

2022

Annual Report

Napanee Water Pollution Control Plant

300 Water Street W.
Napanee, Ontario
K7R 1X3

Prepared: January 2023

Executive Summary

The quality of effluent released to the Napanee River from the Napanee Water Pollution Control Plant (WPCP) during 2022 complied with the limits stipulated in the plant Environmental Compliance Approval (ECA). The effluent bacteriological quality measured as *E. Coli*. met the ECA operational objective (<200 CFU/100mL) in 9 months of the year. The highest reading was in March 2022 when the monthly geometric mean was 1629 CFU/100mL.

Total annual flow measured in 2022 increased by approximately 8.3 percent when compared to the previous year, with the average day flow representing 75 percent of the plant design capacity. Efforts to detect the inflow and infiltration of storm and ground water sources will continue throughout 2023.

Biosolids generated at the facility were temporarily stored at the Sutcliffe Lagoon and were applied to agricultural land during May, June and October by GFL Environmental, all in accordance with the sites Certificates of Approval and Ontario Regulation 267/03.

Maintenance and upgrading activities during 2022 included replacing both activated sludge valves on the secondary clarifiers at the WPCP. In addition to these projects, the sanitary sewer main on portions of Richard Street and Bridge Street were replaced which included sanitary services to individual property lines. The department also completed five sewer service repairs in 2022.

Planning for the upgrade and expansion of the aging and hydraulically limited Water Pollution Control Plant continued in 2022 with the award of a new design contract in March. Design is underway with construction planned for 2024 through 2026.

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1 Wastewater Flows and Effluent Quality

Wastewater Flow Data

The Napanee Water Pollution Control Plant (WPCP) is a conventional activated sludge process, with an average day design flow rate of 9087 m³/d, and a peak flow rate of 21,370 m³/d. The average flow during 2022 was 6844 m³/d, which is approximately 75 percent of the design capacity. Non-compliance with respect to treatment capacity is defined in the Environmental Compliance Approval as:

“...the introduction of sewage flows in excess of the average daily flow (9087 m³/d) for any consecutive period of time greater than one year.”

The plant design capacity of 9087 m³/d was exceeded on 62 days in 2022 which is an increase when compared to the 27 days experienced in 2021. WPCP flow data collected during 2022 is presented in Table 1.

The hydraulic capacity of the plant continues to be stressed as a result of high flow experienced during heavy precipitation events or during periods of rapid ice and snow melting. The maximum daily flow during 2022 was 29,345 m³/d, with 20,399 m³ receiving full treatment and 8946 m³ bypassing the secondary treatment process. Although the Town of Napanee has a separate storm water collection system, improper connections, broken pipes, or faulty joints in sanitary sewers can result in the introduction of ground and storm water into the sanitary collection system. This misdirected hydraulic load on the sanitary system is collectively referred to as inflow and infiltration. Inflow and infiltration is problematic because it occupies treatment capacity that could otherwise be used to treat sanitary wastewater.

