Metro
Health Impact Assessment
Evaluation of Landfill and Waste to Energy Options for Managing Municipal Solid Waste

Prepared for:

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Environmental Health Management

Executive Summary

Introduction

Metro has oversight of policies, programs, and facilities in Clackamas, Multnomah and Washington counties (Tri-County area) and 24 cities in the region for the management of municipal solid waste (MSW). Approximately 1.3 million tons per year (tpy) of residual post-diversion waste from the Metro Region are disposed of in landfills outside the region. As part of a long-term strategic planning effort, Metro is exploring a variety of potential options to improve the recovery and beneficial use of the municipal solid waste (MSW).

The objective of the Health Impact Assessment (HIA) is to evaluate the potential health impacts and benefits of managing 200,000 tpy of Metro's MSW through either landfill or waste-to-energy (WTE). This assessment considers:

Generic Landfill:	with landfill gas management and energy production, located 150 miles from Portland.
Covanta WTE Facility	expansion of the Marion County WTE Facility, 50 miles south of Portland and ash disposal at the Coffin Butte Landfill (36 miles).

Each of these options is assessed separately and then the HIA provides a comparative analysis, where possible, of the two disposal methods.

This HIA was conducted at the early stages of the process and is but one report and source of information available to the public and Metro Council. In addition, a *Literature Review of WTE Issues* provides the results of international scientific research on the topic. The HIA is not intended to replace the need for additional information that would be required during the permitting of such WTE management options. This HIA presents the issues and provides recommendations for mitigation of potential concerns or enhancement considerations for positive health outcomes. It also provides recommendations for future studies or work that could be contemplated in subsequent stages of the undertaking.

The HIA incorporates a wide range of potential health determinants. Often referred to as the 'social determinants of health'. This collection of factors related to health status range from biological characteristics (i.e., age, gender, genetics, etc.), to socioeconomic factors (i.e., education, income, lifestyle factors, etc.), as well as distribution of health impacts (and overall perceptions of well-being).

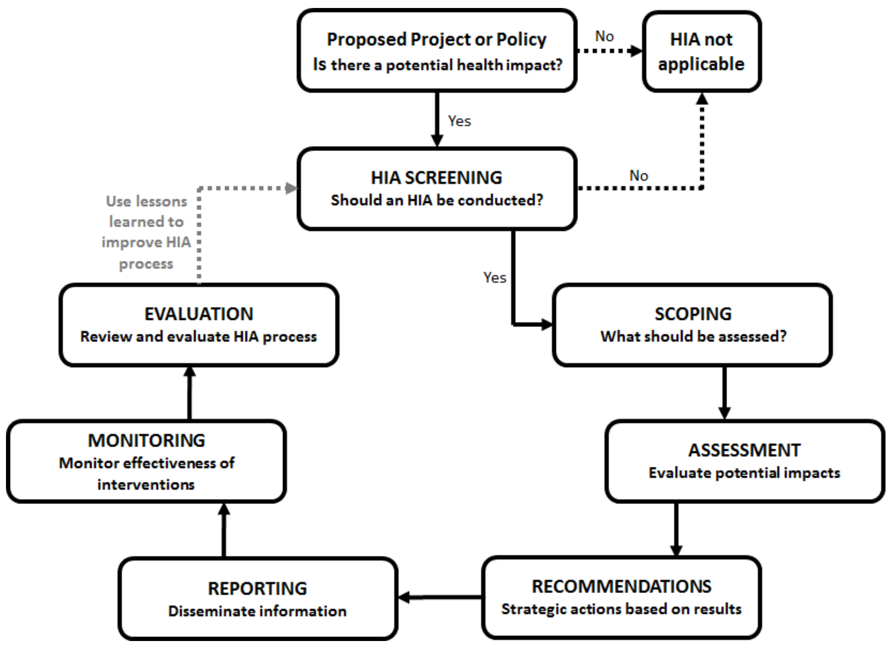
It provides Metro Council an evaluation that is transparent in its origin and method of evaluation, so that it can make a decision of how best to manage MSW.

HIA Methodology

The World Health Organization (WHO) defines health as "*a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*" (WHO, 1948). The HIA assesses a wide range of potential health determinants. Often referred to as the 'social determinants of health'. This collection of factors related to health status range from biological characteristics (i.e., age, gender, genetics, etc.), to socioeconomic factors (i.e., education, income, lifestyle factors, etc.), as well as distribution of health impacts (and overall perceptions of well-being).

This HIA consists of five steps: Screening, Scoping, Assessment, Recommendations and Reporting. Metro may wish to undertake monitoring and evaluation of the HIA in the future.

A decision matrix approach is employed to work through a series of factors - magnitude, frequency, duration and reversibility – to arrive at characterizing the potential for a negative or positive impact of the project on each determinant of health.



Selection of Determinants of Health

A Stakeholder Engagement Workshop brought together a diverse group that included Metro staff, public health officials, environmental advocates, representatives of community interest groups, a representative from Marion County, and the HIA consultants. The workshop participants identified 40 determinants of health that were considered relevant to the assessment. The participants ranked these from low to very high priority for public concern.

Below is a sample table of 26 determinants. Priority 1 (Blue), 2 (Red) and 3 (Orange) determinants of health were retained for inclusion in the HIA. However, resource allocation priority was given to those with higher priority (1 and 2) for decision matrix evaluation and those of lower priority (3) were discussed briefly in text. The priority 4 (Green) determinants would not be impacted by the undertaking and not considered further in the HIA.

Determinants	Potential Impact on Health	Public Concern/ Interest	Data Availability	Priority
Environmental Factors				
Air quality (pollutants, dust, smog etc)	---	Very High	Substantial	1A
Greenhouse gas (GHG) emissions	---	Very High	Substantial	1A
WTE Ash	---	High	Substantial	1A
Accidents / Spills / Injury	---	High	Partial	1B
Soil quality	--	High	Substantial	2A
Traffic volume and safety	--	Very High	Partial	2B
Surface water quality	--	Very High	Partial	2B
Groundwater quality	--	High	Partial	2B
Seismic	--	High	None	2D
Odor	-	Very High	Substantial	3A
Changes in road structure	-	High	Partial	3B
Prevalence of vermin/vectors	--	Medium	Partial	3B
Virus / pathogen exposure	-	High	Very Limited	3C
Social and Economic Factors				
Political Involvement	+++	Very High	Substantial	1A
Employment	++	Very High	Substantial	2A
Working conditions	++	High	Substantial	2A
Local economic growth	++	Very High	Partial	2B
Public safety / perception of safety	-	High	Partial	3B
Property values	-	High	Partial	3B
Childhood development (stimulating/enriching environment)	+	Very High	Partial	3B
Regional economic growth	+	High	Partial	3B
Access to Services				
Child care/daycare	-	Medium	Partial	4B
Education	+	Medium	Partial	4B
Biological and Equity Factors				
Ethnicity/ race/	--	Very High	Partial	2B
Age	-	High	Substantial	3A
Socio-Economic Status (SES)	+	Very High	Partial	3B

Equity and Identification of Vulnerable Populations

A fundamental tenet of HIA is the consideration of health equity in the assessment of determinants of health. Equity through Metro's perspective is founded on the understanding that historically marginalized communities (e.g. communities of color, individuals with disabilities, LGTBQ, low-income communities, youth, older adults, etc.) face disproportionately negative outcomes in every aspect of social well-being (e.g. homeownership, health outcomes, income, education, access to parks, access to transportation, etc.). In particular, communities of color face even greater inequities due to the culmination of negative impacts produced by previous discriminatory practices and policies. The HIA attempts to address equity issues through the identification of 'Vulnerable or Sensitive Populations' for each health determinant.

That said there is a higher population of youth and those reporting to be of two or more races that in Brooks that necessitates their consideration in the HIA as potential vulnerable populations and equity considerations.

Comparative Assessment of WTE and Landfill Options

Most of the determinants of health were the same for the assessment of both the Covanta WTE Facility and the Generic Landfill, with the exception of:

- Environmental Factors:
  - Surface Water assessed for the Covanta WTE Facility
  - Groundwater assessed for the Generic Landfill

There was no difference between the findings of the assessment for the common environmental determinants of health, with the exception of Energy Production. This does not mean that there are no health differences between the two waste management options. However, overall the assessment reveals that modern, properly permitted waste management facilities are unlikely to have an environmental health impact on surrounding communities. There were minor differences in the Employment and Working Conditions for WTE and Generic Landfill, although there is a high degree of uncertainty in the information about the Generic Landfill.

