

Review of a Document for the Regional Municipality of Halton:

Step 4a: Identification and Description of Potential Health and Environmental Effects.

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REVIEW OF HALTON EFW STEP 4a

Executive Summary L.D. Pengelly, May 14, 2007

The document under review (referred to it here in short form as “4a”) forms part of a detailed feasibility study referred to as the “Development of a business case” to manage municipal solid waste (MSW) in Halton region. The proposal is to use an “Energy from Waste”(EFW) incineration process. The business case design includes four steps, of which 4a is part of the final step.

Section 1, Introduction The authors of 4a state:

“The approach undertaken in this report was to evaluate criteria through which a modern EFW facility could be operated, such that emissions are within those acceptable for the protection of human and environmental health. In order to put these concerns into context, issues related to landfill operations or the “base case” scenario were also documented.”

and as well:

“This literature review covers the history of incineration operations, changes in the regulatory standards, and a summary of documented health and environmental concerns reported in the primary literature. The review contains updates that attempt to address issues of potential public concern related to the operation of an EFW facility and the mitigative approaches that have been taken during the design and operation of EFW systems.”

The authors state that this is to be a review of the “primary literature”, but less than half of the citations are from primary peer-reviewed studies. The greater part of the citations were from U.S., U.K. or Canadian government sources. Although much important information can be found from government sources, and was included, it cannot be characterized as “primary literature”.

Section 2 describes the search methodology, but apparently “numerous” (p2-1) primary literature articles were rejected, based on the criterion that they had been published prior to the year 2000. It is not clear whether this part of the literature was simply excluded from the retrieval process, or whether, once retrieved and examined, they were not included as a source of information in this Report. In any event, as the authors state, this was purposefully a source of selection bias. In spite of this stated criterion, there were 9 papers included which had been published before 2000. No formal or systematic structure of critical appraisal is stated, so that comparison of one paper to another is haphazard. Table 5.2 (pp 5-21 to 5-23) provides a summary (for 30 of the health-based studies) of technical information about the waste management facility and associated emissions or ambient levels. This table does not summarize epidemiological methods or health outcomes, and thus has limited value in the context of a “comprehensive literature review of health studies.” (p 1-2).

There is a recurrent theme that articles in the literature relate to “old technology” MSW management (in spite of a selection criterion that was stated to exclude “old technology”), and thus they are no longer relevant to newer “best available technology” facilities. Still, the contaminants that were released in the past, for the most part are still being released, albeit in some cases at lower concentrations. Thus studies relating to the older technology can inform us about the current potential for health problems, by comparing their emissions to what is expected from the new technology.

There are some missing references, such as “Amalendu” and “Bigger”, and one incorrect one “Fiedler”. There are typographical errors on every 1 or 2 pages, some of which (such as p 5-11) interfere with the interpretation of the citation.

Section 3; Historical Context. There are several issues addressed here: advancement of

incinerator technology to increase energy efficiency and reduce pollutant emissions; concerns citizens have expressed about incinerators and landfills; emissions and health impacts reported with respect to incinerators and landfills; and studies by the Ontario government of landfills or incinerators.

This section claims that emissions have been reduced, but no data on the reductions achieved by improvements in either incinerator or landfill technology are provided. The impression is conveyed (citing two publications before 2000) that citizens living in close proximity to incinerators are not strongly concerned about their presence or the potential for health impacts, but the context of this study, if examined carefully shows otherwise.

Although evidence of health problems associated with landfills or incinerators is presented, on the whole it is dismissed as being “limited” on the basis of methodological concerns. This is not supported by careful examination of the evidence. However a caveat was included at the end of section 3.1 that “... *there remains a level of concern that emissions from an EFW facility could adversely impact health and the environment. These concerns are often expressed by the general public, non-government organizations, and the public health sector.*” This statement is curiously at odds with the later statement of a lack of concern in communities in close proximity to MSW incinerators. Similar caveats with respect to “health concerns” appear at the end of the “Incinerator” and “Landfill” sections.

The findings of the Ontario government studies were reviewed critically, and on careful inspection some questions were raised about the methodology used, including the Toxicity Reference Values (TRVs). In the end, the **4a** Report states: “*This [OME] report only serves as a potential road map to conducting site-specific studies. In the event that Halton Region selects EFW as an alternative to managing its MSW, this type of assessment should be conducted on a site-specific basis in Halton using most up-to-date science and consideration of existing background conditions of chemicals in the environment.*”

Sections 5 and 6 give more detailed examination of the risk of adverse health effects associated with incineration and landfill operations.

The Summary of Health Effects from EFW Systems is given in Section 5. The review of Cormier *et al.* cautions us that we must have serious concerns about potential adverse health effects associated with waste incinerators. Furthermore, all of the recent epidemiological literature on particulate and gaseous combustion-related pollutants demonstrate clearly that statistically significant associations with a suite of different outcomes at lower and lower concentrations form a coherent picture of adverse effects on public health. These substances are still being emitted by MSW incinerators, and the health risks associated with them were not adequately assessed. in this Review.

The Summary of Health Effects from Landfill sites given in Section 6 states (incorrectly) that the risk from cancer, respiratory, skin and intestinal health effects “has been shown to be negligible”, or “is negligible” in a number of studies. In some studies, as referred to in Rushton, significant cancer risks have been shown. The studies cited in **4a** have not shown that the risk is negligible: what has been shown is that a potential risk cannot be demonstrated, using the methods employed in the study. The greatest flaw in this Summary is the failure to mention the well demonstrated risk of **congenital malformations** in children born to those who reside in proximity to a landfill site.

In Section 8, Table 8-1 is a very useful comparative summary of the important issues that need to be addressed with respect to on-going use of landfills and implementation of EFW systems. This section introduces the concept of “net environmental lifecycle emissions” as applied to both landfill and various EFW scenarios. The specific EFW scenarios are defined.

Section 9. Background environmental programs are proposed before and/or following implementation of any MSW strategy.

Section 10. (Environmental Effects) This section introduces the concept of “net environmental lifecycle emissions” as applied to both landfill and various EFW scenarios. The specific EFW scenarios are defined.

It is true that regulation and technical advance have led to substantial reduction in emissions of toxic contaminants from landfill sites and MSW incinerators. We agree that an EFW system is a potential solution to Halton’s waste management problem. We do not agree that all options have been presented or properly evaluated in this document, and health risks associated with pathogens have not been examined.