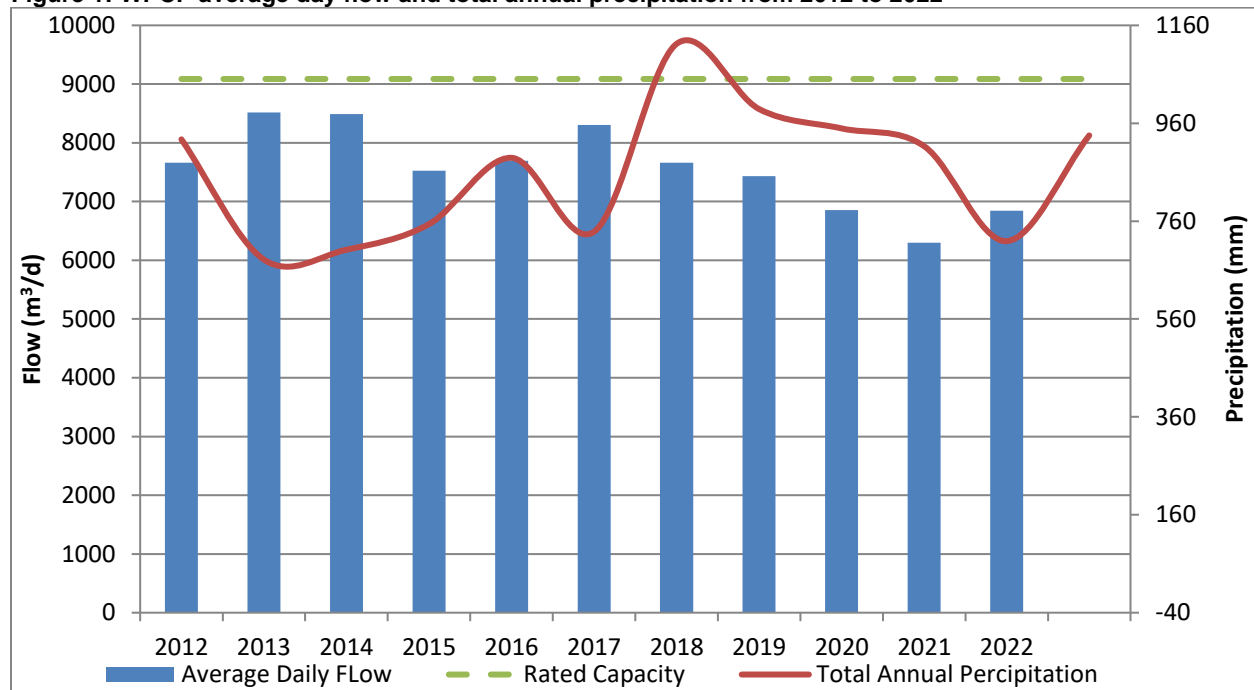
Table 1: Summary of flow data for 2022

Month	Treated Volume			
	Total (m ³)	Average (m ³ /day)	Maximum (m ³ /day)	Minimum (m ³ /day)
January	166872	5383	6858	4484
February	206242	7366	16320	4615
March	326485	10532	16014	5887
April	296399	9880	15481	7204
May	235155	7586	14159	5805
June	208218	6941	11631	4649
July	153707	4958	9574	3993
August	152179	4909	10122	3699
September	142052	4735	8073	4097
October	159098	5132	7214	4144
November	180848	6028	12313	4425
December	269036	8679	20399	5672
Year Total	2496291			
Average		6844		
Min / Max			20399	3699
C of A Limit		9087	21370	

The apparent impact of inflow and infiltration over the past several years on the Napanee system is highlighted by trending annual average day flow with total precipitation as shown below in Figure 1.

Dry weather flow, typically experienced during summer months (July through September), is an approximate representation of sanitary wastewater flows exclusive of the effects of inflow and infiltration. Minimum daily flow rates recorded during those months indicate that dry weather flow accounts for 41 percent of the average day design capacity. The 2022 average day flow was 75 percent of the design capacity, an increase from 69 percent in 2021. Inflow and infiltration continue to be problematic and repairs to identified issues will continue throughout 2023.

Figure 1: WPCP average day flow and total annual precipitation from 2012 to 2022



Efforts to identify and control sources of inflow and infiltration have included the following:

- Greater Napanee Utilities retained a consultant in early 2012 to conduct an inflow and infiltration study. Using this study, collection system deficiencies were corrected in 2013 and 2014.
- Flow meters are installed at six of seven sewage lift stations to determine areas of the collection system most impacted by inflow and infiltration.
- Restoration work has been conducted on manhole joints, connections, and benching as problem areas are identified.
- Covers (dishes) have been installed under the lids of several manholes to prevent surface water from entering through holes in the manhole lids.
- Local construction specifications require that new manhole installations include rubber seals.
- A municipal bylaw prohibits the connection of sump pumps and rain leaders to the sanitary sewer. Staff have had great success in removing existing connections

through education and outreach, with 58% of known connections disconnected since 2016.