The HIA determined that there would not be a significant impact on Air Quality, Soil, Surface Water or Groundwater if facilities are stringently permitted and monitoring requirements for chemical release are in place. The following provides comment GHG analysis and observations on the significant negative health outcomes for Accidents and Malfunctions and Seismic Activity.

Greenhouse Gas Comparison

The *Comparative Greenhouse Gas Analysis* prepared by HDR (Appendix 1) provided two modeling approaches to assess GHG outputs from WTE and landfill. The two models were the Waste Reduction Model (WARM) method and the Municipal Solid Waste Decision Support Tool (MSW-DST) method. The HDR report indicated for both modeling exercises that:

> *As WARM and MSW-DST generated conflicting answers to the question of which waste management scenario would result in fewer GHG emissions, HDR can make no definitive recommendation on which scenario would have the lesser impact on climate change. It is recommended that Metro consider the results of this GHG emissions modeling as indicative of the potential effects of each waste management scenario, with the understanding that these are broad estimates based on broad assumptions and there are limitations in the models used. Furthermore, as there is not yet consensus among the developers of the models, it should be noted that these results are not replicable across different models, even though each model may be well documented and widely used in a certain geographic or academic setting. It is beyond the purview of this study to comment on which approach is most appropriate for considering GHG emissions from the waste management options being considered. As such, caution is recommended to decision makers not to place too much emphasis, one way or another, with respect to relying on the findings of GHG emissions, given the lack of consensus in scientific communities for estimating the GHG impacts of waste management options. In the future, additional insight may be provided by refining the parameters and sensitivity analyses of the models, or creating a customized LCA using measured, site-specific operating data from each of the facilities involved in the waste management alternatives.*

There is considerable debate by the scientific community as to how GHG from the two waste management options should be considered. HDR chose to use the WARM and MSW-DST models, because they are the two most widely accepted models in the US. There is also disagreement between the two modeling approaches as to the net GHG account for WTE facilities. This is due to inherent differences in model assumptions, inputs and calculations.

It is beyond the purview of the HIA to comment on which approach is most appropriate for considering GHG emissions from the waste management options being considered. Given the conflicting results the HIA determined that the impact would be neutral for both the Covanta WTE Facility and the Generic Landfill.

Accidents and Malfunctions

There is no question that with any industrial activity or waste management options that accidents or malfunctions can occur. For both WTE and landfill the most significant of these events would be a large fire. Although these events are rare, they do occur. At either facility a major fire would pose a significant threat to workers and the surrounding communities. There are no comparator statistics that can predict which facility would more likely experience a major fire. These events are very dependent on local operations and management. However, it is noted that the Covanta WTE Facility is located in closer proximity to the local population than the Generic Landfill.

Seismic Activity

Oregon is located in a zone of potential significant seismic activity. If a significant seismic event were to occur either in the area of the Covanta WTE Facility or the Generic Landfill it could have significant negative health consequences. That said, such an event would also have serious ramifications on the entire area. Given the relative uncertainty in this assessment it was not possible to compare one option against another for potential magnitude of potential health impact.

Additional Comparisons

Traffic Volume and Safety and Vehicle Emissions

The two scenarios involve very different haul distances and vehicle miles traveled. The Generic Landfill is 300 miles round trip from Metro region, although it is able to receive tipping trucks with higher maximum payloads (34 tons per vehicle). The proposed expanded Covanta WTE Facility involves a 100 mile round trip from Metro region and a 72 mile round trip to the ash disposal facility, using vehicles that are assumed to have a payload of approximately 26 tons.

Table 52 provides the comparators between the two waste management options for hauling of 200,000 tpy of MSW.

Comparison of Vehicle Miles Traveled and Emissions.

	Covanta WTE Facility + Ash		
Parameter	Covanta WTE Facility	Ash Disposal	Generic Landfill
Round Trip Distance (mi)	100	72	300
Vehicle Miles Traveled per year	892,000		1,778,000
Gallons of Diesel per Year	148,000		296,000
Total HAPs Emitted per year (t/y)	0.0175		0.0348

Assessment of the Traffic Volume and Safety determinant found that both options would not significantly impact health. However, the Generic Landfill option requires approximately an additional 886,000 VMT each year that would almost double the probability of a truck accident over that of the WTE option.

The Generic Landfill option would require nearly 2 times the number of gallons of diesel per year than the WTE option. There are no refineries in Oregon and the potential health impact of extraction and production of increased diesel fuel was not accounted for in the HIA.

The truck traffic associated with either scenario is insignificant compared to overall traffic volume and would not measurably contribute to roadside ambient HAP concentrations. However, the annual transportation generated HAP emissions for the Generic Landfill option would be higher than those of WTE. Overall, the WTE option would result in a net health benefit for Traffic Volume and Safety and Vehicle Emissions over that of the distant Generic Landfill option.

Energy Production

The Oregon DOE considers both WTE and LFGTE to be sources of renewable energy. They are both given Renewable Energy Certificate (RECs) in Oregon. It is noted that for 200,000 tpy of disposal of MSW that WTE generates 13 MW of electricity compared to 1.3 MW of electricity for the Generic Landfill option.

Social and Economic Considerations

For the Covanta WTE Facility and the Generic Landfill, both Employment and Working Conditions have significant positive benefits to health. Although Local/Regional Economic Growth was not scored Covanta has indicated that it will conduct a full economic benefit analysis of the expansion in the future. It is expected that disposal of 200,000 tpy of MSW to Generic Landfill would include local and regional economic benefit in the form of payment of a portion the tipping fee to the local government.

Recommendations

A summary of potential mitigation measures and enhancement recommendations that could be considered if the expansion of the Covanta WTE was to proceed is provided in the table below. Additional measures would be likely during the permit phase of the project through discussion with the responsible state agencies.

Summary of Mitigation and Enhancement Recommendations

Air Quality
In the event that Metro elects to proceed with sending 200,000 tons per year to the Covanta facility, it is recommended that the Best Available Control Technology (BACT) analysis and a dispersion modeling demonstration of compliance with the National Ambient Air Quality Standards (NAAQS) and the Prevention of Significant Deterioration (PSD) increment consumption limits for all criteria air pollutants for which PSD is triggered be conducted. This would serve to confirm the assumptions in this assessment and is anticipated to be required as part of the regulatory process. Additional studies Metro may wish to consider include: 1. Baseline Ambient Air Quality Monitoring in Brooks. There was no site-specific ambient air quality monitoring data available in the vicinity of the existing Covanta WTE Facility. To ascertain the actual existing ambient concentration of chemicals in the airshed a detailed pre-construction baseline air monitoring program could be undertaken for a one year period. Consideration should be given to collecting a broad suite of chemicals beyond those that are merely envisioned for regulated stack emissions standards. A monitoring plan should be developed that would conform with EPA and DEQ requirements. Such a program would likely require 18 months to design, implement and report. 2. Detailed Air Quality Dispersion Modeling – Metro could consider requiring a more detailed air quality dispersion modelling than may be required under the routine permitting requirements. This would involve inclusion of a broader list of chemicals of concern (50 plus) than only those that have stack emission permitted levels. The