Section 11 examines stack emission factor guidelines, and some data from existing facilities. OME Guideline A-7 emission factors (concentrations) for MSW incinerators are compared with Guidelines from other jurisdictions, as well as emission factors as reported from other existing facilities. It is not clear to what extent these guidelines are useful in assessing health impacts, as emission factor information by itself cannot be used to compare the various EFW scenarios. Also, it is not made clear that emission factors (concentrations) alone cannot be used to “*model dispersion of potential contaminants from potential facilities*”, as stated in Section 11.5.

Annual Emission quantities for the different scenarios are compared in Section 12. It is clear from Table 12-2 that air pollutant (and contaminant to water) emissions from an EFW facility increase directly in proportion to the size (capacity) of the facility. Thus a 100,000 t/y facility might meet OME standards, where a 1,200,000 t/y facility might not.

Comparisons were also made between the emissions of various pollutants from the 100,000 t/y EFW scenario to other sources in Ontario. Such a comparison might be meaningful in the case of CO₂, but for all of the other pollutants this comparison is inappropriate, as typically emissions from an individual stack have their greatest impact locally (within 1 to 20 km). For this reason scenarios should be evaluated using pollutant levels found within a range of approximately 20 km from the facility, rather than comparing them to the whole province.

In a similar vein, Lifecycle Analysis (Section 13) is concerned with the concept of “offsets” to demonstrate benefits from EFW facilities. The EFW incinerator is clearly going to generate large quantities of fine particles and combustion gases from the stack which will undoubtedly have local and perhaps regional impacts. Offsets related to electrical power generated in another airshed will do little to reduce health impacts in Halton and Peel Regions.

Regional Airshed Concerns. We have already demonstrated to Halton Public Health that NO₂ is responsible for a substantial burden of premature mortality in the Region. The introduction of another major source of fine particles and oxides of nitrogen by virtue of siting a large EFW facility where it is proposed may not be an acceptable choice for the health of the population living within this airshed. This important consideration was not examined explicitly by the authors of **4a**.

Limitation

The major limitation of the **4a** review is its ambiguity in defining the potential health risk associated with the EFW facility, and in particular those risks associated with criteria pollutants or pathogens. At the end of Sections in which clear statements of health risks and their associated quantified level of confidence might be expected, the authors of **4a** have opted instead to suggest the examination of these in the context of a “site-specific risk assessment” e.g.: ***“Halton Region should undertake site-specific studies with respect to local background conditions and emission rates specific to any proposed facility to ensure the protection of health and the environment.”***

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INTRODUCTION

The document under review (we will refer to it in short form as “4a”) forms part of a detailed feasibility study referred to as the “Development of a business case” to manage municipal solid waste (MSW) in Halton region. The proposal is to use an “Energy from Waste”(EFW) incineration process. The business case design includes four steps as outlined below:

Step 1 - Develop List of Potential EFW Systems

- 1A Develop EFW Waste Disposal Scenarios and Range of EFW Capacities
- 1B Identify, Review and Document Types/Classes of EFW Technologies
- 1C Develop List of Alternate EFW Systems

Step 2 – Develop Comparative Process

Step 3 - Develop Financial Analysis

Step 4 - Identify Environmental and Health Matters; Approvals and Planning Requirements; and Set Framework for Public Consultation Process

- 4a Identify and Describe Potential Health and Environmental Effects
- 4B Identify Regulatory Approvals and Planning Requirements
- 4C Recommend Framework for Public Consultation Program

The document under review is Step 4a: Identify and Describe Potential Health and Environmental Effects.

DOCUMENT STRUCTURE

This document has 14 Sections, organized as follows:

- Sections 1 and 2: scope of work and methodology of search and review
- Section 3: Historical context of MSW management (landfill and incineration)
- Section 4: Recent regulatory change and technological advancement
- Section 5: Health concerns related to incineration / EFW
- Section 6: Health concerns related to landfill
- Section 7: Limitations of the literature review
- Section 8: Comparisons between health concerns of landfill vs incineration
- Section 9: Potential design for health risk assessment for a proposed EFW system in Ontario
- Section 10: Summary
- Sections 11, 12 and 13: Life Cycle modeling for base case and 5 Scenarios.
- Section 14: Key Findings.

The review will follow the document structure.

SECTION 1

The Scope of Work as agreed upon is described in the following excerpt from the RFP:

“Identify and describe potential health and environmental impacts associated with alternative EFW Systems compared to the “Base Case” Scenario. This study should address potential stack emissions, fugitive emissions, greenhouse gas emissions, leachate, waste products, vibration and noise under normal operating conditions and under conditions in which there has been an operational failure.

A comprehensive literature review of health and environmental studies associated with various types and sizes of EFWs already in operation is to be completed.”

The authors of this report indicate (in response to the first paragraph above);

“The approach undertaken in this report was to evaluate criteria through which a modern EFW facility could be operated, such that emissions are within those acceptable for the protection of human and environmental health. In order to put these concerns into context, issues related to landfill operations or the “base case” scenario were also documented.”

and (to the second paragraph):

“This literature review covers the history of incineration operations, changes in the regulatory standards, and a summary of documented health and environmental concerns reported in the primary literature. The review contains updates that attempt to address issues of potential public concern related to the operation of an EFW facility and the mitigative approaches that have been taken during the design and operation of EFW systems.”

General Approach

When examining the health consequences of exposure to environmental contaminants in general, (and to the possible health effects of waste management operations in particular), two main approaches have been adopted: the first, which might be called “diagnostic” consist of *epidemiological* studies of the distribution (or pattern) and determinants (or causes) of disease in human populations; and the second, which might be called “prescriptive” consist of *emissions based* studies, which measure emissions being released into the environment from one or more sources, and based on this, human exposures to emitted substances can be estimated, and the risks to human health can be assessed (DEFRA 2004). It is important to understand that these approaches should be regarded as complementary, and not contradictory. Each has its own strengths and weaknesses.

The strength of an epidemiological design is that it gains its health outcome information directly from human beings: its weakness is in determining their exposure to contaminants and the consequences of other factors (often called “confounding factors”) which may influence the relationship between the health outcome being studied and the contaminant(s) to which the outcome is being related.

The strength of the emissions based design is the determination of the exposure, and the degree to which the “dose” can be ascertained and verified: the weakness lies in the prediction of health outcomes in humans based on dose-response relationships determined for the most part from studies for single pollutants on laboratory animals. In the few instances where the relationships

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are based on human studies, they cannot be generalized to community populations, or have not been updated to current science.

