

**2023**

# **Annual Report**

**Napanee Water Pollution Control Plant**

300 Water Street W.  
Napanee, Ontario  
K7R 1X3

Prepared: January 2024

## **Executive Summary**

The quality of effluent released to the Napanee River from the Napanee Water Pollution Control Plant (WPCP) during 2023 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 6 months of the year. The highest reading was in October 2023 when the monthly geometric mean was 12,800 CFU/100mL.

Total annual flow measured in 2023 increased by approximately 8 percent when compared to the previous year, with the average day flow representing 83 percent of the plant design capacity. Efforts to detect the inflow and infiltration of storm and ground water sources will continue throughout 2024.

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

Maintenance and upgrading activities during 2023 included rebuilding both sludge pumps for the primary clarifiers and installing a new ferric sulfate pump. In addition to these projects, the sanitary sewer main on East St. was replaced which included sanitary services to individual property lines. The department also completed four sewer service repairs in 2023.

Planning for the upgrade and expansion of the aging and hydraulically limited Water Pollution Control Plant continued in 2023 with design nearing completion.

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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 m<sup>3</sup>/d, and a peak flow rate of 21,370 m<sup>3</sup>/d. The average flow during 2023 was 7578 m<sup>3</sup>/d, which is approximately 83 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 m<sup>3</sup>/d) for any consecutive period of time greater than one year.”*

The plant design capacity of 9087 m<sup>3</sup>/d was exceeded on 80 days in 2023 which is an increase when compared to the 62 days experienced in 2022. WPCP flow data collected during 2023 is presented in Table 1.

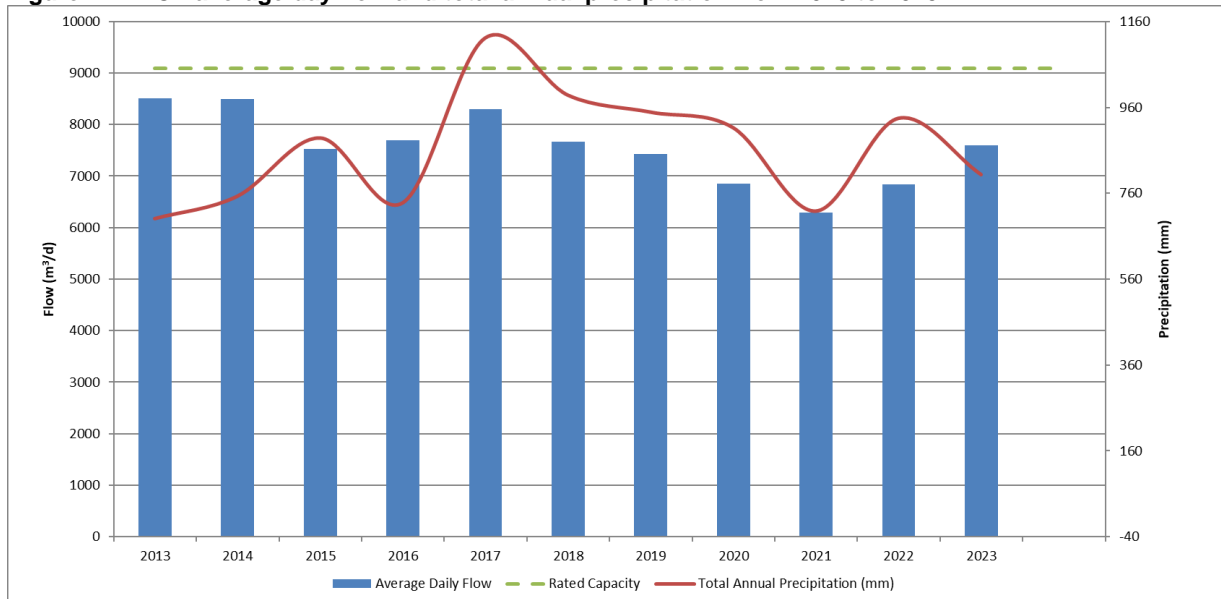
The hydraulic capacity of the plant continues to be stressed as a result of high flow experienced during heavy precipitation events or during periods of rapid ice and snow melting. The maximum daily flow during 2023 was 23,073 m<sup>3</sup>/d, with 11,332 m<sup>3</sup> receiving full treatment and 11,741 m<sup>3</sup> 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 2023**

