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# Cost-Benefit Analysis of Retrofitting the Duffin Creek Water Pollution Control Plant to Incorporate Cogeneration Systems

PREPARED FOR: York Region

PREPARED BY: CH2M HILL

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This memorandum examines the technical and cost implications of retrofitting the Duffin Creek Water Pollution Control Plant (WPCP) to incorporate cogeneration and the impact of food waste grinders on cogeneration viability.

## Summary Conclusions

The viability of cogeneration at Duffin Creek WPCP is independent of whether food waste grinders are used or not. Two previous assessments of the Duffin Creek WPCP recommended against implementing cogeneration as it was not financially viable. The current business case for biogas cogeneration in Ontario is weak, due to relatively low electricity and natural gas prices against which biogas cogeneration must compete.

Implementing cogeneration and anaerobic digestion of all biosolids at Duffin Creek WPCP would require an investment estimated to be approximately $350 million, in addition to requiring the acquisition of more land and reducing the fuel value of biosolids for incineration thereby requiring supplemental fuel. Pursuing digester expansion would negate the Region's current investment of approximately $306 million in the Stage 3 solids expansion program which is scheduled to complete commissioning by the second quarter of 2014.

Solids produced at and imported to Duffin Creek WPCP are currently incinerated. This approach is in accordance with the 2004 Durham Region Biosolids Master Plan and 2005 Environmental Study Report which established incineration as the most cost effective and long term sustainable solution for biosolids management at Duffin Creek WPCP.

The existing incineration facility already recovers energy from the solids management system. Energy from incinerator steam is recaptured by turbines which run the fluidizing air blowers for the incinerators and offset electricity that otherwise would have been purchased. The remaining steam is sent through a steam distribution system to meet plant building heating requirements.

## Biogas from anaerobic digestion of food waste can be used to produce electricity and heat through cogeneration

The use of food waste grinders has been suggested by stakeholders as a means to produce more biogas in the digesters at Duffin Creek WPCP. Food waste is readily biodegradable, and in some jurisdictions, the use of food waste grinders is being promoted to divert food waste from landfill and produce biogas in anaerobic digesters at water pollution control plants.

When fuel, such as anaerobic digester biogas, is burned, the energy can be converted to useful energy as heat, electricity, or electricity and heat (cogeneration). Cogeneration systems are more efficient than producing electricity alone; for example, fuel efficiency may be 30 to 40 percent when only generating electricity compared to 60 to 85 percent overall when recovering heat as well as generating electricity.

## Digester expansion at Duffin Creek WPCP would require approximately $350 million investment

In theory, incorporating cogeneration at Duffin Creek WPCP could be considered through constructing additional digesters at Duffin Creek WPCP to produce more biogas. Allowing for digestion of all plant sludge, imported sludge and sludge from food waste at a 30 percent food waste grinder use rate would require ten (10) new primary digesters in addition to the existing four (4) primary digesters. Additional facilities would also be required to support this digester expansion, such as sludge thickening, biosolids dewatering modifications, biosolids truck loading, land acquisition and site development.

As summarized in Table 1, the cost of implementing anaerobic digestion of all sludge at Duffin Creek WPCP including food waste at 30 percent food waste grinder use rate would require an investment estimated to be approximately $350 million.

Table 1. Cost Estimate to Implement Anaerobic Digestion of all Sludge at Duffin Creek WPCP

| **Duffin Creek WPCP Modification** | **Estimated Cost [(a)]** |
|---|---|
| 10 new primary digesters | $200 million |
| Support facility requirements (sludge thickening, dewatering modifications, biosolids truck loading, site acquisition and development, etc.) | $100 million [(b)] |
| 10 megawatt cogeneration facility | $50 million |
| **TOTAL ESTIMATED COST** | **$350 million** |

[(a)] Class 5 estimate with an accuracy of +100 percent to -50 percent.

[(b)] The conceptual cost estimates for support facility requirements is an allowance based on professional opinion and is subject to site-specific implementation details which are not available at the present time.

## Expanding anaerobic digestion capacity at the Duffin Creek WPCP would require land acquisition

Current constraints at the plant site need to be addressed to implement anaerobic digestion of all sludge at Duffin Creek WPCP. First, there is insufficient space at Duffin Creek WPCP to construct more digesters. The additional (estimated to be 10) digesters could be located where the future Stage 4 expansion is planned, however that would constrain any future planned liquid treatment capacity expansion. Existing developed industrial land could be purchased north of the plant and re-zoned and re-developed. The amount of truck traffic would also increase significantly if land application of digested biosolids is pursued; alternatively, if the digested biosolids are incinerated there may be a need for supplemental fuel (diesel) to offset the lost fuel value through digestion – currently the incinerators run without supplemental fuel except during startup or commissioning.