- Annual capital infrastructure renewal continued in 2022 with sanitary mains and services on Town property replaced on sections of Richard and Bridge Streets.

Efforts to reduce inflow and infiltration to optimize treatment reserve capacity will be ongoing.

Primary Bypass / Sewage Spills / Lift Station Bypass

Under all but the most extreme conditions, wastewater entering the plant undergoes preliminary treatment (screening and grit removal), primary treatment (gravity separation of solids by sedimentation), and disinfection. If the influent flow rate exceeds 38,000 m³/d, the excess will bypass the primary clarifiers, mixing with the primary clarifier effluent prior to flowing to the aeration basins. Bypassing of the primary clarifiers did not occur in 2022.

The discharge of untreated sanitary sewage from the collection system can occur at any of the seven sewage lift stations and/or collection system manholes as the result of flooding events, power outages, pump failures, or sewer blockages. Measures are in place to prevent bypassing/spills which include: multiple (backup) pumps at all lift stations, high level alarms, backup power generation capability, and readily available vacuum truck service.

Secondary Bypass

If the flow of wastewater directed to the aeration basins exceeds approximately 16,000 m³/d, the excess will pass over a flat weir (located immediately upstream from the aeration tanks), bypassing the secondary treatment process. Secondary bypassing limits the hydraulic loading on the secondary treatment process (aeration tanks and secondary clarifiers) to prevent washout of activated sludge which is essential for maintaining treatment process performance. Wastewater that bypasses the secondary process (which tends to be weak in strength due to dilution from inflow and infiltration) is

blended with the ~16,000 m³/d of secondary clarifier effluent, prior to disinfection and is discharged to the Napanee River.

The volume of secondary bypass discharged during 2022 was approximately 10 times more than the volume observed in 2021. This increase can be contributed to two large precipitation events and snow melts in December of 2022. A summary of the secondary bypass events during 2022 is provided below in Table 2.

Table 2: Summary of secondary bypass events during 2022

Month	Secondary Bypass Events		
	Total m ³	Events #	Duration hours
January	0	0	0
February	7651	2	55
March	6477	4	178
April	970	2	68
May	562	1	18
June	267	2	19
July	153	1	10
August	634	1	9
September	0	0	0
October	0	0	0
November	1661	2	17
December	20845	2	103
Annual Total	39220	17	475.9

*Ministry policy defines a bypass event as an occurrence separated by a period of more than 12 hours from another occurrence. When a bypass stops, it is considered to be the end of the event. If, however, a bypass begins again within 12 hours, it is considered to be the same event.

The relationship between precipitation and secondary bypass volume is illustrated in Figure 2. Staff will continue to follow trends as more inflow and infiltration issues in the wastewater collection system are addressed.

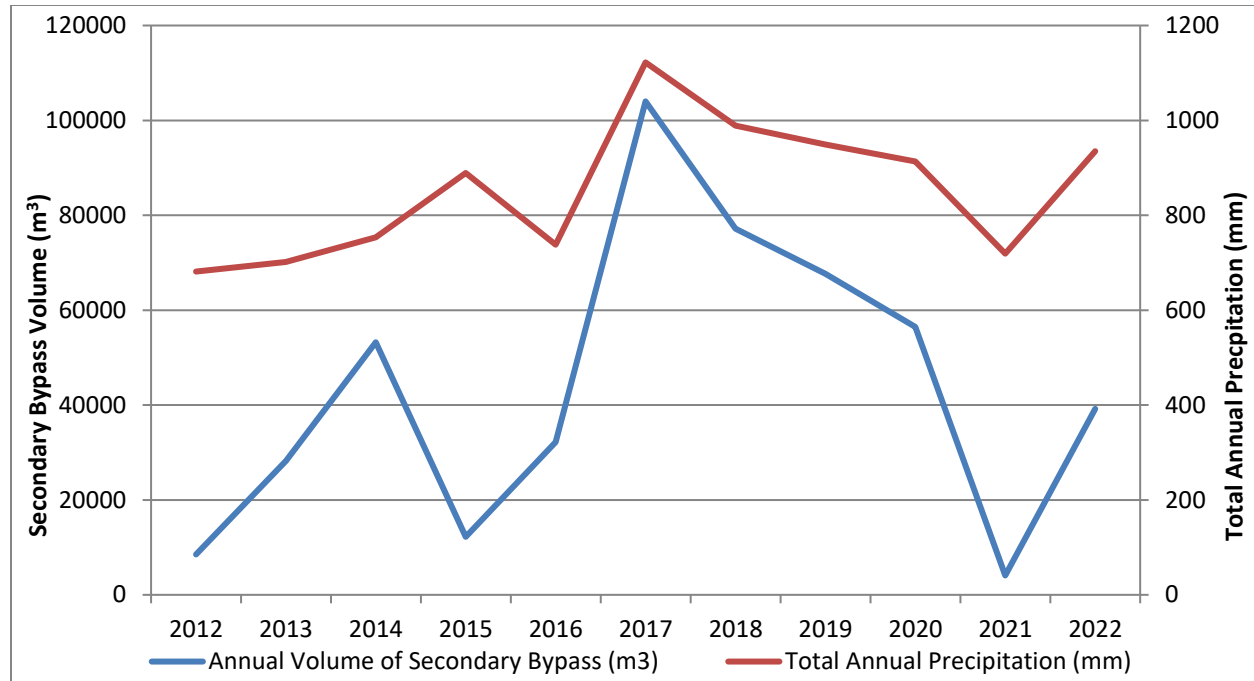


Figure 2: Total annual precipitation and volume of secondary bypass for 2022

BOD₅ and Total Suspended Solids Analytical Data

The removal of biochemical oxygen demand (BOD₅) and suspended solids from municipal wastewater is the primary design function of the Napanee WPCP, which utilizes a conventional activated sludge process. The principal mechanisms of removal include screening, sedimentation, and biodegradation. BOD₅ and suspended solids data collected during 2022 are summarized in Table 3.

Raw sewage entering the treatment process during 2022 was of moderate strength, having BOD₅ and total suspended solids concentrations averaging 122 mg/L and 156 mg/L respectively. The pollutant removal efficiency of the plant is typical of the conventional activated sludge process with BOD₅ and total suspended solids removals averaging 94 and 96 percent. Annual average effluent concentrations and mass loadings of both BOD₅ and total suspended solids were well below the compliance limits of 25 mg/L and 227 kg/d.

Table 3: Summary of average monthly BOD₅ and suspended solids results for 2022

Month	BOD ₅			Suspended Solids		
	Raw Sewage (mg/L)	Final Effluent (mg/L)	Removal %	Raw Sewage (mg/L)	Final Effluent (mg/L)	Removal %
January	115	7.8	93.3	169	4.1	97.6
February	114	7.8	93.2	175	6.3	96.4
March	94	3.8	96.0	102	7.7	92.4
April	91	5.3	94.2	134	7.8	94.2
May	105	6.6	93.7	173	6.9	96.0
June	74	9.0	87.8	133	4.6	96.5
July	152	5.8	96.2	151	4.3	97.2
August	117	9.8	91.7	178	12.2	93.2
September	139	5.8	95.9	184	10.8	94.2
October	203	8.0	96.1	162	6.2	96.1
November	140	5.8	95.8	166	4.1	97.5
December	123	10.3	91.6	145	7.2	95.1
Average (mg/L)	122.2	7.1	93.8	156	6.8	95.5
Average (kg/d)		48.8			46.9	
C of A Limit (mg/L)		25			25	
C of A Limit (kg/d)		227.2			227.2	

Phosphorus and Nitrogen Analytical Data

Phosphorus is a nutrient that is essential to biological growth. It is typically present in raw sewage at concentrations sufficient to cause excessive plant and algae growth in natural surface waters if released untreated. Excessive growth in surface water deteriorates the aquatic environment when the plants / algae decompose.

Phosphorus is removed from sewage at the WPCP by the addition of ferric sulfate

which forms an insoluble precipitate when it combines with phosphorus in the wastewater. The precipitate is then removed by sedimentation. Ferric sulfate is added to the process immediately downstream from the pre-treatment process but can also be added at the aeration tank influent channel, or at the tail end of the aeration tanks.

The annual average concentration of phosphorus in the raw sewage was 3.99 mg/L, while the average effluent concentration was 0.14 mg/L. Effluent quality consistently met the Environmental Compliance Approval Limit of 1.0 mg/L throughout 2022.

Total Kjeldahl Nitrogen (TKN) represents the total quantity of organically bound nitrogen plus ammonia nitrogen which are the forms that most commonly occur in raw sewage. Removal or conversion of the nitrogen species is important because if released in the form of un-ionized ammonia, it can be toxic to aquatic organisms.

In 2022, the annual average concentration of un-ionized ammonia in the process effluent was 0.1 mg/L which is well under the Federal Wastewater Systems Effluent limit of 1.25mg/L.

Analytical data for phosphorus, nitrogen, pH, temperature, and alkalinity are summarized in Tables 4 and 5.

Table 4: Summary of nutrient data for 2022

Month	Total Phosphorus			TKN		NH ₃ (Effluent Only)	
	Raw Sewage (mg/L)	Final Effluent (mg/L)	Removal (%)	Raw Sewage (mg/L)	Final Effluent (mg/L)	Total (mg/L)	Un-ionized (mg/L)
January	3.41	0.11	96.7	32.43	21.28	18.55	0.67
February	3.64	0.13	96.3	31.05	23.53	20.43	0.07
March	2.67	0.16	94.1	29.40	17.48	14.53	0.048
April	2.69	0.16	94.0	30.35	16.08	13.26	0.022
May	3.77	0.17	95.4	27.34	22.80	20.64	0.079
June	3.87	0.14	96.3	37.60	19.68	17.78	0.092
July	4.68	0.09	98.2	40.33	21.88	18.97	0.115
August	4.42	0.23	94.8	38.72	22.22	18.63	0.105
September	4.84	0.15	96.8	40.68	17.85	11.98	0.055
October	4.81	0.12	97.6	44.30	21.50	21.33	0.084
November	5.15	0.10	98.1	42.56	16.74	14.86	0.048

December	3.89	0.11	97.2	35.9	15.3	13.1	0.05
Annual Average	3.99	0.14	96.3	35.9	19.7	17.0	0.120

*Environmental Compliance Approval limit: 1 mg/L and Bay of Quinte Remedial Action Plan Objective: 0.3 mg/L
Note: All samples were collected as 24-hour composite samples

Table 5: Summary of temperature, pH and alkalinity data for 2022

Month	Final Effluent		
	Temperature (°C)	pH (pH)	Alkalinity (mg/L)
January	10.04	7.25	227
February	9.18	7.22	223
March	8.41	7.23	248
April	10.25	7.11	267
May	13.19	7.19	270
June	16.05	7.21	250
July	19.04	7.19	243
August	20.80	7.13	242
September	19.90	7.08	235
October	17.83	7.05	214
November	15.49	7.08	207
December	12.7	7.2	225
Average	14.4	7.2	238

Note: All measurements were conducted on daily grab samples, typically collected 5 times per week

Disinfection / Bacteriological Testing

Prior to discharge to the Napanee River, the treated effluent is dosed with a disinfectant (chlorine) to inactivate any potential pathogenic organisms that may remain.