	modeling plan should be developed in accordance to EPA and DEQ requirement and would likely involve the use of the more sophisticated CALPUFF dispersion model. Stack emissions data would include proposed regulatory emissions limits and use of chemical stack test data for the additional chemicals from a similar designed facility. It could include specific requirements for modeling Start-up and Shut-down conditions, where chemical release could be higher than during normal operating conditions. The modeling domain would include the point of maximum modeled ground level concentrations and isopleths (predicted concentrations) of chemicals further from the facility. The resulting ground level concentrations would be compared to existing ambient air quality objectives and deposition rates of chemicals to the soil would also be provided as input to the human health risk assessment.
3.	Human Health Risk Assessment (HHRA) – in some jurisdictions an expansion of a WTE facility has required the conduct of a detailed quantitative multiple pathway (including biomagnification into food and water) HHRA to be undertaken. This would involve input from the baseline ambient air quality program and the detailed air quality dispersion modeling of the broader list of chemicals selected for analysis. Such an undertaking would use the most up-to-date toxicity reference values for both inhalation and oral exposure. For example, any new information published from Clean Air Oregon initiative would be considered. It will evaluate the risk to the local population of the baseline ambient air quality, the expanded Covanta WTE Facility emissions alone, and then a cumulative effects analysis on how expansion of the facility would impact health in combination with existing conditions. Exposures would result in risk quantification benchmarked on hazard quotients (non-cancer chemicals) and incremental lifetime cancer risk (ILCR) (e.g. probability of 1 additional cancer case in a population of 100,000 or 1,000,000 people). The results could be used to ascertain if regulatory stack emissions are sufficient to protect health or if more stringent standards should be used to regulate the proposed expanded facility. It would include Start-up and Shut-down conditions. A focus on health equity for sensitive sub-populations, the elderly, children, those with pre-existing conditions would be undertaken. This assessment would provide additional details on the expanded list of chemicals that would be released from the facility to ensure that they would not impact the people of Brooks.
4.	Best Practices for Monitoring - although the AQ/HHRA reports would have to demonstrate no appreciable risk to people from exposure to chemical emissions from the expanded facility, a review of international best practices on facility monitoring can be completed. This would involve review of engineering practices for stack monitoring/sampling, and the need for ground-level monitoring of air, water, and soil. This could guide the monitoring program for an expanded Covanta WTE Facility.
Greenhouse Gas (GHG) Emissions	
It is recommended that further discussions between the interested parties be undertaken in the future in an attempt to reach consensus on the best approach for determining GHG impacts.	
WTE Ash	
Over the past decade there has been considerable investment and investigation into additional beneficial reuses of WTE ash. The two main areas of research and demonstration projects appear to be used as aggregate and in the production of cement. It is recommended Covanta be encouraged to pursue ongoing research in these areas of beneficial reuse of ash in Oregon.	
Energy Production	
In addition to electricity production, the steam produced in the process can be used as a co-generated source of district heating. Although Metro would not benefit from such improvements, the environmental benefits accrued to the facility would be greatly improved if multiple uses of steam such as district heating to either nearby business or the town of Brooks could be implemented.	

Accidents and Malfunctions
It is recommended that if the Marion County WTE facility is to be expanded that an emergency response plan be developed, or revised if one already exists, that details fire action plans and potential for other industrial releases.
Political Involvement
Public notification and public meetings should be held in the community of Brooks to ascertain what, if any, concerns they may have.
Employment
Covanta has indicated that "At the appropriate time, Covanta will commission a study that will further localize the economic impact of the Marion County facility expansion". It is recommended this undertaking include an assessment of employment and the direct benefit to workers and the local economy.
Local and Regional Economic Growth
It is recommended that a formal socio-economic evaluation report be conducted at the appropriate time in the process to better understand the impact.
Health Equity and Social Environmental Justice
Health equity and social environmental justice were considered at a high level in this HIA. A more focused study could be completed if the proposed expansion of a WTE facility was to be undertaken. This would benefit from broader stakeholder survey (e.g., community of Brooks) and incorporate inputs from the formal socio-economic evaluation.

Conclusion of HIA Comparison of WTE and Generic Landfill

Both the Generic Landfill and the expansion of the Covanta WTE Facility were assessed as employing best available control technologies and adhering to stringent federal and state permitting requirements. Each option has benefits and potential drawbacks. The HIA finds that either can be done in a manner that would not adversely affect public health. The HIA provides Metro Council an evaluation that is transparent in its origin and method of evaluation, so that it can make a decision of how best to manage MSW.

Comparison of HIA Assessment of Proposed Expansion of the Covanta WTE Facility and Generic Landfill Options for Managing 200,000 tpy MSW.

Health Determinant	Covanta WTE Facility				Generic Landfill			
	Health Impact	Probability	Significance	Uncertainty	Health Impact	Probability	Significance	Uncertainty
Environmental Factors								
Air Quality	Neutral (=)	Probable	Not Significant (=)	Low	Neutral (=)	Probable	Not Significant (=)	Low
Greenhouse Gas	Neutral (=)	Possible	Not Significant (=)	High	Neutral (=)	Probable	Not Significant (=)	High
WTE Ash	Neutral (=)	Probable	Not Significant (=)	Low				
Energy Production	Moderate (++)	Probable	Significant (++)	Low	Minor (+)	Probable	Significant (++)	Low
Accident and Malfunction	Major (---)	Unlikely	Significant (--)	High	Major (---)	Unlikely	Significant (--)	High
Soil	Neutral (=)	Probable	Not Significant (=)	Low	Neutral (=)	Probable	Not Significant (=)	Low
Traffic Volume and Safety	Minor (-)	Probable	Not Significant (=)	Low	Minor (-)	Probable	Not Significant (=)	Low
Vehicle Emissions	Neutral (=)	Probable	Not Significant (=)	Low	Neutral (=)	Probable	Not Significant (=)	Low
Seismic Activity	Major (---)	Unlikely	Significant (--)	High	Major (---)	Unlikely	Significant (--)	High
Surface Water	Neutral (=)	Probable	Not Significant (=)	Low				
Groundwater					Neutral (=)	Probable	Not Significant (=)	Low
Social and Economic Factors								
Political	Minor (+)	Probable	Significant (+)	Low	Minor (+)	Probable	Significant (+)	Low
Employment	Major (+++)	Probable	Significant (+++)	Medium	Minor (+)	Probable	Significant (+)	Medium
Working Conditions	Major (+++)	Probable	Significant (+++)	Medium	Moderate (++)	Probable	Significant (++)	High
Local/Regional Economic Growth	Not scored			High	Not scored			High

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1 Project Introduction

Metro has oversight of policies, programs, and facilities in Clackamas, Multnomah and Washington counties (Tri-County area) and 24 cities in the region for the management of municipal solid waste (MSW). Approximately 1.3 million tons per year (tpy) of residual post-diversion waste from the Metro Region are disposed of in landfills outside the region. As part of a long-term strategic planning effort, Metro is exploring a variety of potential options to improve the recovery and beneficial use of the municipal solid waste (MSW).

Currently, Metro disposes of nearly 500,000 tpy of MSW to the Columbia Ridge landfill located approximately 150 miles from Portland in eastern Oregon. In April 2015, Metro released a Request for Expressions of Interest (RFEOI) to solicit responses from vendors and technology providers to offer solid waste treatment options that beneficially use MSW prior to disposal. Covanta Energy LLC (Covanta) offered the potential expansion of its existing Marion County Waste to Energy (WTE) Facility (Covanta WTE Facility) in Brooks, Oregon. The potential use of an existing facility was viewed as a unique response because it was the only WTE respondent that offered an existing, operating facility within close proximity (50 miles) to the Metro Region. The Covanta RFEOI response offers to expand their Covanta WTE Facility to be capable of receiving an additional 200,000 tpy of MSW beyond their existing permitted annual throughput.

In order to evaluate the viability of the Covanta response, Metro's Property and Environmental Services Department has directed HDR Engineering Inc. (HDR) to undertake an assessment of the environmental, health, and economic benefits and costs of diverting MSW to the Covanta WTE Facility. As part of this undertaking HDR subcontracted Ollson Environmental Health Management (OEHM) to conduct a Rapid Health Impact Assessment (HIA) in cooperation with HDR.

The objective of the HIA is to evaluate the potential health impacts and benefits of managing 200,000 tpy of Metro's MSW through either landfill or WTE. This assessment considers a Generic Landfill with landfill gas management and energy production located 150 miles from Portland. It also evaluates the option of transporting MSW to an expanded Covanta WTE Facility, 50 miles south of Portland and WTE ash disposal at the Coffin Butte Landfill (36 miles). Each of these options is assessed separately and then the HIA provides a comparative analysis, where possible, of the two disposal methods. This HIA was conducted at the early stages of the process and is but one report and source of information available to the public and Metro Council. In addition, a Literature Review of WTE Issues (Appendix 2) provides the results of international scientific research on the topic. The HIA is not intended to replace the need for additional information that would be required during the permitting of such WTE management options. This HIA presents the issues and provides recommendations for mitigation of potential concerns or enhancement considerations for positive health outcomes. It also provides recommendations for future studies or work that could be contemplated in subsequent stages of the undertaking.

