantity of sample water is filtered through a glass fiber filter paper. The paper is weighed before the sample is filtered through it and after drying at 104º C, for one hour, giving weight of solids left on filter.

pH: Test for the amount of hydrogen atoms in a water sample (1-6 acid, 7 neutral, 8-14 alkaline) by a probe connected to the meter with a temperature compensation probe also inserted into the sample.

E. Coli: Test for the amount of e. coli in a water sample where a set quantity of sample water added to sealed media tray and kept at 35º C for 24 hours. E. coli colonies are then counted under a florescent light.

Settleable Solids: Test where 1000 mL of Influent and 1000 mL of Effluent are settled in separate Imhoff cones for 60 minutes (stirred at 45 minutes).

Volatile Solids: Test where organic solids are burned off at 550º C for 1 hour leaving inorganic solids. Original weight – residue weight = volatile solids.

Influent: Untreated water that enters the facility.

Effluent: Treated water that leaves the facility. **MGD**: Millions of Gallons per Day.

Weight of water: 8.34 pounds per gallon. **Gallons of water per cubic foot**: 7.48 gallons.

Anaerobic: without oxygen **Anoxic**: less than 0.5 mg/L O_2 **Aerobic**: over 2.0 mg/L O_2

Mixed liquor: Industry term for bacteria under aeration **Cake**: Industry term for processed Biosolids

Nitrification: Process in aeration tanks where ammonia is converted by Nitrosomonas bacteria to nitrite and nitrite is then converted by Nitrobacter bacteria to nitrate under temperatures above 10º C and O_2 levels >2 mg/L. Ammonia to Nitrite: $NH_4^+ + 1.5\ O_2 \rightarrow NO_2^- + 2\ H^+ + H_2O$ Nitrite to Nitrate: $NO_2^- + 0.5\ O_2 \rightarrow NO_3^-$

Denitrification: Process where nitrate converted to nitrogen gas by heterotrophic bacteria in anoxic conditions. Nitrate to Nitrogen gas: $2\ NO_3^- + 10\ e^- + 12\ H^+ \rightarrow N_2 + 6\ H_2O$

BNR (Biological Nutrient Removal): Process that facilitates the removal of nitrogen and phosphorus. The first tank in series is anaerobic where influent is mixed with recycled mixed liquor that has been through an anoxic zone to remove nitrates. The lack of oxygen and nitrates forces the bacteria to utilize stored energy in their cells in the form of phosphorus when taking in the influent BOD (food) to reproduce and grow.

F/M (Food to Mass): = (Influent BOD into tank * Influent flow into tank * 8.34) / (Size of tank * 8.34 * Tank Suspended Solids * Total Volatile Solids). Optimum ratio for South Burlington is approximately 0.30.

MCRT (Mean Cell Residence Time): = Pounds of solids in the aeration tanks + Pounds of solids in secondary clarifiers / Pounds of solids wasted to the digesters (in days). Optimum for South Burlington varies by season but approximately 10 days is average.

Detention Time: Gallons into facility for plant detention time or into digesters for digester detention time / capacity of facility or digesters in gallons = detention time in days.