Month	Treated Volume			
	Total (m <sup>3</sup> )	Average (m <sup>3</sup> /day)	Maximum (m <sup>3</sup> /day)	Minimum (m <sup>3</sup> /day)
January	304377	9819	18557	6586
February	277868	9924	18931	6253
March	323018	10420	17069	6846
April	312485	10416	19002	6981
May	268950	8676	23073	5543
June	170065	5669	8393	4751
July	194901	6287	12346	4535
August	233427	7530	12594	5214
September	142501	4750	5283	4078
October	135909	4384	4957	4123
November	145985	4866	6551	4179
December	254121	8197	12346	5404
<b>Year Total</b>	<b>2763607</b>			
<b>Average</b>		<b>7578</b>		
<b>Min / Max</b>			<b>23073</b>	<b>4078</b>
<b>C of A Limit</b>		<b>9087</b>	<b>21370</b>	

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 44 percent of the average day design capacity. The 2023 average day flow was 83 percent of the design capacity, an increase from 75 percent in 2022. Inflow and infiltration continue to be problematic and repairs to identified issues will continue throughout 2024.

**Figure 1: WPCP average day flow and total annual precipitation from 2013 to 2023**

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 2023 with sanitary mains and services on Town property replaced on sections East Street.

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 m<sup>3</sup>/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 2023.

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 m<sup>3</sup>/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 m<sup>3</sup>/d of secondary clarifier effluent, prior to disinfection and is discharged to the Napanee River.



The volume of secondary bypass discharged during 2023 was over double the volume observed in 2022. This increase can be contributed to large precipitation and melt events in the first 5 months of 2023. A summary of the secondary bypass events during 2023 is provided below in Table 2.

**Table 2: Summary of secondary bypass events during 2023**

Month	Secondary Bypass Events		
	Total m <sup>3</sup>	Events #	Duration hours
January	13483	1	159
February	10024	2	112
March	10558	3	140
April	29661	3	200
May	19570	1	168
June	106	1	3
July	1224	3	28
August	1056	3	31
September	0	0	0
October	0	0	0
November	0	0	0
December	220	3	35
<b>Annual Total</b>	<b>85902</b>	<b>20</b>	<b>876</b>

\*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.

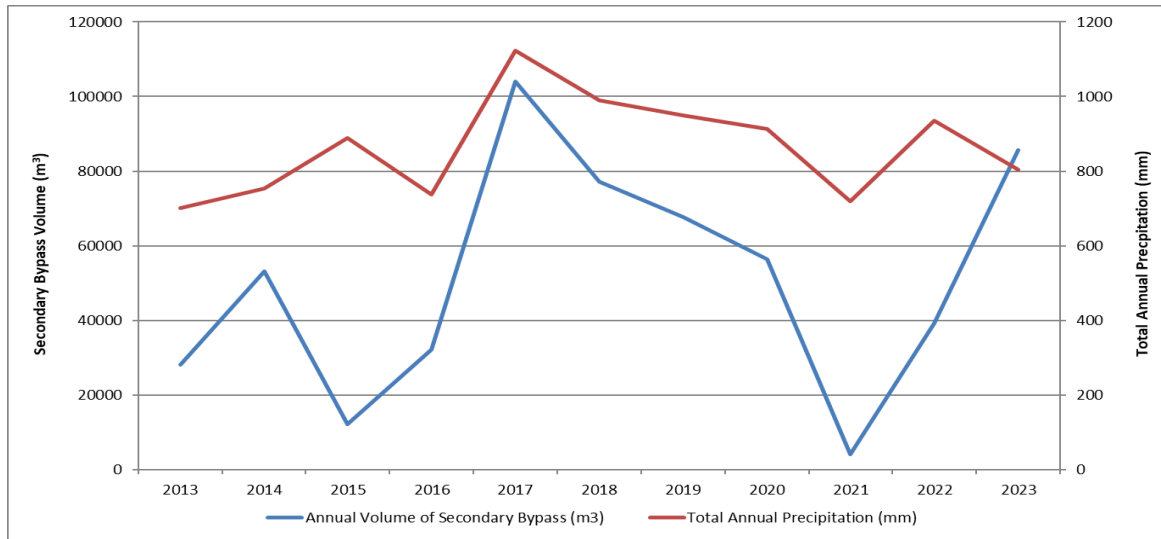


Figure 2: Total annual precipitation and volume of secondary bypass for 2023

### ***BOD<sub>5</sub> and Total Suspended Solids Analytical Data***

The removal of biochemical oxygen demand (BOD<sub>5</sub>) 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. BOD<sub>5</sub> and suspended solids data collected during 2023 are summarized in Table 3.