## Pursuing the Anaerobic Digestion approach would negate over $300 million invested in the solids expansion and require revisiting the Biosolids Master Plan and Environmental Study Report

The 2004 Durham Region Biosolids Master Plan and 2005 Environmental Study Report, established incineration as the most cost effective and long term sustainable solution for biosolids management at Duffin Creek WPCP. Solids produced at Duffin Creek WPCP as well as solids imported from other water pollution control plants in York Region and Durham Region are incinerated. Duffin Creek WPCP has four incinerators, two of which are currently being commissioned as part of the Stage 3 Expansion program and anticipated to be in full service by the second quarter of 2014.The plant also has four primary digesters, two secondary digesters, and two sludge blending tanks. Current practice is to anaerobically digest about 10 to 15 percent of the sludge at the plant.

Consideration for expanding anaerobic digestion at Duffin Creek WPCP would require development of a new Environmental Study Report to confirm the approach and assess any associated environmental impacts. Furthermore, pursuing digester expansion would effectively negate the Region's current investment of approximately $306 million in the Stage 3 solids expansion program.

## Food waste grinders do not make cogeneration economically viable at Duffin Creek WPCP

The viability of cogeneration at Duffin Creek WPCP is independent of whether food waste grinders are used or not. A cogeneration facility provides financial revenues from the electricity and heat generated, although this benefit incurs a capital investment to construct the facility and operating costs to run it. If the revenues are insufficient to cover the initial investment and operating costs, then cogeneration is not economically viable.

Two previous assessments of the Duffin Creek WPCP recommended against implementing cogeneration (Team Duffin 2005; Team Duffin 2011). These assessments evaluated the feasibility of cogeneration at Duffin Creek WPCP for various scenarios that considered: different capacities for the cogeneration equipment; various types of sludge heating arrangements for the digesters; treating more sludge through the digesters to maximize biogas production from the existing units; using steam from incineration for cogeneration; and, higher electricity revenues from Ontario's Feed-In-Tariff program.

Both assessments concluded that cogeneration at Duffin Creek WPCP is not economically attractive and therefore recommended against implementing cogeneration.

## Business case for cogeneration in Ontario is weak due to low electricity prices and low natural gas costs

Historically, the business case for biogas cogeneration in Ontario has not been strong. Of the approximately 470 municipally-owned water pollution control plants in Ontario, approximately 98 have anaerobic digestion and of those only seven have biogas cogeneration systems.

The cost of buying electricity in Ontario has historically been relatively low, less than 10 cents per kilowatt-hour, which has tended to disfavour cogeneration. Ontario's Feed-In-Tariff program provides an above-market price of 14.7 cents per kilowatt-hour to support more production of renewable electricity from biogas. Although this higher price improves the business case, it is still not strong, which was confirmed in the 2011 cogeneration assessment for Duffin Creek WPCP that incorporated the potentially higher revenue from the Feed-In-Tariff program. Cogeneration is more prevalent in jurisdictions where the cost of buying electricity is significantly higher than prices paid in Ontario.

The interest in cogeneration at water pollution control plants and the opportunity to use excess biogas heightened during the recent rise in natural gas prices around 2008 and 2009. Data from the United States Energy Information Administration indicates industrial prices for natural gas peaked at almost $0.46 per

cubic metre in 2008, compared to about $0.11 to $0.18 per cubic metre at the present time. Interestingly, the current price of natural gas is about the same as it was a decade ago, even ignoring inflation (US Energy Information Administration). Such low prices do not encourage biogas cogeneration because biogas as a fuel competes with natural gas.

## Duffin Creek WPCP already recovers energy from incineration

Presently at Duffin Creek WPCP, all solids are combusted in incinerators with steam produced as a byproduct. Energy from the steam is recaptured by turbines which run the fluidizing air blowers for the incinerators which offset electricity that otherwise would have been purchased. The remaining steam is sent through a steam distribution system to meet plant building heating requirements. Therefore, the existing facility already recovers energy from the solids management system.

## References

Team Duffin (2005) Technical Memorandum: Cogeneration. Prepared by Team Duffin September 28, 2005.

Team Duffin (2011) Technical Memorandum: Cogeneration. Prepared by Team Duffin April 19, 2011.

US Energy Information Administration (2013) U.S. Natural Gas Prices.
http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm