TAKING A LEAP IN GREENING FACILITIES: REGION OF WATERLOO'S FIRST WASTEWATER TREATMENT PLANT GHG FACILITY INVENTORY

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INTRODUCTION

Climate change has been directly associated with increased concentrations of greenhouse gas (GHG) in the atmosphere, causing a negative impact on the earth's climatic balance. The importance of inventories, particularly baseline inventories, in helping to mitigate GHG should not be underestimated. First, inventories are the primary step in understanding the sources and extent of GHG emissions before any mitigation efforts are undertaken. Second, as a basis for preparing for, or engaging in, possible future carbon markets, a well documented baseline inventory is essential for establishing a benchmark against which carbon credits can be claimed. Even in the absence of such a carbon market, an inventory allows a proponent to be in a position to proactively lessen its impact on the atmosphere.

The Regional Municipality of Waterloo (Region), whose operations have been guided by a Strategic Focus that includes environmental sustainability, has taken the opportunity to initiate a Facility Greenhouse Gas Inventory for the Hespeler Wastewater Treatment Plant (WWTP). The objectives of the study were both to

develop a baseline inventory of GHG's contributing to climate change by the current operations of the plant, and to evaluate the greenhouse gas impacts of any future expansion or upgrade of the plant operations. In addition, a GHG analysis tool was developed that allows the user to make finer adjustments for future inventories.

The Hespeler WWTP was built in 1973, and has served the north-east area of the City of Cambridge within the Region of Waterloo, Ontario. The plant has been serving an estimated residential population of 21,500 as well as some light commercial operations.

The GHG inventory needed to only consider three of the six compound gases having a climate-forcing effect recognized by the Intergovernmental Panel on Climate Change (IPCC), as the remaining three were not found at this facility. Table 1 shows the six greenhouse gases and their corresponding global warming potential, a standardized measure of the degree to which the gas contributes to global warming.

TABLE 1: THE SIX GREENHOUSE GASES AND GLOBAL WARMING POTENTIAL)

GHG (n)	Global Warming Potential (GWP) in carbon dioxide equivalents (CO_2e)
CO_2	1
CH_4	21
N_2O	310
HFC	140 – 11,700
PFC	7,000 – 9200
SF_6	23,900

Internationally, with regard to Facility inventories, the World Resources Institute (WRI) jointly with the World Business Council for Sustainable Development (WBCSD) have been leaders in providing guidance and protocols for corporate plant reporting through the GHG Protocol Corporate Standard. The GHG Inventory of the Hespeler WWTP reviewed the greenhouse gases and followed the standards established in the WRI / WBCSD Protocol.

The GHG survey took into account the direct and indirect emissions from sources both inside and outside the plant including raw sewage, treatment processes, biosolids, natural nitrification and denitrification, associated transportation activities, as well as land application of biosolids as fertilizer.

A base-year of 2007 was selected for the plant based on the most available activity data at the time of this investigation.

EXISTING HESPELER WWTP OPERATIONS

The Hespeler WWTP is an extended aeration plant. The overall process includes raw sewage pumping, aerated grit removal, secondary biological treatment, secondary clarification, chlorine disinfection, after which the final effluent is discharged to the Speed River. Waste activated sludge is pumped to aerobic digesters, from which it is hauled to the New Hamburg Wastewater Treatment Plant. There, the sludge is combined with activated sludge in aerated digesters from New Hamburg as well as two other wastewater treatment plants within the Region. The resulting biosolids are land-applied within the Region as fertilizer.

HESPELER WWTP GHG ANALYSIS BASED ON PROTOCOL METHODS

The WRI/WBCSD Protocol has established three 'Scope' levels that categorize sources of direct and indirect emissions for organizations to follow in carrying out the GHG inventories. Scope 1 are direct emissions caused by activities occurring within the operational boundaries of the facility for which the organization is directly responsible. Scope 2 are indirect emissions occurring outside facility boundaries and caused by activities associated with the facility operations. Electricity production required to supply the facility is the primary source of Scope 2 emissions. Scope 3 emissions include all other emissions emanating from outside the facility boundary that are the result of the facility's activities. Waste disposal or employee travels are examples of Scope 3 sources. The inclusion of Scope 3 within the Facility Inventory is optional under the Protocol. It may be

included when organizations wish to track the complete life cycle of emission sources.