The authors of **4a** have not made a clear distinction between these two approaches, nor do they demonstrate an understanding of the strengths and weaknesses of both, or the degree to which they both can contribute to our understanding of the problem at hand.

SECTION 2

Review and Search Methodology

The authors state that this would be a review of the “primary literature”, but only 45 of the 119 citations are from primary studies. The greater part of the citations were from U.S., U.K. or Canadian government sources. Although much important information can be found from government sources, and was included, it cannot be characterized as “primary literature”.

The search methodology is described, but apparently “numerous” (p2-1) primary literature articles were rejected, based on the criterion that they had been published prior to the year 2000. It is not clear whether this part of the literature was simply excluded from the retrieval process, or whether, once retrieved and examined, they were not included as a source of information in this Report. In any event, as the authors state, this was purposefully a source of selection bias. In spite of this stated criterion, there were 9 papers included which had been published before 2000. No formal or systematic structure of critical appraisal is given, so that comparison of one paper to another is haphazard. Table 5.2 (pp 5-21 to 5-23) provides a summary (for 30 of the health-based studies) of technical information about the waste management facility and associated emissions or ambient levels. This table does not summarize epidemiological methods or health outcomes, and thus has limited value in the context of a “comprehensive literature review of health studies.” (p 1-2).

There is a recurrent theme that articles in the literature relate to “old technology” MSW management (in spite of a selection criterion that was stated to exclude “old technology”), and thus they are no longer relevant to newer “best available technology” facilities. Still, the contaminants that were released in the past, for the most part are still being released, albeit in some cases at lower concentrations. Thus studies relating to the older technology can inform us about the current potential for health problems, by comparing their emissions to what is expected from the new technology.

There are some missing references, such as “Amalendu” and “Bigger”, and one incorrect one “Fiedler”. There are typographical errors on every 1 or 2 pages, some of which (such as p 5-11) interfere with the interpretation of the citation.

SECTION 3

3.1 MSW Management History

The case for lower emissions resulting from improved pollution recovery systems in EFW facilities is made in **4a**, but we are not provided with any “before and after” emission data to support this contention, and the “Amalendu” reference is missing. No data of this type are provided with reference to the Brampton facility, and the issues around the closure of SWARU in Hamilton have been oversimplified, and the role of the public in its ultimate closure has been misrepresented.

In the detailed analytical and methodological paper in the same journal, immediately preceding that of Eyles (1993), Elliott *et al.* indicate that the survey data were obtained in 1990. At that time specific emission data for SWARU were not available to the public, and in Hamilton, emissions from other larger industrial sources were of greater concern. By the late 1990s, citizens were concerned about SWARU emissions, and were involved with making operational choices to help reduce emissions, but decisions were made by Regional Council to increase tonnage burned beyond the limits of the pollution control systems, and earlier opportunities to maintain and upgrade the facility were lost, again due to political interference (EH 2002). This demonstrates that the presence of adequate techniques of pollution control does not guarantee acceptable performance in terms of pollutant emissions. This issue is not addressed at all in 4a.

Use of this study to generalize about citizen response to solid waste management issues ignores the extent to which local circumstances unrelated to waste disposal can play an important role. There is no reference citation provided to support the “acceptability” of waste incineration (p 3-2).

Section 3.1.1 The statement: “*However, the ability to treat the incinerator gases for these compounds before release into the atmosphere has minimized environmental impact and helped alleviate public concerns.*” cannot be supported, on careful reading of the reference provided (Hamer, 2003). On the contrary, the main thrust of this paper, not referred to in this Section, is the warning from Hamer about the unrecognized risk of pathogens in all current modes of waste treatment. Also, 4a misquotes Hamer (p 3-2) as stating that it is possible to *minimize* emissions, when Hamer actually says they can be *reduced*. The distinction is important, as “reduction” implies further improvement is possible; minimization implies that the reduction limit has been achieved, and no further reduction is possible (or can be expected).

Section 3.1.2 One citation (Bigger *et al.*) is not in the reference list. This Section on historical health concerns related to incinerators dismisses epidemiological evidence as an “indicator of the nature of health concerns”. Furthermore, here, as elsewhere there are relevant comments from The Royal Society’s Peer Review of the DEFRA document which have not been noted by the authors of 4a. Some of the Royal Society’s review comments express similar concerns with respect to problems in interpretation of epidemiological studies as do the authors of 4a, but they also have others:

- *The [DEFRA] report’s relevance to waste management decision-making by Local Authorities is limited, as several important issues are not addressed. These include the effect of local environmental and health sensitivity to pollutants and the impact on emissions of specific waste management activities operating under non-standard conditions.*
- *Bias in the availability of good quality information means the report concentrates mainly on the effects of air pollution. Consideration of the potential effects of exposure to pollutants through other pathways is not consistent throughout the report and therefore prevents adequate comparison of the options.*

The discussion of the epidemiological evidence in [DEFRA] Chapter 3 (3.2.1) is also limited. Confounding factors and cancer latency are important but full comprehension of the potential health effects of the different options for waste management requires discussion of the susceptibility of populations to a particular health outcome and sensitivity to certain emissions, cumulative effects, timelines for exposure, effect of mixtures and synergies of emissions and the additive effects, for example, when combined with other environmental and occupational exposures. The

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latter is particularly important for workers involved in composting and material recycling facilities. Without consideration of these factors the report fails to recognise the limitations in the data.

One of the most serious limitations in **4a** is the failure to examine the implications of the oral intake (in particular, food) pathway for toxic substances such as heavy metals and toxic organics, and the susceptibility of sensitive sub-populations such as infants: issues clearly identified by the Royal Society Peer Reviewers in the excerpt given above.

Section 3.2 Landfill Operations

The authors of **4a** reassure us (p 3-4) about the technological advances used in modern landfill sites, and it is very likely that they have greatly improved in recent times. However the evidence they use from Environment Canada to support their contention is weak, and unquantified, and in this instance contradictory. Here is Environment Canada describing landfills in the two separate issues of their Web-based “Envirozine” cited in **4a**:

“If the surface of the site is properly prepared, all the water will run-off the surface without coming into contact with any contaminants.” (EC issue 36)

“Leachate is produced by all landfills. It is formed when moisture percolates through layers of waste, dissolving and carrying along various chemicals.” (EC issue 30)

4a has not provided any evidentiary data from old or new landfill sites to support the claims of reduced emissions as a result of technological advances.

3.2.2. Historical health concerns.

The problems related to the studies examined in Vrijheid’s review are the focus of attention in **4a**, but the potential for real health problems raised in the review is not presented:

“From this review we can conclude that increases in risk of adverse health effects have been reported near individual landfill sites and in some multisite studies. Although biases and confounding factors cannot be excluded as explanations for these findings, the findings may indicate real risks associated with residence near certain landfill sites.” (Vrijheid 2000)

It is this lack of balance in the **4a** review that is of great concern. Also it seems that the authors of **4a** have a rather superficial understanding of “reporting bias”. They describe it as: *“the tendency of exposed subjects to self-report more symptoms when surveyed than unexposed subjects.”* Indeed, it would be expected that those exposed would report more symptoms if there were a causal link between exposure and symptoms. Reporting bias is more about the perception of exposure, than the fact of exposure: this distinction is not made.

3.3 OME 1999 Study on Landfill and Incineration

Document **4a** quotes extensively from this study, which appears never to have been subject to peer review. The study was largely a mathematical modeling exercise; however the air dispersion model used was the OME’s “standard modeling approach” which has long been subject to adverse criticism as not well verified, and has now been replaced. Emission data for incinerators were obtained from installations with “modern pollution control equipment”, which the OME

authors go on to say do not employ controls for oxides of nitrogen, mercury or dioxin / furans.

One important limitation of the study revealed in **4a** was stated on p 3-6 “*Unfortunately, during the preparation of this report the emissions velocity from the stack could not be located*”. It is troubling that no reference was given in support of this statement. This is a matter of grave concern, as it casts into doubt both the emission rate (g/sec) and ground level concentration (ug/m³) data given in Table 3-1. There is a fixed relationship between stack diameter, gas flow rate, and gas velocity. Since stack diameter is usually easily available, if the gas velocity is unknown, it is apparent that gas flow rate is also unknown, and without gas flow rate, neither the emission rate nor the ground level concentrations can be calculated.

There is also a substantial error in Table 3-1: The emission rate for hydrogen chloride in the human health risk assessment is 71.2 g/sec; the rate for hydrochloric acid in the terrestrial ecological risk assessment is 790781 g/sec. The same error is present in the ground level concentrations. Obviously these two should be the same. If the lower value was actually used in the HHRA, the risk would have been underestimated by 10,000 times.

Although some data for landfill gas emissions were used, no physical data on leachate from existing Ontario landfills were obtained. Background levels for none of the emissions (landfill or incineration) were considered. This deficiency was noted by the authors of **4a**, but the consequences were not examined.

A major limitation of the application of the OME study to the Halton EFW **4a** Review is the lack of inclusion of a food pathway for beef, pork or poultry, or recognition that in the area surrounding the proposed site there are currently substantial agricultural activities. These include several “pick-your-own” farms, which could be a substantial food source for many residents in the area. This level of exposure, greater than the usual “suburban” back-yard food exposure was not examined in the OME model. This has major implications for exposure to heavy metals, PAHs and dioxin / furans from both landfills and incineration systems.

In spite of risk under-estimates from these limitations, according to **4a** the OME results for landfill reported cancer risks from 4 to 10 per million, well in excess of the Ontario *de minimus* risk of 1 per million. How this can be described as “no adverse health impacts” by OME is a matter of question.

Document **4a** did not provide any specific data for the human health risk associated with the primary criteria pollutants (PM_{2.5}, NO₂, SO₂, CO) as determined in the OME document. Although benzene would be expected to be one of the PAHs emitted, there is currently no Ontario air standard for this known carcinogen, and the risk associated with it was not reported. The OME study was quoted as stating that (for both the landfill sites and the incinerator) NO_x emissions would be “negligible when compared to total NO_x emissions in Ontario”. This is an irrelevant statement, which could be applied to any point source of pollutant in Ontario, including individual automobiles. What the statement ignores is the necessity of considering emissions from any source in the context of the local, as well as the global environment.

4a noted several important additional limitations of the OME study at the end of Section 3.3: impact on agricultural lands, potential hazards of pathogens in the incineration of biosolids, problems of increased emissions as incinerator capacity is scaled up, and failure to consider background levels of contaminants in air, water or soil.

4a also provides a comparison of the toxicity reference values (TRVs) used in the OME 1999

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study, and in Tables 3-3 and 3-4 compares them with other more recently available values that might be used. Although the USEPA considers dioxin / furans (d/f) as a human carcinogen, as does the IARC, the cancer slope factor for d/f does not appear in this table. There is a conflict between the text and the table heading for Table 3-4, but it appears that the content of the table in fact refers to carcinogenic chemicals. Given that “dioxins” are one of the greatest concerns the public (as well as health agencies) have with respect to incinerators, a more conservative approach would be to evaluate both non-carcinogenic and carcinogenic modes of action for d/f (JWEL 2003). It appears that this was not done in the OME study.

The 4a report states appropriately: *“This [OME] report only serves as a potential road map to conducting site-specific studies. In the event that Halton Region selects EFW as an alternative to managing its MSW, this type of assessment should be conducted on a site-specific basis in Halton using most up-to-date science and consideration of existing background conditions of chemicals in the environment.”*

3.4 Brampton EFW

The Cantox risk assessment of the proposed upgrade of this facility was also reviewed, and it was quoted as concluding *“the probability of adverse health effects should be considered negligible”*, in spite of the prediction that the highest 1-hr and 24-hr ground level concentrations of NO_x would exceed the acceptable criteria levels. No comments were made in 4a about PM_{2.5} levels. Although the Ontario (CCME) criterion for PM_{2.5} is well supported scientifically, this is not so for the 35-year old criterion for NO₂. This issue will be discussed further. If the appropriate criterion for NO₂ was used, and background levels in the airshed were included, a more than negligible burden of illness associated with this facility could be demonstrated.

The 4a report states [sic]: *“With respect to the Halton Region study the majority limitation in extrapolating the results of the KMS Peel facility is that it is only a 150,000 t/y. In addition, the scope included only an assessment of residential receptor, ecological receptors and other human receptor scenarios were outside the scope of work. Therefore, it points to the need to conduct a Halton Specific study to ensure the protection of health and the environment.”*

It is important that these limitations have also been recognized.

4. Recent Regulatory Changes

On the whole, this is a reasonable summary of regulatory changes in several jurisdictions including Ontario. However, one cannot rely on the statement: *“The air standards as presented in O.Reg. 419 are risk-based standards derived by the MOE as being protective of environmental and human health.”* This may be true in some cases, but it is not true for several contaminants important in the context of MSW management: benzene, nitrogen dioxide, sulphur dioxide and carbon monoxide. In Ontario there is no current ambient or POI air standard for benzene, and the NO₂ standard is based on studies published in 1970. The SO₂ standard is based on a study published in 1966, and the CO standard is based on studies in the 1960s as well. (Fisheries and Environment Canada 1976). None of these standards or criteria can currently be considered protective of public health.

4.2.2. Changes in Landfill technology.

This section provides a very important and cogent summary of the objectives of current landfill

technology, and deserves wider dissemination. It is important to understand that the purpose is not to seal landfill in a tomb, but to house it appropriately so that natural or enhanced forms of decomposition can take place without the release of toxic materials at rates in excess of that which would be harmful of the environment.

4.3 Regulatory and Technological Summary

One of the difficulties with this section is that, in the few instances where emissions are quantified, they are provided in terms of the concentrations of stack effluent. This does not allow for an assessment of impact in terms of amount emitted per unit time, either in the short term to determine ground-level concentrations, or in the long term to be able to compare one mode or facility to another, or to itself, as a result of alterations of the process.

There are important qualifying statements in **4a** that deserve emphasis: *“These standards are the maximum allowable concentration from a facility, however, they do not account for regional background concentrations of these substances in air, nor in the case of the metals and dioxin and furans do they necessarily account for uptake into the food chain or other exposure pathways. Therefore, a site-specific air modeling of emissions of chemicals from any proposed Halton EFW facility should ensure that emission limits for the facility are protective of site-specific factors.”*

In addition: *“Halton Region should undertake site-specific studies with respect to local background conditions and emission rates specific to any proposed facility to ensure the protection of health and the environment.”*

5.0 Health Concerns Related to EFW Systems

It is not clear how the approach in this Section differs from that in Section 3.1.2, as many of the citations in that section were used again in this. This section examines the publications in more detail, so perhaps 3.1.2 is redundant. The information in Section **5.1 (Pathways)** is useful and appropriate, but section numbering following 5.1 appears to be haphazard.

5.2 Health Impacts from MSW Incinerators

The studies of Elliott et al. (1996, 2000) describe a link between residential proximity to municipal waste incinerators and the incidence of liver cancer. Elliott et al. state that: *“One difficulty in interpreting these numbers is the issue of socio-economic confounding”* In the second-last paragraph on page 5-3, the authors of **4a** seem confused about their understanding of confounding in epidemiological studies: confounding is usually understood as an extraneous factor acting in the same (not opposing) direction as the factor of interest.

Despite these caveats, the conclusion given in the Summary (Elliott et al. 2000) is that there is a risk of excess liver cancer incidence within 1km of an incinerator of between 5.3 and 7.8 per million. This is not reported by the authors of **4a**, whose last sentence on this reference is a partial quote, and then an “interpretation”: *“Furthermore, the authors admit if indeed there is a causal link, it relates to historical exposure patterns around incinerators and not to current or future incinerators...”*

Elliott et al. say nothing about current or future incinerators. What they actually say is very revealing: *“The findings in this and our previous paper (Elliott et al, 1996), if causal, relate to*

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historical exposure patterns around incinerators. Since our original report, municipal solid waste incinerators in the UK have been required to meet emission limits in two European Communities' (1989 a, b) directives and a dioxin emission limit of 1 ng /m³ from December 1996. Consequently, there are now only 11 municipal solid waste incinerators currently in operation in the UK burning around 2.5 million tonnes of waste a year."

The implication of this is that the new emission limits have led to the closure of at least 85% of the municipal solid waste incinerators in the U.K. This also was not reported in **4a** .

In their review of the studies of Knox et al. which demonstrated links between childhood cancer in children born close to incinerators, the authors of **4a** state "*without exposure emissions data from all industrial sources of combustion, a casual [sic] link to incinerators and increased childhood cancer cannot be clearly made.*" A very important point is missed here: MSW incinerators emit qualitatively similar pollutants to other industrial or transportation sources; when levels are already elevated, adding those from a new incinerator may create unacceptable risks in an overloaded airshed. However, **4a** does emphasize the need to examine the potential risk of childhood cancers associated with MSW incinerators.

This same point (site-specific background levels) was raised in the review of the studies of Viel and Floret, who demonstrated an increased risk of non-Hodgkin lymphoma in people living near a MSW incinerator.

The review of the Roberts and Chen study was compared to the Ontario risk regulatory environment and the proposed Halton facility. The conclusion was that the cancer risk would be negligible in Halton, but **4a** failed to consider that one of the proposed scenarios in Halton was to burn 10 times as much waste as the Roberts and Chen example, giving a risk ten times higher, which would be well in excess of the Ontario regulatory criterion. There was, however recognition of the need for site-specific studies in Halton.

In summary, for cancer, the **4a** authors state [sic]: "*Again this section seeks only to identify that varying forms of cancer that were associated with the facilities examined in the individual studies. It suggests that any consideration of an EFW facility for Halton Region should involved detailed studies to ensure that the emissions from the proposed size facility do not result in a predicted increased cancer risk for the local population.*"

This implies that the cancer risk should be determined for the various scenarios, based at least in part on specific emission rates, as distinct from concentrations, and with better analysis of the food pathways and local environmental conditions, including contaminant background levels.

5.3.2 Respiratory effects

The authors of 4a summarize as follows: "*Unfortunately only a limited number of studies that investigated potential respiratory effects from exposure to EFW Systems could be obtained from the literature. This is perhaps the most contentious issues surrounding particulate matter emission from EFW facilities. This is an area that would deserve in-depth study during any health impact assessment to be undertaken for the proposed Halton Region EFW.*" This statement ignores the very large body of epidemiological literature on the health effects of particles and combustion-related gases. However, this issue has been examined in Section 5.4.1.

5.4 Chemicals of Public Concern

5.4.1 Criteria Air Pollutants

MSW incinerators and EFW systems emit a suite of pollutants formed on combustion which are common to industrial processes, electrical power generation and on- and off-road transportation. This is true for “criteria” pollutants as well as “air toxics”. Recent studies have clearly shown population health effects at much lower concentrations than mandated by currently accepted objectives and standards for air quality in most jurisdictions, and this is especially true in Ontario. Studies of outcomes such as premature mortality, hospital and emergency room admissions for both cardiac and respiratory disease, school absenteeism, increased physician visits as well as increased medication use all show a coherent and highly statistically defensible association with combustion-related air pollutants. It is important to recognize that compliance with regulatory limits does not imply circumstances protective of public health.