The HIA incorporates a wide range of potential health determinants. Often referred to as the 'social determinants of health'. This collection of factors related to health status range from biological characteristics (i.e., age, gender, genetics, etc.), to socioeconomic factors (i.e., education, income, lifestyle factors, etc.), as well as distribution of health impacts (and overall perceptions of well-being).

It provides Metro Council an evaluation that is transparent in its origin and method of evaluation, so that it can make a decision of how best to manage MSW.

1.1 Generic Landfill Option

Metro develops and administers the Regional Solid Waste Management Plan (RSWMP). Metro is accountable for state-mandated waste reduction goals in the Tri-County region, and works with its local government and private sector partners to accomplish these goals. It provides funding assistance to local governments for waste reduction programs, and operates household hazardous waste prevention and collection programs within the region. Metro oversees the operation of two Metro-owned transfer stations and administers contracts for the transport and disposal of the waste handled by these facilities. Metro also oversees a system of licenses to regulate privately owned and operated solid waste facilities that accept waste from the region. Finally, Metro plays a role in closure and monitoring of inactive landfills located in the region. Approximately 1.3 million tons per year (tpy) of waste from the Metro Region are disposed of in landfills located outside the region.

The cities and counties are responsible for designing and administering waste reduction programs for their jurisdictions. These activities must comply with state laws, including the Opportunity to Recycle Act, the Oregon Recycling Act and the Metro RSWMP. Local governments are also responsible for regulating and managing solid waste and recycling collection services within their jurisdictional boundaries (including setting franchise boundaries), and reviewing collection rates and service standards. Within the Metro region, private haulers that are permitted or franchised by their respective jurisdictions provide garbage and recycling collection services and have the liberty to select where they will take their collected waste. However, waste generated in the Metro region must be delivered to a “Designated Facility” or the hauler must have a “Non-System” license unless they are hauling to one of Metro’s two transfer station.

Metro currently contracts with Waste Management, Inc. (WM) to dispose of waste at WM owned landfills. The contract between Metro and WM is scheduled to expire on December 31, 2019.

There are three large modern landfills located in eastern Oregon and Washington that serve the western US and Canada. They are located between 150 and 170 miles east of Portland along the Columbia River.

- The Columbia Ridge Landfill is located near the town of Arlington, Oregon, in the eastern part of Oregon and is owned and operated by WM. This landfill is currently receiving the majority of Metro’s waste.
- The Roosevelt Regional Landfill is located in eastern Washington near the town of Roosevelt. It is owned and operated by Republic Services, Inc.
- The Finley Buttes Landfill is located in eastern Oregon near the city of Boardman, and is owned and operated by Waste Connections, Inc.

These three landfills are modern, regulatory compliant facilities and are equipped with modern landfill gas recovery and energy production systems. All are accessible by truck from Portland.

Table 1 provides a summary of the three landfills located in the eastern Oregon/Washington area that are in close proximity to each other and accessible by way of the Columbia Gorge.

Given that an expanded WTE facility in western Oregon will not be operational prior to 2020 it is unknown which specific landfill waste would be diverted from. Therefore, a “Generic Landfill” has been developed for the purposes of evaluation in the Health Impact Analysis (HIA). At the direction of Metro, the Generic Landfill scenario includes consideration of hauling 200,000 tpy of MSW 150 miles along the I-84 corridor to a similar facility. It is worth noting that the diversion of 200,000 tpy of Metro's MSW to a WTE facility would represent 4 percent of the overall waste received in the region on an annual basis.

Table 1. Eastern Oregon and Washington Landfill Summary

Feature	Roosevelt	Columbia Ridge	Finley Buttes
Permit Numbers	Title V – 14AQ-C182 Solid Waste - 20-001	Title V – 11-0001-TV-01 Solid Waste – 391	Title V – 25-0001-TV-01 Solid Waste – 394
Driving Distance From Portland (miles)	140	150	168
Facility area (acres)	2,545	2,036	1,800
Waste received annually (million tons)	2.5	2	0.7
Owner/Operator	Republic Services, Inc.	Waste Management, Inc.	Waste Connections, Inc.
Landfill gas to energy facility capacity (MW)	36.5	12.8	4.8

The use of "Landfill" as a waste treatment technology is defined (for the purpose of this study) as the sanitary burial of the waste consisting of the placement, compaction and daily covering of MSW so as to protect the environment. An MSW landfill unit is a discrete area of land or an excavation that receives household waste, and that is not a land application unit, surface impoundment, injection well, or waste pile. An MSW landfill unit may also receive other types of wastes, such as commercial solid waste, nonhazardous sludge, and industrial solid waste.[1]

Modern landfill designs have several aspects that serve to protect the environment. These include liner systems, leachate (liquids) management systems, gas collection and landfill gas collection and energy conversion systems, and operational protocols.

For assessment purposes, we have also assumed the Generic Landfill is equipped with a landfill gas collection and control system (GCCS) and a landfill gas to energy (LFGTE) process. The GCCS consists of a network of extraction wells installed in the waste mass and is connected to an energy producing facility (the LFGTE plant). This assumption is consistent with the landfills described in the previous section. The Generic Landfill is assumed to utilize Internal Combustion (IC) Engines for the LFGTE process. This technology has a relatively high efficiency and low capital and operating costs, and has been in commercial operation for decades. Additional discussion on the LFGTE process is provided below in Section 1.1.3.7.

1.1.1 Regional Setting

The eastern portions of Oregon and Washington are known for several key features that are conducive to landfill operations. The region has a unique underlying geology consisting of very thick layers of clay,[2] which reduces the potential for leachate to impact local groundwater. The existing landfills upon which the Generic Landfill is based are located within a relatively dry climate that experiences an average annual rainfall of 9.25 inches and 7 inches of snow.[3] In contrast, Portland receives 36 inches of rainfall and four inches of snowfall annually. Being located in a relatively dry climate can allow for generation of less

[1] Source: AP-42 Section 2.4 Municipal Solid Waste Landfills
[2] Source: https://mrdata.usgs.gov/geology/state/fips-unit.php?code=f41021
[3] Source: http://www.usclimatedata.com/climate/arlington/oregon/united-states/usor0013

stormwater and leachate that needs to be managed at the Landfill site. Finally, all three existing landfills are located in rural settings and have a significant buffer of land between the landfill and local residents. The Generic Landfill is assumed to be similarly located.

1.1.2 Regulations and Permitting

The Resource Conservation and Recovery Act (RCRA), Subtitle D regulates the management of nonhazardous solid waste. The United States Environmental Protection Agency (USEPA) provides oversight and establishes minimum federal technical standards and guidelines for state solid waste plans. The two example Oregon landfills are regulated by ODEQ under the Oregon Administrative Rules (OAR) Division 94, Solid Waste: Municipal Solid Waste Landfills. The one example Washington landfill is regulated by the Washington Department of Ecology (Ecology) under the Washington Administrative Code (WAC) 173-351.

Requirements for environmental monitoring of Oregon landfills fall under:

- 40 Code of Federal Regulations (CFR) Part 258, Solid Waste Disposal Facility Criteria
- OAR 340 Division 94, Solid Waste Management
- OAR 340 Division 40, Groundwater Quality Protection

Requirements for environmental monitoring of Washington landfills fall under:

- 40 CFR Part 258, Solid Waste Disposal Facility Criteria
- WAC 173-351, Criteria for Municipal Solid Waste Landfills
- WAC 173-200, Water Quality Standards For Groundwaters Of The State Of Washington

Regarding compliance with the Clean Air Act, the current Federal New Source Performance Standards and Emission Guidelines (NSPS/EG) regulations would be applicable for the Generic Landfill. These regulations set standards on the requirement of a GCCS and the operational and recordkeeping requirements associated with the installation and operation of the GCCS.

