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Site specific risk assessment of an energy-from-waste/thermal treatment facility in Durham Region, Ontario, Canada. Part B: Ecological risk assessment☆

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HIGHLIGHTS

- Ecological risk assessment was performed for an energy-from-waste facility.
- Results suggest that the facility is unlikely to pose undue risk at approved operating capacity.
- Future expansion may cause slightly elevated risks under upset conditions.
- Further risk assessment is required if/when future expansion is pursued.

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ABSTRACT

The regions of Durham and York in Ontario, Canada have partnered to construct an energy-from-waste (EFW) thermal treatment facility as part of a long term strategy for the management of their municipal solid waste. In this paper we present the results of a comprehensive ecological risk assessment (ERA) for this planned facility, based on baseline sampling and site specific modeling to predict facility-related emissions, which was subsequently accepted by regulatory authorities. Emissions were estimated for both the approved initial operating design capacity of the facility (140,000 tonnes per year) and the maximum design capacity (400,000 tonnes per year). In general, calculated ecological hazard quotients (EHQs) and screening ratios (SRs) for receptors did not exceed the benchmark value (1.0). The only exceedances noted were generally due to existing baseline media concentrations, which did not differ from those expected for similar unimpacted sites in Ontario. This suggests that these exceedances reflect conservative assumptions applied in the risk assessment rather than actual potential risk. However, under predicted upset conditions at 400,000 tonnes per year (i.e., facility start-up, shutdown, and loss of air pollution control), a potential unacceptable risk was estimated for freshwater receptors with respect to benzo(g,h,i)perylene (SR = 1.1), which could not be attributed to baseline conditions. Although this slight exceedance reflects a conservative worst-case scenario (upset conditions coinciding with worst-case meteorological conditions), further investigation of potential ecological risk should be performed if this facility is expanded to the maximum operating capacity in the future.

1. Introduction

The regions of Durham and York in Ontario, Canada have partnered to build a new energy-from-waste (EFW) thermal treatment plant as part of a long-term sustainable solution for managing their municipal solid waste. Energy-from-waste facilities can significantly reduce the volume of waste (by >90%) while producing energy for use in the surrounding community (Rushton, 2003). Research and monitoring programs around similar modern EFW facilities in Europe suggest that these facilities are not hazardous to human health or the environment (Bordonaba et al., 2011; Cangialosi et al., 2008; Lee et al., 2007; Morselli et al., 2011; Rovira et al., 2010; Schuhmacher and Domingo, 2006). However, as no similar facility has been constructed in Ontario

Abbreviations: ADD, average daily dose; COPC, contaminant of potential concern; CR, concentration ratio; EA, environmental assessment; EFW, energy-from-waste; EHQ, environmental hazard quotient; EPC, exposure point concentration; ERA, environmental risk assessment; HHRA, human health risk assessment; LC50, median lethal concentration; LD50, median lethal dose; LOAEL, lowest observed adverse effects level; LRASA, local risk assessment study area; NOAEL, no observed adverse effect level; SAR, species at risk; SR, screening ratio; TRV, toxicity reference value; UP, uptake factor.

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for over 20 years, it was necessary to demonstrate through an environmental assessment (EA) process that this new facility would not cause any undue toxicological risks to local human or wildlife receptors. Therefore, extensive human health and ecological risk assessments (HHRA and ERA, respectively) were undertaken. In this paper we describe the methods and results of the ERA component of the EA, the purpose of which was to evaluate the potential that ecological receptors (e.g., mammals, birds, plants and fish) may experience adverse environmental effects as a result of exposure to chemical emissions from the proposed EFW facility. The methods and results of the HHRA are provided in a separate publication (Ollson et al., 2013). The final EA for this project, which included both of these risk assessments, was submitted to the Ontario Ministry of the Environment (MOE) in 2009 and received approval in 2010. Following this approval, project construction was initiated in 2011 and facility start-up is anticipated by the end of 2014.

2. Material and methods

2.1. Scope of the assessment

This ERA, like the HHRA, followed a recognized framework that progressed from a qualitative initial phase (i.e., problem formulation), through exposure and hazard assessments, and concluded with a quantitative or semi-quantitative (in the case of aquatic and terrestrial community-based receptors) risk characterization. The risk assessment methodology for this ERA was based on a number of guidance documents, including but not limited to: Ontario Regulation 153/04 Record of Site Condition Regulation, Part XV.1 of the Environmental Protection Act: Guidance Protocol (MOE, 2004b); A Framework for Ecological Risk Assessment (General Guidance) (CCME, 1996); Guidelines for Ecological Risk Assessment (US EPA, 1998); and US EPA Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (US EPA, 1999).