Unfortunately very little of the primary literature was reviewed in **4a**. The authors did include an analysis done by Pengelly (2003) which estimated the elevated mortality and morbidity associated with nitrogen dioxide (NO₂) in Halton.

What is most surprising is that very little mention was made by the authors of **4a** of the extensive review of Cormier *et al.* This excellent paper gives a detailed explanation of the combustion chemistry process, and provides a comprehensive and well-balanced review of the epidemiological studies of the effects of particles on human health, including some excellent clinical and laboratory studies which are directed at elucidating the mechanism of action of particles containing chemicals associated with different combustion sources. Their description of the various forms of chemical reactions taking place in 5 specified thermal zones of various kinds of “thermal treatment” facilities gives insight into the degree to which toxic halogenated compounds can form, be altered or re-formed, and which depend to an important degree on the catalyzing effects of metals in the waste stream. What this paper clearly shows is that very toxic substances are still emitted by “best available technology” thermal treatment processes, and many of these toxic materials are associated with fine and ultrafine particles which may not be well removed by current pollution control technology. This paper is in stark contrast to the modeling exercise of Glorre nec *et al.* , which minimizes the particle contribution of waste incinerators.

The authors of **4a** stated: “*It will be important to ensure that the cumulative loading of CACs in to the local airshed by any proposed EFW System does not adversely result in an unacceptable increase in local CAC levels.*”

5.4.2 to 5.4.5 Air Toxics

Those chemicals that are within the rubric of “air toxics” include dioxin / furans, polycyclic aromatic hydrocarbons (PAHs) and “heavy metals” including mercury, lead, cadmium, arsenic and others.

5.4.2 Dioxins / Furans

Dioxins / furans (D/F) were examined in several of the studies reviewed. The study by Gonzalez *et al.* did not show a relationship between blood levels of dioxins and distance of residence from the incinerator. However, by virtue of stratification of the sample of 199 residents in all, and pooling of the blood into 5 samples for the “near” and 5 samples for the “far” group of residents, the statistical power of this study was diminished, and in these circumstances a negative finding is not proof of a lack of effect. This issue was not addressed in the review. The point was made in this study that “levels of dioxin / furans increase with age”, quoting other studies, in part as explanation

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of the increase in D/F levels in both groups.

The study by Evans *et al.* showed a decrease in serum D/F of their subjects (independent of distance of residence from the incinerator) over the period of a year during exposure to a hazardous waste incinerator burning material contaminated with D/F. The reviewers seem confused about whether waste oil or soil was being incinerated {it was, in fact soil}. They also did not comment on the anomaly of D/F levels decreasing with age, nor did they identify some serious methodological problems in the study, such as the fainting of some (unknown number) of the first 18 subjects, who had been instructed to fast before 500 ml of blood was removed. Nor did the reviewers note that the levels of D/F found in this study were “among the lowest reported in the literature”, to quote Evans *et al.* These issues could call into question the negative findings of this study.

The study by Glorennec *et al.* cannot be characterized as a health study, as it was in entirety a modeling and risk assessment exercise, and deserves no further comment. The same is true for the study of Porteous, which has no primary health component. Although the study by Ferré-Huguet *et al.* found no relationship between blood plasma levels of D/F and distance of residence from the incinerator, or period exposed, the sample size of 20 probably had insufficient statistical power to detect such a difference if it existed. Two studies by Reis *et al.* were reviewed, using biomonitoring of breast milk (in the one study) and blood (in the other). The 4a authors stated (for the first study) “Emissions results from both incinerators indicate that there is no increase of human body burden of dioxins as measured in human milk of individuals living nearest to these facilities.” How emissions results could be used in this way was not explained. The second study, although failing to show a relationship between distance of residence from the incinerator and blood levels of D/F, found increased levels in subjects from the urban area of Lisbon compared to those in Madeira, and the authors of the study attributed this to generally increased levels of exposure to D/F in the urban environment. Once again, this shows the importance of consideration of background levels in assessing exposure to incinerator emissions.

The Summary of the D/F studies makes the point that “recent biomonitoring/risk assessment studies indicate that concentrations of PCDD/F from thermal treatment facilities are unlikely to adversely impact public health.” This statement cannot be accepted in isolation, as impacts on public health still depend on the design, construction and operation of the facility, as well as background and local environmental and exposure circumstances. 4a states [sic]: “The class of chemicals will require close scrutiny in any site-specific studies to be conducted for Halton Region.

5.4.3 and 5.4.4. Mercury and PAHs

The same general statements can be made for both mercury and PAHs, although as previously noted, in Ontario benzene is a problem because of the lack of a regulatory standard for air. An important point was raised in the study of Mâitre *et al.* : “Although big incineration units with efficient pollution control equipment mean less atmospheric pollution, they also concentrate the chemical and noise pollution associated with heavy truck traffic.”

5.4.5. Metals

These include cadmium, chromium, nickel, lead, arsenic, barium, and beryllium. Only two of the papers in this section gave results of measurements in human subjects, and these were Gonzalez and Reis, referred to above with respect to D/F studies. There was no relationship detected between residence near the incinerator and blood lead levels found by Gonzalez *et al.*, but the authors point out that presence of lead in gasoline still used in Spain at that time would have introduced considerable uncertainty to the observations. The same problem would have been present in the

study of Reis et al.

The reviewers caution wisely in their Summary: *“Given the nature of the feedstock to undergo treatment in a EFW System, metals will constitute an important output in both ash/char and to some extent aerial emissions. Therefore, monitoring and modeling of metals pollutants will be necessary in any undertaking by Halton Region.”*

5.? Health Effects from Operational Failure and Upset Conditions.

The authors of **4a** were not able to find reports of either emissions datasets or health studies associated with upset conditions at waste incinerators. Nevertheless, upset conditions will occur in practice, and their impact should be assessed in terms of predicted emissions, and the potential health risks associated with them.

5.5 Summary of Health Effects from EFW Systems

The review of Cormier *et al.* cautions us that we must have serious concerns. Furthermore, all of the recent epidemiological literature on particulate and gaseous combustion-related pollutants demonstrate clearly that statistically significant associations with a suite of different outcomes at lower and lower concentrations form a coherent picture of adverse effects on public health. These substances are still being emitted by MSW incinerators, and the health risks associated with them must be assessed.