Bacteriological testing is conducted each week to evaluate the effectiveness of the disinfection process. Grab samples for bacteriological testing (*E. Coli.*) were collected immediately downstream from the chlorine contact chamber, normally during peak flow conditions (between 8am and 10am) when the treatment process is typically most heavily burdened.

During 2022, 9 of the monthly geometric mean¹ values calculated from weekly analyses were below the operational objective of 200 CFU/100mL, the other 3 months were

¹ Statistical reduction using geometric mean is consistent with the *Ontario Provincial Water Quality Objectives* and with the U.S. EPA *Bacterial Water Quality Standards for Recreational Waters*.

above the operational objective. The geometric mean value for all samples collected during 2022 was 94 CFU/100mL.

In response to the Federal regulation requiring the elimination of total chlorine residual from municipal wastewater treatment plant effluents, de-chlorination using sulfur dioxide was introduced at the Napanee facility in January 2010. Total chlorine residual concentration in effluent discharged to the Napanee River has remained at or below 0.02 mg/L since the process was commissioned.

A summary of disinfectant residuals and bacteriological results for 2022 is provided in Table 6.

Table 6: Summary of disinfection and bacteriological data for 2022

Month	Chlorination				De-chlorination			E. Coli.
	Mass Applied (kg/mo)	Dosage (mg/L)	Residual (mg/L)	Demand (mg/L)	Mass Applied (kg/mo)	Dosage (mg/L)	Residual (mg/L)	Geo. Mean (CFU/100mL)
January	168	1.00	0.55	0.45	109.6	0.90	0.00	31
February	178	0.91	0.47	0.44	154.6	1.02	0.00	143
March	246	0.76	0.49	0.27	183.4	0.74	0.00	1629
April	237	0.80	0.57	0.23	167.6	0.75	0.00	456
May	176	0.75	0.47	0.28	162.3	0.93	0.00	81
June	198	0.95	0.43	0.52	144.4	0.99	0.00	128
July	204	1.33	0.42	0.91	155.5	1.35	0.00	31
August	228	1.57	0.29	1.27	162.6	1.47	0.00	284
September	174	1.23	0.42	0.81	165.2	1.56	0.00	29
October	205	1.28	0.46	0.83	149.3	1.30	0.00	39
November	228	1.23	0.58	0.65	146.6	1.15	0.00	11
December	232	0.87	0.44	0.43	157.5	0.86	0.00	82
Average	206	1.06	0.47	0.59	155	1.09	0.00	94
Total	2474				1858.6			
Objective			<=0.5				<=0.02	<=200

Notes: Chlorine is measured as total chlorine residual. All samples are collected as grab samples

2 Maintenance / Improvements & Plant Upsets

Maintenance / Improvements

Notable maintenance activities and process improvements during recent years include the following:

In 2011, a Municipal Class Environmental Assessment was completed to assess capacity limitations and to plan for the upgrade and/or expansion of the facility over a 20 to 30-year design horizon. The Environmental Study Report concluded that an additional 25 percent average day flow capacity and approximate doubling of peak capacity is required to meet future needs. Following the announcement of federal funding assistance in 2019, the Town has completed preliminary design studies exploring both retrofit and new-build design concepts. Detailed design of a project focused on the mitigation of process bypassing and renewal of aging equipment commenced in 2022.

- Efforts to detect and reduce inflow and infiltration are ongoing. Flushing and camera inspections of approximately 25% of the collection system takes place each year.
- The 2012 Inflow and Infiltration Study identified several key areas of concern. The targeted areas include infrastructure that has been in service for over 100 years. A considerable amount of infrastructure renewal occurred between 2014 and 2019 with portions of the targeted areas addressed each year. The study has become an integral part of our 10-year capital planning process.
- The sanitary sewer main was replaced on portions of Richard and Bridge Streets. The replacement included sanitary services up to individual property lines. Secondary process isolation valves were replaced on both secondary clarifiers.