In general, all of the existing landfills, and therefore the Generic Landfill, are subject to highly regulated monitoring and reporting requirements that are reported to their respective state environmental regulatory agencies ODEQ and Ecology including the federal USEPA. Details on emissions standards and monitoring requirements are provided in Section 1.2.3.5 below.

1.1.3 Landfill Design and Monitoring

The typical cross section of a modern landfill with gas management is provided in Figure 1.

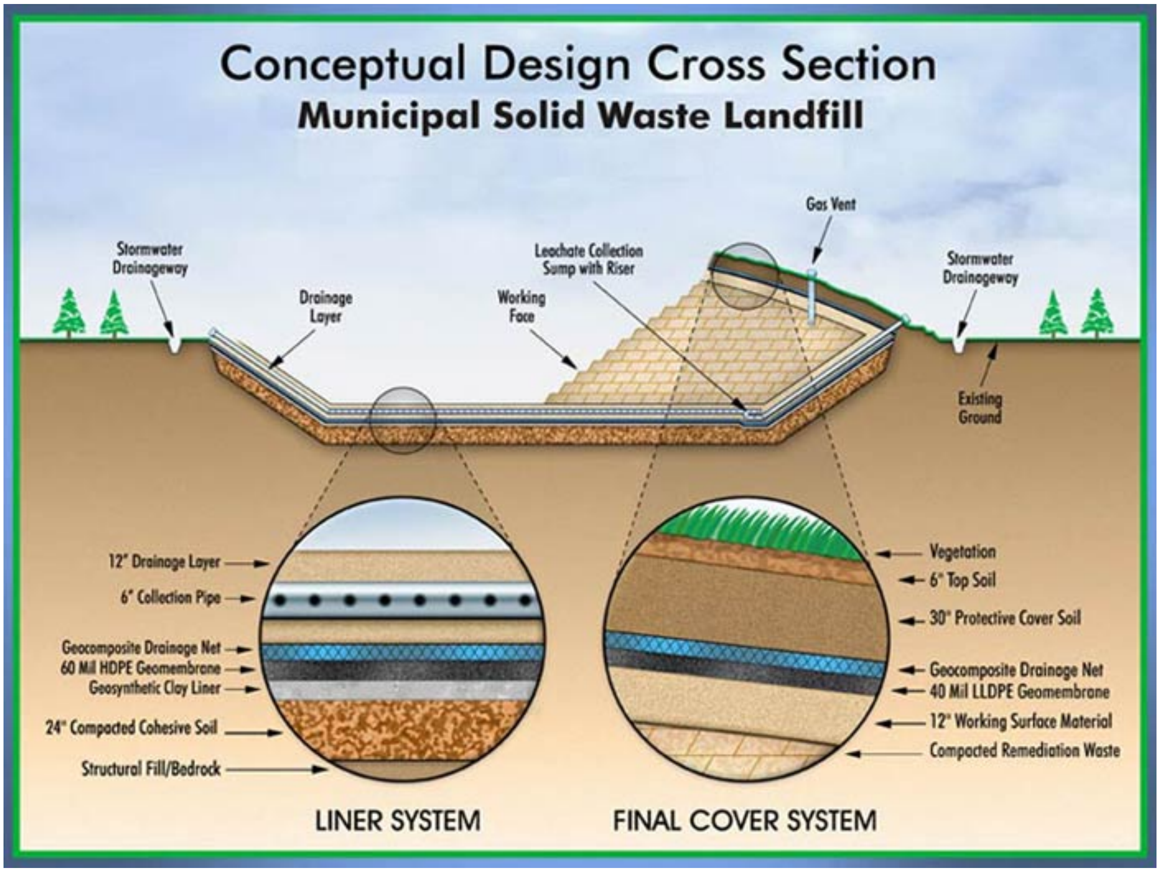


Figure 1. Typical cross section of a modern landfill[4]

1.1.3.1 Landfill Containment Design

The Columbia Ridge example landfill has a multi-layer composite liner system that includes an engineered clay barrier and a 60-mil high-density polyethylene (HDPE) geomembrane to ensure that waste and wastewater (leachate) are contained and isolated from soil and groundwater.[5] Similarly, the other example landfill sites use a multi-layer composite liner system to ensure containment of the waste and wastewater (leachate) so as to isolate them from soil and groundwater. The Roosevelt Regional Landfill has a similar lining system, but utilizes an 80-mil HDPE geomembrane.[6]

The Generic Landfill assumes a design with an underlying secondary barrier consisting typically of a multi-foot re-compacted natural clay layer or an equivalent geosynthetic clay liner. The primary liner consists of a HDPE geomembrane overlaid by a geotextile and covered with highly permeable aggregate.

[4] Source: http://site.republicservices.com/corporate/environmenteducation/landfill-engineering.aspx
[5] Source: http://wmnorthwest.com/landfill/columbiaridge.htm
[6] Source: http://local.republicservices.com/site/roosevelt

1.1.3.2 Waste Acceptance and Placement Operations

The Generic Landfill is assumed to accept general MSW as well as brush, rubbish, construction/demolition waste and certain special wastes. No industrial hazardous or Class I hazardous wastes would be allowed for disposal at the Landfill. All Landfill personnel would be trained in understanding acceptable and unacceptable wastes. Site personnel would conduct periodic screening of waste entering the site. A waste screening report is completed when the screening is undertaken. Inspections would be conducted randomly.

The Gate/Scale-house Attendant would direct solid waste entering the Landfill to the working face. Portable signs and/or barricades would be positioned to direct vehicles from the entrance area to the active disposal area. Solid waste unloading at the working face is directed by Landfill personnel to prevent disposal in locations other than those specified. The Landfill Supervisor would attempt to confine the working face to a minimum width, yet allow safe and efficient operations. The width and length of the working face would be maintained as small as practical, typically less than one-half acre, in order to maintain the appearance of the site, minimize windblown litter, minimize stormwater infiltration into the waste, and minimize the amount of daily cover required at the end of each day. The typical size of the working face would increase proportionally if the quantity of waste disposed per hour of operation increases. The size of the working face would also increase depending on daily waste acceptance rates delivered to the facility. Normally, only one working face would be active on any given day, with all the deposited waste in other areas covered by daily, intermediate, or final cover, as appropriate.

Waste disposal operations would be maintained in limited areas during operations, thereby exposing as little waste as possible to the open air. Waste would be disposed of promptly into the working face of the landfill. Waste would be covered on a daily basis. Some landfills employ alternative daily cover (ADC) to conserve the landfill quantity for waste. If ADC is used, and significant odors are detected, the use of ADC would be re-evaluated by landfill staff. Litter would be controlled through several methods, including proper unloading, compaction, and cover procedures; use of portable litter control fences; orientation of the working face relative to the prevailing wind direction; placement of screening berms, stockpiles, and adequate staffing for litter control.

In the event of a discharge of unauthorized wastes at the Landfill, site management would employ equipment, personnel, and materials as necessary to move them to a proper disposal site. Unauthorized wastes would be removed from the working face immediately upon discharge and placed back in the offending transporter's vehicle, if possible. Unauthorized waste would be isolated from the remaining waste and contained to the extent possible. If replacing the material in the offending transporter's vehicle is not possible, the unauthorized waste would be placed in a suitable location until removal from the facility for proper disposal, if feasible.

The need for extensive vector control (control of rodents, birds, flies, and mosquitoes) would be minimized through proper site operation, including on-going compaction and application of daily cover. The primary method for vector control is proper daily cover. If insects or rodents become a problem, insecticides and/or pesticides would be used to eliminate the vector problem. A licensed pest control professional would be utilized. If necessary, a program of bird deterrence using appropriate landfill bird control techniques would be developed. Any ponded water at the site would be controlled to avoid its becoming a nuisance and attracting vectors.

The Landfill would be required to operate under a plan of operation. The plan of operation must describe the facilities' operation and must convey to site operating personnel the concept of operation intended by the designer. The plan of operation must be available for inspection at the request of the jurisdictional health department and the state agency. The facility must be operated in accordance with the plan of operation or the plan must be modified with the approval of the jurisdictional health department. Each plan of operation must include the following elements:

- How solid wastes are to be handled on-site during its active life including transportation, routine filling, grading, cover, and general housekeeping;
- How inspections are conducted and their frequency;
- Actions to take if there is a fire or explosion;
- Actions to take for sudden releases (e.g., failure of run-off containment system);
- How equipment such as leachate collection and gas collection equipment are to be operated and maintained;
- A safety plan or procedure;
- How operators will meet the regulatory operating criteria; and
- Other such details as required by the jurisdictional health department.