The authors of **4a** correctly state: *“Overall, review of the literature has revealed that there are some potential health concerns associated with communities living in close proximity to MSW facilities. Unfortunately, the bulk of the literature is published on studies conducted on facilities that may not employ the latest pollution control technology. In addition, the majority of studies do not specify the volume of MSW or the actual emission rates or ground level concentrations of contaminants being emitted from these facilities. Thus conclusion on potential health impacts related to the varying Halton Region scenarios ranging from 100,000 t/y to 1.2 million t/y could not be evaluated.”*

6.0 Health Risks Associated with Landfill Operations

We refer the reader to the considerable limitations we have previously identified in the Landfill section of the MOE (1999) publication, under Section 3.3.

6.1 Exposure pathways

One major limitation of the approach the authors of **4a** have taken in this Section is the failure to explicitly acknowledge the problem of leachate, and its potential for migration considerable distances off-site.

6.2 Health impacts: 6.2.1 Cancer

The authors of **4a** are dismissive of the links between landfill sites and cancer, but careful reading of Rushton reveals that two studies from the USA, and two from Canada showed significant links between cancer and landfill sites. Other studies, such as those of Jarup et al. And Fielder et al. failed to show associations between proximity to landfill sites and cancer: in the case of the latter, the period of exposure (8 years) may have been too short to deal with the known latency of the

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incidence of cancer. This was not commented on by the 4a reviewers.

6.2.2 and 6.2.3 Respiratory, skin and reproductive effects

The 4a authors dismiss the consistent and highly statistically significant findings of congenital abnormalities in children born close to a landfill, on the basis of the comments of Roberts *et al.* that there was no “direct evidence that the landfill site is the cause”. Experiments on pregnant mothers by administration of toxic leachate, which might satisfy Roberts of a causal link are not only repugnant but morally and ethically untenable. The nature of epidemiology is to build up coherent, statistically defensible associations: these cannot be dismissed because there is no direct causal link. The studies of Elliott *et al.* and Palmer *et al.* also show clear and consistent associations between congenital birth defects and exposure to toxic substances from landfill sites. Together these three studies show the same associations, but using different methods in different locations. This is a clear warning of an unacceptable health outcome associated with residence near landfills.

6.3 and 6.4 Chemicals of Public Concern, and Health Effects due to Operational Failure and Upset Conditions.

Neither of these Sections make use of primary literature, and are essentially lists of potential problems, with a few unjustified estimates of health outcomes which are made to appear trivial. Probably the most serious operational failure for a landfill would be a failure in the landfill lining, which one suspects is a frequent occurrence, especially in areas where the ground is prone to freezing. The authors of 4a claim that this would be detected quickly using boreholes around the landfill, but fail to give evidence of any instance where this has taken place.

6.5 Summary of Health Effects

The Summary states (incorrectly) that the risk from cancer, respiratory, skin and intestinal health effects “has been shown to be negligible”, or “is negligible” in a number of studies. In some studies, as referred to in Rushton, significant cancer risks have been shown. The studies cited in 4a have not shown that the risk is negligible: what has been shown is that a potential risk cannot be demonstrated, using the methods employed in the study.

The greatest flaw in this Summary is the failure to mention the well demonstrated risk of **congenital malformations** in children born to those who reside in proximity to a landfill site.

7.0 Limitations of the Literature Review

A few of the limitations are discussed: probably the most significant is the first; the failure to relate the effects of facility size to human health effects. In the context of making policy decisions with respect to choices between the several scenarios, it is essential to know whether, for example doubling of the facility capacity would “cross the threshold” from acceptable to unacceptable health outcomes. This, in fact could have been approached even from the MOE (1999) study, by making some changes in assumptions. This also relates to our previous concern as a result of reading Step 1b, as well as the MOE Guideline values in 4a; that is emissions which are expressed in terms of concentration, instead of flux (amount per unit time).

Other limitations have been documented in our own review of 4a, but the major limitation of the 4a document is its ambiguity in defining the potential health risk associated with the EFW facility, and in particular those risks associated with criteria pollutants or pathogens. At the end of Sections in which clear statements of health risks and their associated quantified level of confidence might

be expected, the authors of 4a have opted instead to suggest the examination of these in the context of a “site-specific risk assessment” e.g.:

“Halton Region should undertake site-specific studies with respect to local background conditions and emission rates specific to any proposed facility to ensure the protection of health and the environment.”

8.0 Conclusions and Qualitative Comparison of Environmental Health Issues Related to Landfills and EFW Systems

Table 8-1 is a very useful comparative summary of the important issues that need to be addressed with respect to on-going use of landfills and implementation of EFW systems.

9 Potential Environmental and Health Investigations for a Proposed EFW System in Halton

9.1 Baseline Environmental Data Collection

On the whole, the proposal for baseline environmental data collection is appropriate, except a comprehensive study of leachate and groundwater in and around the existing landfill should also be carried out.

9.3 Site Specific Risk Assessment

The authors of 4a advise: *“In the event that a risk from exposure to any contaminant is identified in the initial stages of study, this does not automatically suggest that an EFW facility could not be built. Rather, it would lead to investigation of better pollution control technologies that could be put in place to ensure the protection of health and the environment.”*

10 Introduction to Environmental Effects

This section introduces the concept of “net environmental lifecycle emissions” as applied to both landfill and various EFW scenarios. The specific EFW scenarios are defined.

11 Stack Emission Concentrations

In this section, OME Guideline A-7 emission factors (concentrations) for MSW incinerators are compared with Guidelines from other jurisdictions, as well as emission factors as reported from other existing facilities. It was pointed out that *“A-7 is a guideline, not a regulation”*, which allows OME *“flexibility when deciding on limits and operational practices for Certificates of Approval.”* Given that this is the case, to what extent are these guidelines meaningful? Also, it is not made clear that emission factors (concentrations) alone cannot be used to *“model dispersion of potential contaminants from potential facilities”*, as stated in Section 11.5. Emission factor information by itself cannot be used to compare the various EFW scenarios.

12 Annual Emissions from the Facility for Various Scenarios

It is clear from Table 12-2 that air pollutant (and contaminant to water) emissions from an EFW

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facility increase directly in proportion to the size (capacity) of the facility. At any point, with a given dispersion model, ground level concentrations will increase in the same proportion. Thus a 100,000 t/y facility might meet OME point of impingement standards outside the property line, but when increased to 1,200,000 t/y, standards would not be met, and adverse health effects downwind could be expected.