Process Upsets

During 2022 there were no observed significant upsets to plant performance other than the decreased level of treatment experienced during high flow events when heavy precipitation or melting is occurring. Although inflow and infiltration continues to be problematic, efforts to regain hydraulic capacity by monitoring, repairing, and maintaining the collection system are ongoing and appear to be effective.

3 Biosolids

Biosolids Quality and WPCP Output (Lagoon Input) Volumes

Accumulated solids (sludge), removed from the municipal wastewater through the treatment process are stabilized in the anaerobic digestion process. The digestion process reduces the quantity of solids requiring disposal by converting the volatile fraction to methane gas. The methane gas is then beneficially used in the plant boiler for process and building heat.

Following the digestion process, the resulting stabilized sludge (referred to as biosolids) is hauled to an off-site storage lagoon owned and operated by Mr. Fred Sutcliffe Jr. (Provisional Environmental Compliance Approval S-3712-39) and located on part lots 5 & 6, Concession IV, in the Town of Greater Napanee. The lagoon is leased by The Town of Greater Napanee for the exclusive temporary storage of biosolids generated at the Napanee WPCP.

An average of 16 m³ of biosolids were hauled from the WPCP by Sutcliffe’s Septic Service to the Sutcliffe Storage Lagoon each day in 2022. A summary of the volumes hauled during 2022 is provided in Table 7.

Table 7: Summary of biosolids hauled to the storage lagoons for 2022

MONTH	LAGOON	
	Loads #	Volume m ³
January	34	462.4
February	26	353.6
March	28	380.8
April	20	272
May	28	380.8
June	61	829.6
July	42	571.2
August	43	584.8
September	31	421.6
October	50	680
November	31	421.6

December	29	394.4
Total	423	5752.8

Agricultural Land Application of Biosolids

In 2022, the land application of biosolids took place on May 24th & 25th, June 16th- 20th and October 11th-14th. A total volume of 5752.8 m³ of biosolids was applied by GFL Environmental under the supervision of the Town of Greater Napanee. Green For Life is contracted to conduct and administer the land application program.

Samples of biosolids were collected each month from the WPCP digester to determine appropriate, compliant rates of application.

The following Tables 8 and 9, summarizes the 2022 land application program.

Table 8: Sites applied with biosolids in 2022

Date 2022	Farmer/Landowner Farm Name	NASM #	Lot	Con	Municipality	Ward	Application Method	Total Volume (m3)
May 24-25	MacLean - Chambers Rd.	23425	23-24	4 South	Town of Greater Napanee	Fredericksburgh	Surface	1320
June 16	Smith's Storage Lagoons	N/A	19	6	Loyalist Township	Ernestown	N/A	40
June 16-20	Sutton Farms - River Rd.	24091	14	6 North	Town of Greater Napanee	Fredericksburgh	Surface	1320
Oct 11-14	MacLean - Chambers Rd.	23425	23-24	4 South	Town of Greater Napanee	Fredericksburgh	Surface	2148
								4828

Table 9: Average biosolids quality for 2022

Metals	Maximum Acceptable Concentration (mg/kg)	2022 Average
As	170	6.3
Cd	34	1.6
Co	340	9.8
Cr	2800	28.6
Cu	1700	764.0
Hg	11	0.55
Mo	94	12.0
Ni	420	32.7
Pb	1100	35.1
Se	34	6.0
Zn	4200	1330.3
E. Coli	Maximum Acceptable Concentration (CFU/g)	
	2,000,000	2,561
Liquid Biosolids		
Total P (mg/L)		894
Ammonia+Ammonium (mg/L)		581
Nitrate+Nitrites (mg/L)		2.3
TKN (mg/L)		1,630
Potassium (mg/L)		53
Solids (mg/L)		33,116