In analysing Hespeler WWTP the 3 Scope framework has been included for information purposes. The following details our findings. Refer to Figure 1 for a schematic illustration of the three Scope Levels at Hespeler WWTP.

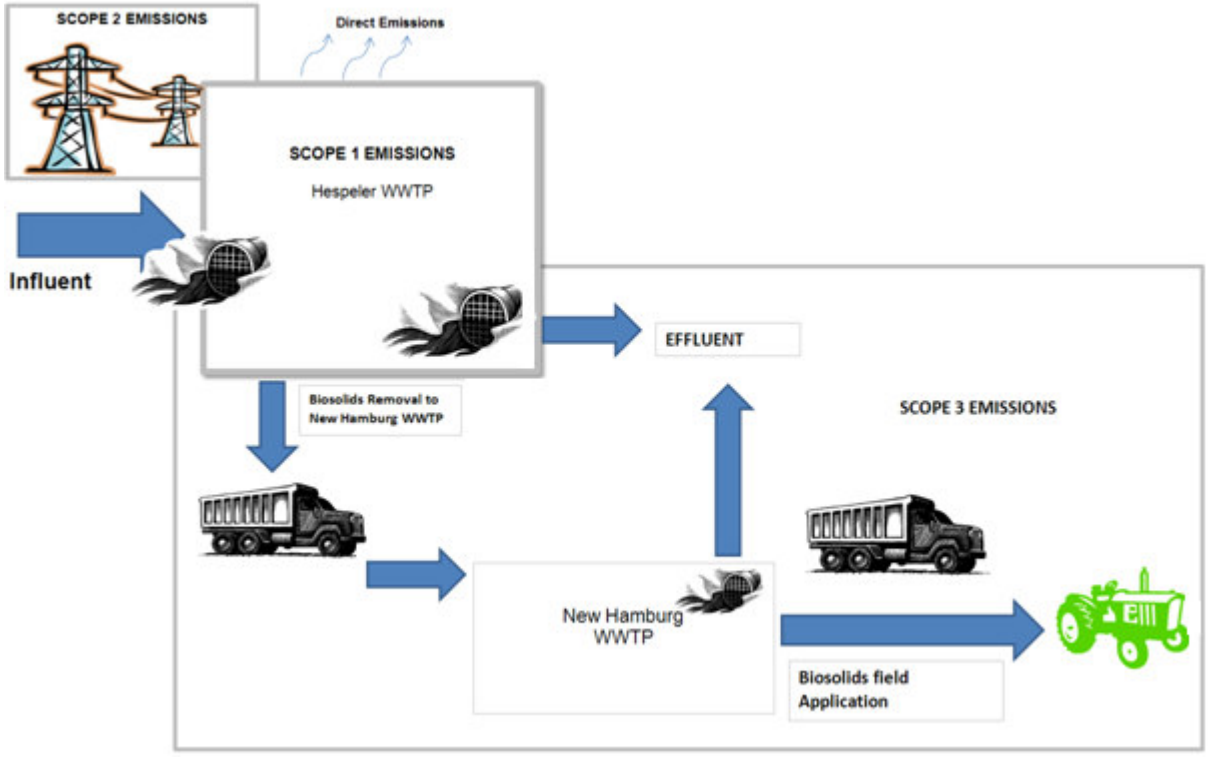

FIGURE 1: SCHEMATIC OF HESPELER GHG EMISSION SOURCES

Scope 1 – Base Year:

The analysis of Scope 1 direct emissions at the Hespeler WWTP shows these emissions to be relatively minor in the base year. Sources of Scope 1 emissions include on-site generation of electricity by a back-up diesel generator as well as the occasional use of a tractor for miscellaneous mobile site maintenance activities (i.e. snow plowing and lawn mowing). Being that the Hespeler WWTP is an extended aeration plant, there is no anaerobic digestion and therefore, it was assumed that no fugitive methane (CH_4) was generated from the wastewater treatment process.

Sources such as IPCC and Environment Canada suggest that conversion of nitrogen and nitrogen compounds found in sewage to N_2O result in releases of this powerful GHG (refer Table 1) from wastewater and treatment facilities. It was assumed that extended aeration plants such as Hespeler do not provide adequate formation conditions for N_2O and thus, limited to minor inadvertent nitrification/denitrification only. Estimates of fugitive gases are highly uncertain perhaps by an order of magnitude and depend on many factors such as temperature, nitrogen content and so on. The inventory utilizes indicative research findings to estimate N_2O emissions. N_2O formation is assumed as 1 gm N_2O / kg of influent N. Of this total only 3% of the gas is assumed emitted within the WWTP (activated sludge 2.8%, inadvertent nitrification/denitrification 0.1%). The majority of N_2O (97%) is assumed emitted from sources outside the Facility boundary as a result of land application of biosolids.

Scope 1 estimated emissions of the three greenhouse gases are provided in Table 2, expressed in kilograms. Since each climate forcing gas has a unique atmospheric lifetime or "strength", each gas has its own global warming potential (GWP). Inventories account for this strength difference and account for the emissions of different gases by normalizing expected atmospheric lifetimes to that of CO_2. Refer to Table 1 for the GWP of each of the reviewed gasses. A summation of the "CO_2 equivalent" emissions of all gases is a recognized measure of total impact and is also provided in Table 2. CO_2 equivalent is used as a measure of total emission throughout the inventory.

TABLE 2: SUMMARY OF HESPELER WWTP SCOPE 1 & 2 GHG EMISSIONS – 2007 (KGS – CO_2 EQ.)

SCOPE	SOURCE	CO_2	CH_4	N_2O	TOTAL CO_2 EQ	% of Subtotal	% of Total
1	Stationary	2,903	0.1	0.4	3,041	74.0%	1.0%
	Mobile	345	0.1	0.1	380	9.2%	0.1%
	Process	0	0.0	2.2	688	16.7%	0.2%
	Scope 1 Subtotal	**3,248**	**0.3**	**2.8**	**4,109**	**100.0%**	**1.3%**
2	Electricity Building Systems (Miscellaneous) subtotal	12,762	1	0	12,846	4.2%	4.2%
	Electricity Process subtotal	289,783	15	5	291,683	95.8%	94.5%
	Raw Sewage Lift pump	34,596	2	1	34,823	11.4%	11.3%
	Return Activated Sludge Pumps	57,947	3	1	58,327	19.2%	18.9%
	Blowers	173,884	9	3	175,024	57.5%	56.7%
	Other pumps	23,356	1	0	23,509	7.7%	7.6%
	Scope 2 Electricity Subtotal	**302,545**	**15**	**5**	**304,529**	**100.0%**	**98.7%**
Total		**305,793**	**15**	**8**	**308,638**		**100.0%**

Scope 2 – Base Year:

Scope 2 sources include all indirect emissions resulting from electricity generation (excluding transmission losses) outside of the property boundaries but used for the operation of the Facility. Total emissions were calculated based on the annual average emission factors of CO_2, CH_4, and N_2O of Ontario generation sources for the base year of 2007. To allocate this total emission within the plant the power rating and annual usage of all equipment was estimated and then calibrated for the sum to correspond to the plant's 2007 electricity meter reading. Estimated Scope Two emissions have been provided in Table 2, with the percentage of totals illustrated in Figure 2.