The goal of ERA is typically to identify potential risks to ecological receptors at the population level rather than at the individual level, with the notable exception being species of conservation concern or species at risk as defined by federal and provincial regulation. Therefore, in this assessment, the primary endpoint considered was the protection of wildlife populations or communities based on predicted changes to growth, reproduction or survival. However, for identified species at risk or species of conservation concern, protection at the individual level was also considered.

Facility design information for this assessment was provided by Covanta Energy Corporation, which was selected as the preferred vendor for the project by the regions of Durham and York. Additional information about the facility design is available in (Ollson et al., 2013). The initial operating design capacity of the proposed facility was 140,000 tonnes per year, with a capacity for expansion to 400,000 tonnes per year within the 30-year planning period. As the expansion of the facility beyond the initial approved capacity of 140,000 tonnes per year would require additional environmental screening under provincial regulations, the present ERA focused primarily on the potential risks from the facility with respect to operation at the 140,000 tonne per year level. However, for comparison purposes, consideration was also given to the potential risks associated with the maximum design capacity of 400,000 tonnes per year. The ERA was conducted for four project scenarios (i.e., existing conditions, facility construction, facility operation and facility decommissioning), each made up of a number of possible cases (Table 1).

Table 1
Project scenarios considered in the ecological risk assessment.

Project scenarios	Case	Conditions assessed
Existing conditions	Baseline	Existing conditions in the assessment area. No facility-related emissions or exposures were included as this was completed prior to construction and operation of the facility.
	Baseline traffic[a]	Offsite vehicle traffic emissions prior to the start-up of the facility.
Construction	Construction	Construction and commissioning of the facility.
Operation	Project alone	Emissions from the facility alone.
	Project (baseline + project)	Emissions from the facility combined with existing/baseline conditions.
	Process upset	Emissions from the facility operating at upset conditions (i.e., facility start-up, shutdown, and loss of air pollution control).
	Process upset project (baseline + upset)	Emissions from the facility operating at upset conditions combined with existing/baseline conditions.
	Traffic[a]	Emissions from offsite and onsite traffic associated with the facility combined with baseline traffic conditions and onsite stationary source emissions for the facility.
Decommissioning	Decommissioning (closure period)	Emissions related to the removal of infrastructure and rehabilitation of the site.

[a] Traffic cases only considered phytotoxicity due to direct exposure (in air) to traffic related emissions of SO_2, NO_2 and HF.

2.2. Study area

The selected location for the facility is located within the municipality of Clarington, Ontario, Canada (approximately 80 km east of Toronto, Ontario). This location is bordered by Lake Ontario to the south, commercial properties to the north and agricultural lands to the east and west. The Darlington Nuclear Generating Station is located approximated 2 km to the east. No significant forested areas or permanent watercourses exist at this location. The flat, open terrain and lack of cover offer few opportunities for specialized habitat or species.

Based on the results of dispersion modeling (see Section 2.4 in Ollson et al., 2013), the local risk assessment study area (LRASA) considered in this assessment was defined as the area within a 10 km radius of the proposed facility location. This LRASA represents the area where maximum air emissions from the facility were predicted to occur and includes the urban centers of Oshawa, Courtice, Bowmanville and Port Darlington.

2.3. Identification of chemicals of potential concern (COPC)

For this ERA chemicals of potential concern (COPC) were defined as compounds that may be released from the facility and may have the potential to adversely affect ecological health if released in sufficient quantity. Chemicals that could potentially be released by the facility to the atmosphere were identified by reviewing sources such as existing provincial guidelines for municipal incinerators (MOE, 2004a), the Canadian National Pollutant Release Inventory for waste incinerators (Environment Canada, 2007), and the results of stack testing of an existing waste incinerator in nearby Brampton, Ontario. Persistent and/or bioaccumulative compounds (i.e., half-life in soil ≥6 months and/or Log $K_{ow} \geq 5$ (Environment Canada, 2006; Rodan et al., 1999)) from this inventory were identified and carried forward as COPC for evaluation in this assessment (Table 2). Generally, the remaining chemicals in the emissions inventory (emitted to air, but neither persistent nor bioaccumulative) were not retained for evaluation because the inhalation pathway was not directly evaluated for ecological receptors (see Section 2.7.2). However, sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and hydrogen fluoride (HF) were retained in order to address their potential effects on vegetation (phytotoxicity), as high concentrations of these contaminants in air are known to produce acute and