1.1.3.3 Water Use

The example sites typically use water to reduce airborne dust, for soil compaction and to maintain the landfill operating equipment. Of these, the use of water to reduce dust is the largest requirement for water. The example sites typically use groundwater as a water source for their water needs although some sites may apply leachate as dust control water on the active portion of a lined landfill. Large quantity landfills similar to the three example sites are estimated to use between 2 to 4 million gallons of water per year. Most of the water use is for application to surface roads, circulation areas and the active landfill cell, which is functions of the surface areas and not directly related to the quantity of waste received. Consequently, the increase or reduction of 200,000 tons of waste per year would have a negligible impact on the use of water at the site.

1.1.3.4 Leachate Collection and Treatment

The example sites are equipped with leachate collection and treatment systems. These systems typically consist of an underdrain layer of highly permeable gravel drainage material covering the entire landfill base. This layer contains perforated pipes at low points to collect and route leachate to a double composite lined evaporation pond. It also includes a recirculation process that pumps leachate from the pond back in to the landfill to accelerate waste decomposition and enhance landfill gas production.[7]

Condensate and leachate are generally subject to analytical testing to determine whether they are a dangerous waste under the applicable state regulatory criteria. All leachate monitoring must be conducted on a quarterly basis unless otherwise approved by the jurisdictional health department and ODEQ or Ecology. The monitoring results are required to be consolidated into quarterly and annual reports and submitted to ODEQ or Ecology. The monitoring and reporting requirements are described in Section 1.2.3.5 below.

[7] http://wmnorthwest.com/landfill/columbiaridge.htm

Similarly, the Generic Landfill is assumed to collect and re-circulate the leachate generated at the Landfill or contained within a pond for evaporation. As such, no leachate is required to be sent off-site to the local wastewater treatment plant for disposal. Therefore, no pre-treatment monitoring requirements are necessary.

1.1.3.5 Groundwater Monitoring

The example sites' geology and hydrogeology provide unique natural protections because the groundwater is several hundred feet deep and separated from the waste by naturally occurring low permeability soils. The low precipitation in the region also provides for additional protection. Groundwater is monitored at numerous wells, both up-gradient and down-gradient of the waste disposal footprint.

For example, the Columbia Ridge Landfill's site geology and hydrogeology provide protection because the groundwater is approximately 200-feet deep and separated from the waste by low permeability soils. Groundwater is monitored at seven wells, both up-gradient and down-gradient of the waste disposal footprint.[8]

For the Generic Landfill, a groundwater monitoring program would be established. The groundwater monitoring program would include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide an accurate representation of groundwater quality at the background and downgradient wells installed in compliance with the appropriate regulations. It is assumed that the Landfill will have submitted the sampling and analysis program documentation as a part of its permit application, which has subsequently been approved. The program would include procedures and techniques for:

- Sample collection and handling;
- Sample preservation and shipment;
- Analytical procedures;
- Chain-of-custody control;
- Quality assurance and quality control;
- Cleansing of drilling and sampling equipment;
- Procedures to ensure employee health and safety during well installation and monitoring; and
- Well operation and maintenance procedures.

The groundwater monitoring program would include sampling and analytical methods that are appropriate for groundwater sampling and that accurately measure hazardous constituents and other monitoring parameters in groundwater samples or reflect an acceptable practical quantitation limit (PQL). Groundwater samples must not be field-filtered prior to laboratory analysis except for geochemical indicator parameters used for cation-anion balance evaluations. All samples must be sent to an accredited laboratory for analysis.

The Landfill must prepare and submit a copy of an annual groundwater report to the jurisdictional health department and the state department each year. The groundwater annual report must include completed forms developed by the state department and the following information:

[8] http://wmnorthwest.com/landfill/columbiaridge.htm

- A brief summary of statistical results and/or any statistical trends including any findings of any statistical increases for the year;
- A brief summary of groundwater flow rate and direction for the year, noting any trends or changes;
- A copy of all potentiometric surface maps developed for each quarter or approved semi-annual period; and
- A summary geochemical evaluation noting any changes or trends in the cation-anion balances, Trilinear diagrams and general water chemistry for each well.

A quarterly, or alternate frequency approved by the regulatory agency groundwater report must be submitted to the jurisdictional health department and the state department. The quarterly groundwater reports must include completed forms developed by the department and all of the following:

- All groundwater monitoring data for the sampling period;
- A brief summary of statistical results and/or any statistical trends and all statistical calculations;
- Notification of any statistical increase and concentrations above the state criteria for water quality standards for groundwaters of the state;
- Static water level readings for each monitoring well for each sampling event;
- Potentiometric surface elevation maps depicting groundwater flow rate and direction;
- Cation-anion balances and Trilinear diagrams; and
- Leachate analysis results if sampled and tested.

1.1.3.6 Landfill Gas Collection and Control System Management and Monitoring

The design and installation of a GCCS is assumed for the Generic Landfill, as this is required by the Federal NSPS/EG for the example Landfills. All of the example sites manage landfill gas to comply with local and federal environmental requirements, but also to generate energy, reduce emissions, and prevent odor. These systems include a network of landfill gas wells that collect landfill gas throughout the Landfill, conveying the gas to an energy generation facility equipped with a redundant flare as required by federal regulations.

As stated, the current Federal NSPS/EG regulations are applicable for the Landfill. In addition, and pertinent to the Generic Landfill scenario, the USEPA published amendments to 40 CFR Part 60 – Standards of Performance for New Stationary Sources in the Federal Register / Vol. 81, No. 167 / Monday, August 29, 2016. Specific to the Landfill, the following regulations are added/amended:

- Subpart XXX – Standards of Performance for Municipal Solid Waste Landfills That Commenced Construction, Reconstruction, or Modification After July 17, 2014.
- Subpart Cf – Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills

The Landfill is assumed to be regulated by the rule required by 40 CFR Part 60, Subpart Cf that will be implemented by ODEQ or Ecology. ODEQ and Ecology have until May 30, 2017 to submit their updated rules for approval by the USEPA. The USEPA then has up to four months, until September 30, 2017, to approve it. The rule only goes into effect after the USEPA gives its approval.

The existing and new NSPS/EG regulations for the Landfill include monitoring and reporting requirements for GCCS operations. These regulations mandate the following:

- Monthly wellhead monitoring for gas concentrations (oxygen/nitrogen), gas temperature and wellhead pressure. Exceedance tracking and wellhead re-monitoring are required when monitored parameters surpass regulatory thresholds. If wellhead monitoring shows values exceeding regulatory thresholds, then a root cause analysis investigation is required, as well as re-monitoring and possible expansion of the GCCS if the exceedance cannot be remedied.
- Quarterly surface emissions monitoring for fugitive landfill gas emissions. If surface emissions in excess of 500 parts per million (ppm) above background concentration are recorded, then similar remediation methods and re-monitoring are required to maintain compliance.
- The NSPS/EG reporting requirements include: semi-annual NSPS and Start-up, Shutdown, Malfunction (SSM) Plan reporting, annual emissions reporting; annual compliance certification, and quarterly surface emissions reporting.

State or local air agencies can also stipulate additional monitoring and reporting requirements within the facilities Title V operating permit.

1.1.3.7 Landfill Gas to Energy Management and Monitoring

The beneficial utilization of landfill gas for heat, electricity, or other fuel displacement is not a new concept in the MSW industry. Historically, LFGTE projects were financially and technically feasible mostly at larger landfills with higher LFG generation and collection rates or where significant tax incentives were available. However, with advances in gas processing technology and public awareness of LFG as a fuel source, LFGTE projects have steadily become more feasible for a wider range of landfill sizes and circumstances.

The energy content of landfill gas allows utilization as a fuel source in a variety of ways, and there are many variations of LFGTE projects. However, most projects can be classified into one of three types:

- Generation of electricity for internal use or sale to an electric utility;
- Direct thermal utilization of the landfill gas as a medium-Btu fuel by piping the landfill gas to a nearby thermal energy-user (to offset natural gas or other fossil fuel usage); or,
- Processing of the landfill gas to produce a high-Btu natural gas product for pipeline sale or other alternative fuel use (e.g., compressed natural gas (CNG) for vehicle fuel).