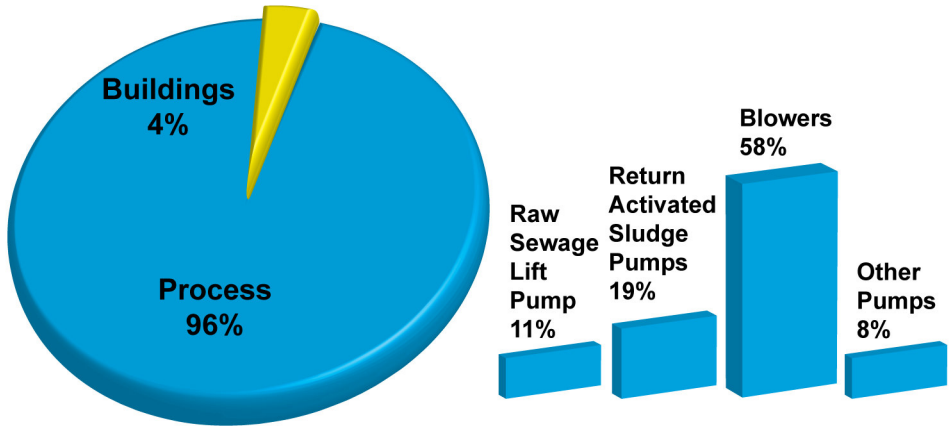

FIGURE 2: SCOPE 2 ELECTRICITY USE CONTRIBUTION TO INDIRECT EMISSIONS 0.30 KT 8%

Scope 3 – Base Year:

Scope 3 emissions for the project are indirect, and result primarily from the disposal (land application) of the sludge. The total emission within this Scope was found to be 0.57kT of CO_2 equivalent. Emission sources include:

1. Diesel used for truck transportation of biosolids from Hespeler WWTP to New Hamburg WWTP (32%)
2. Truck transportation of biosolids from New Hamburg WWTP to fields for application as fertilizer (13%).

Also included were the fugitive N_2O emissions from at least three streams:

1. Inadvertent conversion to N_2O emissions during WWTP process (minimal)
2. N_2O releases from the New Hamburg WWTP treatment of biosolids originating from the Hespeler WWTP (6%)
3. N_2O releases resulting from the land application of biosolids as fertilizer (49%).

It is cautioned that the emissions calculated in this Scope are based on desktop review of related literature and assumptions based on sludge production data collected from the plant, thus great uncertainty is placed on the totals. Improvement on the accuracy of the totals should be conducted when addressing reduction of Scope Three emissions in the future.

Figure 3 summarizes the distribution of Scope 3 emissions.

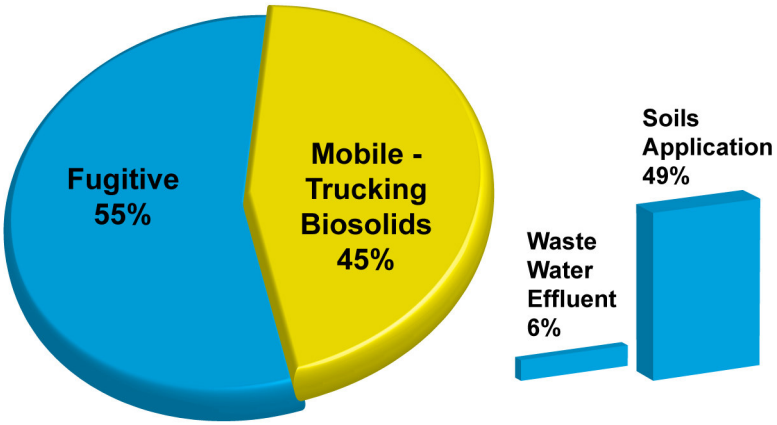

FIGURE 3: SCOPE 3 SOURCES OF EMISSIONS – 0.57 KT CO_2 EQ.

Scope 1, 2 and 3 emissions estimate are summarized in Table 3.

TABLE 3: HESPELER GHG EMISSIONS BY SCOPE (KG CO_2 EQ. / YEAR)

Source / Year	2007
Scope 1	4,109
Scope 2	304,529
Scope 3	568,936

CONCLUSIONS

The results of the GHG inventory indicated that direct emissions from the Hespeler WWTP were minor, but when indirect emissions from Scope 2 and Scope 3 were included the total GHG releases were increased by over a 100 times. Most of the indirect emissions were found to be the result of hauling activities and the processing of biosolids off site, making it clear that the overall operating procedures can have an impact on total emissions.

The baseline established through the inventory survey can be used from this point forward to compare the impact of future plant upgrades on GHG contributions, for the purpose of evaluating GHG impacts of different operational scenarios. This must then be weighed against other typical constraints for plant upgrades such as effluent treatment commitments, adaptation as a result of climate change and additional costs to name but a few.