In Section 12-7, a great deal of effort is expended in making comparisons between the emissions of various pollutants from the smallest of the EFW scenarios to other sources in Ontario, in an attempt to minimize the perceived impact of the EFW facility. A more honest comparison would have been made using the largest EFW scenario. Such a comparison might be meaningful in the case of CO₂, but for all of the other pollutants the comparison is inappropriate. Dispersion models show that emissions from a stack have their direct impact locally (within 1 to 20 km typically). For this reason scenarios should be compared from the point of view of their relationship to pollutant levels found within a range of approximately 20 km from the facility, rather than comparing them to the whole province.

13 Lifecycle Analysis of Scenarios

Our comments on these sections are brief, as they only relate in part to health issues. We have concerns about the "offsets" accrued to electrical power generated by the proposed EFW system... particularly with respect to SO₂ and NO₂ emissions. The thermal and electrical output per tonne of waste (Step 1b, Figure 2-6) seems at odds with other estimates of energy output (e.g., Step 1b, Section 2.1.3.2, page 2-26). All of the other estimates of energy output given in Step 1b seem lower than shown in Figure 2-6, which appears to show the production of both 2 Mwh of heat and 2/3 Mwh of electricity from a tonne of waste. These are important issues in terms of the net local production of NO_x and SO₂. The EFW incinerator is clearly going to generate large quantities of fine particles and combustion gases from the stack which will undoubtedly have local and perhaps regional impacts. Offsets related to electrical power generated in another airshed will do little to reduce health impacts in Halton and Peel Regions.

Impacts on the Halton-Peel and GTA Airsheds

Figure 1 is a GoogleEarth satellite map of the area potentially impacted by the proposed Halton EFW facility, located in the area shown as "Halton WM". The prevailing wind in this location is westerly (from left to right across the map), encompassing the southwest to northwest quadrant. It should be noted that about 8 or 9 km to the north is the location of the Halton Hills Generating Station (shown by the yellow marker with the letters HHGS), a large (683 Mw) gas-fueled combined cycle facility, with its associated NO_x emissions. The area in the south-east quarter of the map outlined in blue is the approximate location of the "Clarkson Airshed", which has been the subject of considerable study by OME, because of the high levels of combustion gas and particle pollution in the area. The Report of Part II of this study has shown that this airshed "*represents a "taxed" or compromised area with respect to respirable particulate matter (PM_{2.5})*", as well as demonstrating sustained levels of oxides of nitrogen (NO_x) as high as any location in the province, including Toronto (OME 2006). We have already demonstrated to Halton Public Health that NO₂ is responsible for a substantial burden of premature mortality in the Region. The introduction of another major source of fine particles and oxides of nitrogen by virtue of siting a large EFW facility where it is proposed may not be an acceptable choice for the health of the population living within this airshed.

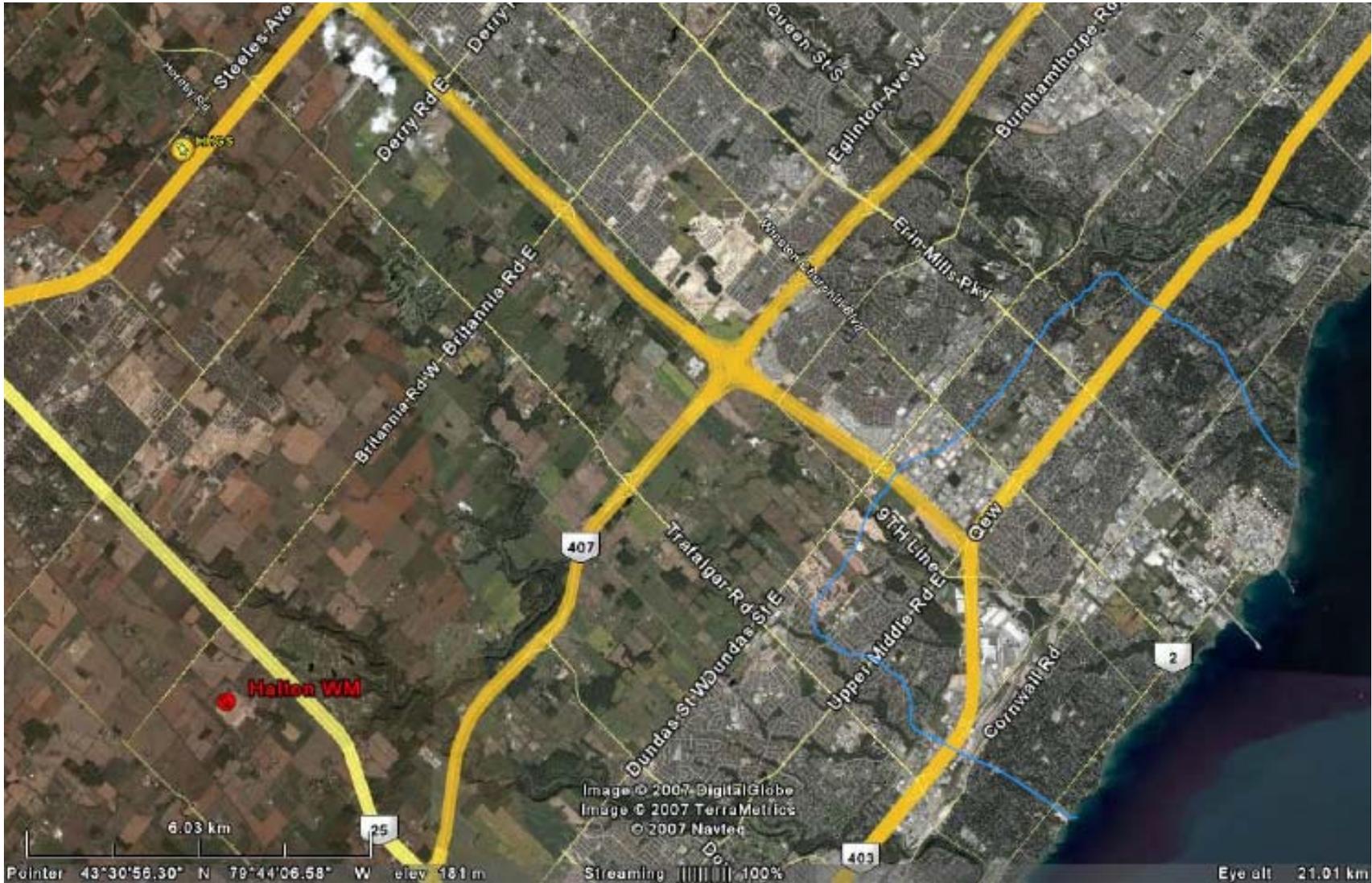


Figure 1. GoogleEarth map of the Halton and Peel Region area potentially impacted by the proposed EFW facility

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