Raw sewage entering the treatment process during 2023 was of moderate strength, having BOD<sub>5</sub> and total suspended solids concentrations averaging 126.8 mg/L and 165 mg/L respectively. The pollutant removal efficiency of the plant is typical of the conventional activated sludge process with BOD<sub>5</sub> and total suspended solids removals averaging 94.1 and 93.6 percent. Annual average effluent concentrations and mass loadings of both BOD<sub>5</sub> and total suspended solids were well below the compliance limits of 25 mg/L and 227 kg/d.

**Table 3: Summary of average monthly BOD<sub>5</sub> and suspended solids results for 2023**

Month	BOD <sub>5</sub>			Suspended Solids		
	Raw Sewage (mg/L)	Final Effluent (mg/L)	Removal %	Raw Sewage (mg/L)	Final Effluent (mg/L)	Removal %
January	126	7.0	94.5	118	7.3	93.8
February	98	9.3	90.6	118	6.5	94.5
March	84	5.3	93.8	117	7.1	93.9
April	113	5.5	95.1	122	8.6	93.0
May	101	6.0	94.0	142	12.1	91.5
June	155	6.8	95.6	193	10.5	94.6
July	143	3.3	97.7	207	9.9	95.2
August	105	4.2	96.0	151	7.9	94.8
September	217	7.8	96.4	256	19.6	92.3
October	130	20.2	84.5	228	22.7	90.0
November	163	5.8	96.5	200	11.2	94.4
December	86	4.5	94.8	129	6.9	94.6
<b>Average (mg/L)</b>	<b>126.8</b>	<b>7.1</b>	<b>94.1</b>	<b>165</b>	<b>10.8</b>	<b>93.6</b>
<b>Average (kg/d)</b>		<b>48.9</b>			<b>74.5</b>	
<b>C of A Limit (mg/L)</b>		<b>25</b>			<b>25</b>	
<b>C of A Limit (kg/d)</b>		<b>227.2</b>			<b>227.2</b>	

### ***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 4.23 mg/L, while the average effluent concentration was 0.19 mg/L. Effluent quality consistently met the Environmental Compliance Approval Limit of 1.0 mg/L throughout 2023.

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 2023, 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 2023**

Month	Total Phosphorus			TKN		NH <sub>3</sub> (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	3.27	0.12	96.2	27.76	16.18	12.78	0.03
February	3.21	0.14	95.7	27.80	14.40	13.19	0.02
March	2.67	0.14	94.7	21.70	14.95	11.28	0.03
April	3.09	0.18	94.2	26.13	16.13	13.12	0.04
May	3.53	0.25	92.8	31.28	14.34	12.94	0.06
June	4.99	0.23	95.3	47.80	23.03	20.63	0.15
July	4.69	0.13	97.2	41.70	21.38	18.23	0.14
August	4.08	0.13	96.9	34.48	18.16	16.14	0.12
September	6.03	0.29	95.1	52.53	16.40	14.35	0.15
October	5.87	0.29	95.1	52.76	20.88	19.68	0.44
November	5.73	0.21	96.3	70.65	30.25	26.53	0.08
December	3.64	0.18	95.1	30.1	18.2	15.7	0.04
<b>Annual Average</b>	<b>4.23</b>	<b>0.19</b>	<b>95.4</b>	<b>38.7</b>	<b>18.7</b>	<b>16.2</b>	<b>0.11</b>

\*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 2023**

Month	Final Effluent		
	Temperature (°C)	pH (pH)	Alkalinity (mg/L)
January	10.48	7.24	247
February	9.20	7.09	236
March	9.14	7.21	238
April	10.73	7.29	266
May	13.13	7.31	254
June	16.60	7.35	252
July	19.55	7.33	240
August	19.89	7.32	246
September	20.44	7.45	250
October	18.83	7.83	228
November	15.60	7.11	227
December	12.8	7.1	218
<b>Average</b>	<b>14.7</b>	<b>7.3</b>	<b>242</b>

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 2023, 6 of the monthly geometric mean<sup>1</sup> values calculated from weekly analyses were below the operational objective of 200 CFU/100mL, the other 6 months were above the operational objective. The geometric mean value for all samples collected during 2023 was 510 CFU/100mL.

In response to the Federal regulation requiring the elimination of total chlorine residual

<sup>1</sup> 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*.

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 2023 is provided in Table 6.

**Table 6: Summary of disinfection and bacteriological data for 2023**

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	200	0.64	0.44	0.20	148.5	0.69	0.00	308
February	208	0.72	0.51	0.21	143.5	0.74	0.00	76
March	229	0.70	0.49	0.21	153.2	0.66	0.00	859
April	210	0.66	0.46	0.20	153.3	0.68	0.00	173
May	221	0.81	0.42	0.38	142.4	0.80	0.00	739
June	189	1.10	0.43	0.68	144	1.19	0.00	273
July	200	1.05	0.50	0.55	163.4	1.22	0.00	26
August	217	0.95	0.54	0.41	160.1	0.97	0.00	156
September	259	1.83	0.38	1.44	145.9	1.36	0.00	106
October	295	2.18	0.19	1.99	144.9	1.43	0.00	3173
November	239	1.67	0.55	1.12	131.2	1.22	0.01	3
December	267	1.07	0.60	0.47	148.2	0.77	0.00	237
<b>2010 Average</b>	<b>228</b>	<b>1.11</b>	<b>0.46</b>	<b>0.65</b>	<b>148</b>	<b>0.98</b>	<b>0.00</b>	<b>510.62</b>
<b>Total</b>	<b>2734</b>				<b>1778.6</b>			
<b>Objective</b>			<b>&lt;=0.5</b>				<b>&lt;=0.02</b>	<b>&lt;=200</b>

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

## 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 East St. The replacement included sanitary services up to individual property lines. Secondary process isolation valves were replaced on both secondary clarifiers.

### ***Process Upsets***

During 2023 one of the two secondary clarifiers were not operational from April until August. The lengthy delay in the repair was because of the age if the infrastructure. There are no readily available parts therefore parts had to be manufactured. The secondary clarifier was not operational during a low flow period. Although inflow and infiltration continue 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 15 m<sup>3</sup> of biosolids were hauled from the WPCP by Sutcliffe’s Septic Service and GFL to the Sutcliffe Storage Lagoon each day in 2023. A summary of the volumes hauled during 2023 is provided in Table 7.

**Table 7: Summary of biosolids hauled to the storage lagoons for 2023**

MONTH	LAGOON	
	Loads #	Volume m <sup>3</sup>
January	27	367.2
February	21	285.6
March	26	353.6
April	23	312.8
May	31	421.6
June	40	544
July	45	612
August	50	680
September	33	448.8
October	36	489.6
November	30	408
December	26	353.6
<b>Total</b>	<b>388</b>	<b>5276.8</b>

### ***Agricultural Land Application of Biosolids***

In 2023, the land application of biosolids took place on June 15<sup>th</sup>-19<sup>th</sup>, August 28<sup>th</sup>-31<sup>st</sup> and October 24<sup>th</sup>-26<sup>th</sup>. A total volume of 4,932 m<sup>3</sup> 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 and directly from the lagoon prior to each land application to determine appropriate, compliant rates of application.

The following Tables 8 and 9, summarizes the 2023 land application program.

**Table 8: Sites applied with biosolids in 2023**

Date 2023	Farmer/Landowner Farm Name	NASM #	Lot	Con	Municipality	Ward	Application Method	Field #	Area Spread (ha)	Total Volume (m3)
June 15-19	Wemp - German Rd.	25209	50	4	Stone Mills Township	Camden	Surface	5	11.05	1436
June	Smith's Storage Lagoons	N/A	19	6	Loyalist Township	Ernestown	N/A	N/A	N/A	120
August 28-31	Putnins - Ham Rd.	60611	13-15	2	Loyalist Township	Ernestown	Surface	1	17.85	2320
Oct 24-26	MacLean - Perry Rd.	60884	24-27	5	Town of Greater Napanee	Fredericksburgh	Surface	3	9.05	1176
									37.95	5052

**Table 9: Average biosolids quality for 2023**

Metals	Maximum Acceptable Concentration (mg/kg)	2023 Average
As	170	0.245
Cd	34	0.053
Co	340	0.478
Cr	2800	1.044
Cu	1700	24.627
Hg	11	0.015
Mo	94	0.429
Ni	420	1.241
Pb	1100	1.059
Se	34	0.182
Zn	4200	43.727
E. Coli	Maximum Acceptable Concentration (CFU/g)	
	2,000,000	182,091
<b>Liquid Biosolids</b>		
Total P (mg/L)		1129.909
Ammonia+Ammonium (mg/L)		557.339
Nitrate+Nitrites (mg/L)		1.168
TKN (mg/L)		3197.136
Potassium (mg/L)		58.340
Solids (mg/L)		51450