These three LFGTE categories have individual benefits and drawbacks, and all have a variety of particular technologies and usages. However, consistent with the example landfills, the Generic Landfill is assumed to utilize the electricity generation option by means of IC engines. Producing electricity from landfill gas is the most common LFGTE application in the United States, accounting for about three-fourths of all domestic LFGTE projects. The most common methodology for electricity generation in the United States is IC engines: about 85 percent of electricity generation LFGTE projects are based upon the reciprocating IC engine.[9]

These engines can require some pretreatment processes (depending on landfill gas quality) and specific operations and maintenance (O&M) procedures to address the contaminants commonly found in landfill gas. Control systems, switchgear and a step-up transformer are also required to increase generated

[9] Source: LMOP LFG Energy Project Development Handbook, Table 3-1: Operation Project Technologies

voltage and maintain synchronization to the local electric transmission lines. Depending on the growth of a landfill, landfill gas fueled engine generators are usually installed in increments, as additional units are installed to take advantage of higher quantities of available landfill gas (as a landfill continues to accept waste over time). There can be situations in which more landfill gas is being collected than can be utilized by the generators installed (in which case the excess landfill gas would be destroyed through flares). Routine maintenance on the engine generators such as oil changes, filter replacements and general tuning are important to continue to maximize electricity output and revenue. Moreover, after every 40,000 - 45,000 operational hours, the engines require a complete overhaul (restoring engine to like-new condition).

1.1.4 Social and Economic Considerations

Although landfills provide an important municipal service, they have social and economic consequences. Socio-economic impacts of landfills include risks for public health derived from surface or groundwater contamination by leachate and the deposition of litter into the surrounding environment. Nuisances such as vectors, odors, airborne litter, dust and noise are frequently cited among the reasons why people do not want to reside in the proximity of a landfill. Some studies have concluded that landfills likely have a negative adverse impact upon housing values depending upon the actual distance from the landfill.

The Generic Landfill is assumed to be located in the rural setting of eastern Oregon or Washington. As such, the facility would not be located in the vicinity of a populated area, which would result in a reduced social and economic impact when compared to other landfills in the region.

1.1.4.1 Employment

The Generic Landfill is assumed to accept approximately 200,000 tpy of MSW at a much larger overall facility. As such, the Landfill will require significant staffing to coordinate the operations and required monitoring. Given that 200,000 tpy would likely represent only 10% of the overall waste being received on an annual basis it is unlikely that diversion or addition of this material to the larger landfill would change staffing requirements by more than 1 or 2 operators.

1.1.4.2 Working Conditions

The Generic Landfill is assumed to have working conditions similar to other landfills in the United States. The Solid Waste Association of North America (SWANA) is a source for industry information in this regard.

At least 98 fatalities directly related to MSW collection, processing and disposal occurred in the United States between July 1, 2015 and June 30, 2016, according to data collected by SWANA. Of the fatalities reported in that time period, 38 were solid waste employees on the job, a majority of which occurred during waste collection. However, 13 of the fatal worker incidents took place at a landfill or materials recovery facility (MRF). The average age of workers who died on the job was 41.7 years old, with 60 percent being over the age of 40. At post-collection facilities, being struck by a vehicle was also the most common cause of death.

In summary, a majority of fatalities occur during the collection operations. Based on the statistic of 13 fatal worker incidents in one year and correlating the 200,000 tons landfilled to the approximately 167 million tons landfilled in the United States,[10] it is clear that for the Generic Landfill, zero fatalities should be assumed. Other worker injury statistics were not readily available for the industry.

1.1.4.3 Local Economic Contribution

The Generic Landfill would provide jobs that help boost the local economy. The Landfill would also provide economic support to local business due to increased traffic and out of town personnel that support construction or maintenance activities. The Landfill would also provide for an increase in tax revenues that would be going to the city and county that the facility resides in.

1.2 Covanta Waste to Energy Facility

The 180,000 tpy Covanta WTE Facility is owned by Covanta and is located on a 16 acres parcel in Brooks, Oregon. It began commercial operation in 1986. The facility serves the solid waste management needs of the more than 325,000 people of Marion County. It processes approximately 90% of Marion County's post-recycling waste. The other 10% of the County's waste consists of non-combustible material that is sent to a landfill. The Covanta WTE Facility also processes a small quantity of non-biologic medical waste that comes from outside the county. The facility is located 50 miles south of Portland.

Approximately 130 refuse trucks arrive daily at the facility and proceed onto the weigh scales. Trucks then drive to the tipping floor and MSW is dumped and then placed into the 34-foot deep storage pit. A large overhead crane then mixes the garbage in the pit and places it into the hoppers that feed the boilers. The facility utilizes two 275 tons per day (tpd) traditional mass burn units to process the waste and each unit is equipped with modern air pollution control equipment (Figure 2). For the WTE conversion process, the waste is combusted on an inclined grate furnace creating a high temperature flue gas and ash. Heat is recovered from the flue gas within the boiler sections of each of the units to generate high-energy steam that is sent through a turbine generator set to create electricity. A 13.1 MW steam turbine converts the steam produced by the boilers into electricity that is sold to the local utility.

1.2.1 Regulations and Permitting

The Covanta WTE Facility is authorized by the DEQ to accept solid waste under Solid Waste Permit No. 364, under OAR 340-093-0030(85). The facility's DEQ Oregon Title V Operating Permit 24-5398-TV-01 was reissued on July 12, 2012 and expired on April 1, 2017. The facility's Title V renewal application was submitted March 30, 2016 and the facility is operating under the permit shield until a new permit is issued. The Title V permit governs permissible air quality emission limits and identifies requirements for continuous stack monitoring and annual stack testing.

In addition, water discharges from the facility are governed under DEQ permits:

- National Pollution Discharge Elimination System (NPDES) Waste Discharge Permit 101240
- NPDES Stormwater Discharge Permit 1200-z

[10] https://archive.epa.gov/epawaste/nonhaz/municipal/web/html/ showing 254.1M tons generated and a recycling rate of 87.2M tons, yielding a total disposed of 166.9M tons

1.2.2 Covanta WTE Facility Operations and Monitoring

1.2.2.1 Control of Air Emissions

The combustion of waste creates a high temperature flue gas that contains various pollutants of concern that must be removed or controlled before they are released to the atmosphere through the facility stack. Air emissions include, but are not limited to, particulate matter (total particulate, PM_{10} and $PM_{2.5}$), acid gases (sulfur oxides (SO_x), hydrogen chloride (HCl), nitrogen oxides (NO_x)), heavy metals (cadmium, lead and mercury), certain volatile organic compounds (VOCs), and carbon monoxide (CO). The flue gas is sent through an air pollution control (APC) system that removes acid gases, heavy metals, and particulate matter.

Air pollution control technologies (APC) at modern WTE facilities can be generally broken into two main types of controls; (1) combustion emissions control technologies, and (2) post-combustion emissions control technologies.

Combustion technologies deal with combustion-oriented pollutants CO, NO_x, VOCs, and organics. Time, temperature and turbulence are key parameters for the proper combustion of the waste, and are used to minimize CO emissions and the destruction of VOCs. NO_x formation in the furnace is the result of the production of Thermal NO_x or Fuel NO_x. Thermal NO_x results from the oxidation of atmospheric nitrogen (N_2), which occurs more readily at temperatures above 2,600°F. Fuel NO_x is formed with the oxidation of the nitrogen content in the fuel (MSW). Combustion control strategies, such as staged combustion and Selective Non-Catalytic Reduction (SNCR) systems for the reduction of NO_x are used in the combustion zone of a modern WTE boiler to control or reduce emissions of NO_x.

The post-combustion APC technology deals with control of gas phase and particulate phase pollutants. These include acid gases, primarily HCl and SO_x, as well as metals (particularly lead, mercury, cadmium), and Dioxins/Furans (PCDD/Fs), ammonia, and fine particulates. The Covanta WTE Facility method to control acid gas emissions is a semi-dry scrubber system. The use of semi-dry scrubbers to control acid gases has been documented to achieve 87-94% removal of HCl. Particulates at the Covanta WTE Facility are controlled through the use of a fabric filter baghouse. Particulate removal efficiencies of up to 99.9% have been documented for baghouses. The injection of activated carbon, either before or after the scrubber device, is used in to remove Dioxins/Furans and Mercury from the flue gas stream.

The current modern APC technologies at the existing Covanta WTE Facility include:

- A Combustion Control System to control the amount and distribution of overfire and underfire air, grate speeds, and feed ram speeds to control steam flow, oxygen, furnace temperature, and to minimize CO.
- An SNCR system using aqueous ammonia to reduce the emissions of NO_x in the upper furnace. The SNCR system could be classified as post combustion control technology but will be referred to as part of the combustion control system.
- A semi-dry flue gas scrubber with a slurry lime injection for acid gas emission reduction, activated carbon injection for the control/removal of mercury and dioxin/furan emissions and fabric filter baghouse for the capture and removal of particulate matter and heavy metals.

The facility's DEQ Oregon Title V Operating Permit 24-5398-TV-01 establishes permissible air emissions limits for the facility. They incorporate the federal Emissions Guidelines for Municipal Waste Combustors in 40 CFR Part 60 Subpart Cb. The permit governs both continuous monitoring and annual stack testing.

Continuous emissions monitoring at the Covanta WTE Facility includes opacity, sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), diluent gas concentrations, unit load, particulate matter (PM) control device inlet temperature and carbon injection parameters.

Annual stack testing, whereby actual emissions measurements are collected from the stack, are required for the broader suite of chemical constituents permitted. They include filterable particulate, total particulate, SO_2, NO_x, CO, HCl, dioxin/furan, mercury, lead and cadmium.

In 2011, as part of the Title V permit renewal the DEQ issued a Review Report. The report provides the justification for the Plant Site Emission Limits (PSELs) and discusses the historical operational compliance. The DEQ reported that they had inspected the facility in 2006, 2008 and 2010 and found it to be in compliance with all permit condition. Only two complaints had been received by the DEQ, ash deposition and smell of burning plastic, and neither was thought to be the result of combustion at the facility. The DEQ also reported that no formal enforcement actions had been taken against the facility since the last permit renewal.

The facility is undergoing renewal of its Title V permit and has undergone biennial Title V inspections (2012, 2014, and 2016) since the last approval. Covanta reported that since the last permit renewal they have on occasion received odor complaints, but none have been attributed to the facility. In addition, they reported that no enforcement action has taken place against the facility since the last permit renewal.

1.2.2.2 Control of Solid Wastes

The combustion process produces a bottom ash that is taken off the grate/stoker and fly ash that is recovered from the boilers and APC process. This combined ash is approximately 20-30% by mass, and 10% by volume of the original waste material that was combusted. Ferrous and non-ferrous metals are recovered from the ash at the Covanta WTE Facility.

Bottom ash is the mineral material left after the combustion of the waste. Bottom ash is a heterogeneous mixture of slag, metals, ceramics, glass, unburned organic matter and other noncombustible inorganic materials, and consists mainly of silicates, oxides and carbonates.

The fly ash from the Covanta WTE Facility process result from the APC system and other parts of the process where flue gas passes (i.e., superheater, economizer). Fly ash includes a mixture of lime and carbon and is removed from the emission gases in a fabric filter baghouse. Fly ash may contain high levels of soluble salts, particularly chlorides, heavy metals such as cadmium, lead, copper and zinc, and trace levels of dioxins and furans, and make up approximately 2 – 5% by weight of the original waste combusted.

As is common practice in the U.S., the Covanta WTE Facility combines the bottom ash and fly ash streams and test it for pH, alkalinity and for the toxicity leaching potential using the *Guidance for the Sampling and Analysis of Municipal Waste Combustion Ash for the Toxicity Leach Ability Characteristic* (often referred to as a TCLP Test). The Solid Waste Permit No. 364, under OAR 340-093-0030(85) dictates quarterly ash testing. The results of the testing are reported to Marion County who is responsible for the ash once it leaves the facility. These tests are required to ensure that the ash material can be classified as inert fill and then be accepted for use as day cover at a landfill. Example results of the Covanta WTE Facility ash analysis are provided in Section 6.1.3.

Under current operation there is approximately 40,000 tons per year of ash is transported 36 miles and used as alternative daily cover at Coffin Butte Landfill located north of Corvallis, Oregon.

1.2.2.3 Water Use and Control of Liquid Wastes

Water usage and disposal can be significant in a WTE facility. The main requirements for water are for cooling of the process steam (in a wet cooling tower) and for make-up water to the boiler. The Covanta WTE Facility obtains process water from their on-site groundwater extraction wells.

Disposal of wastewater at the Covanta WTE Facility is regulated through their NPDES Waste Discharge Permit 101240. The types of wastewater covered by the permit include those for the boiler blowdown, cooling tower blowdown and the demineralizer backwash. The Covanta WTE Facility discharges approximately 80,000 to 100,000 gallons of water per day. This water is first collected in a neutralization tank where pH is adjusted and then it is directed to the on-site sump. Daily monitoring at the sump is required for pH, flow, and residual chlorine. In addition, total suspended solids and total dissolved solids are monitored monthly.

The facility is permitted to discharge to the Willamette River mile 72 (outfall number 001) via an approximately 7 mile pipe. The permitted levels at the discharge limits at the outfall are provided in Table 2.

Table 2. Outfall 001 Willamette River Waste Discharge Limits

Parameter	Concentration	
	Monthly average	**Daily Maximum**
Total chlorine residual	0.4 mg/L	0.6 mg/L
Flow	0.15 MGD	0.30 MGD
pH	Shall not be outside the range of 6.0-9.0	

In addition to the outfall discharge limits the Covanta WTE Facility is required to conduct additional source testing periodically at the facility's north sump, located immediately north of the parking lot. Additional parameters include total flow (MGD), pH, temperature, total chlorine residual, total suspended solids, total dissolved solids, PCBs, iron, mercury, aldrin, dieldrin, DDT, and DDE.

The Covanta WTE Facility has a storm water retention pond that is discharged under the NPDES Stormwater Discharge Permit 1200-z permit. Site stormwater is conveyed via onsite ditches to the stormwater retention pond. Approximately twice a year the pond is discharged to a roadside ditch (along the south side of Brooklake Road), which eventually discharges to Little Pudding River. The facility is required to test the stormwater prior to discharge and meets general and sector specific requirements under the NPDES Stormwater Discharge Permit 1200-z.

The Covanta WTE Facility had a NDPES wastewater inspection in 2015 and a NPDES 1200-z inspection in 2016. Both inspections were passed by the facility. Details of testing are evaluated in Section 6.1.11.

1.2.2.4 Odor Control

In addition to the control of emissions from the combustion process, WTE Facilities must also control the potential for odors from the handling and storage of putrescible wastes. The tipping floor building is kept under negative pressure to reduce the potential of fugitive odors by drawing air into large vents above the crane deck. The air from the tipping floor is used in the combustion process to eliminate the potential odors. The high temperatures associated with the combustion process are sufficient to destroy the odors before exiting the stack.

1.2.2.5 Energy Production

A steam turbine converts the steam produced by the boilers into 13.1 MW of electricity that is sold to Portland General Electric. The utility service area is located solely within the state of Oregon. Covanta has stated that if the facility was to be expanded to accommodate another 200,000 tpy of MSW that they would expect to produce an additional 13 MW of electricity, or a total of 26 MW of electricity.

1.2.3 Social and Economic Considerations

1.2.3.1 Employment

The Covanta WTE Facility currently employs 38 full-time skilled workers, excluding management staff. They are unionized jobs represented by Local 701 Operating Engineers. Covanta reported "*hourly employees at the facility have an average total annual compensation of approximately $90,000*".

Covanta has provided a preliminary estimate that the expansion would create an additional 10 direct permanent jobs, primarily in maintenance and operations support roles. It reported that the current annual compensation of such employees is approximately $90,000. This is a level that is almost $30,000 per year greater than the Marion County average. During construction Covanta estimates that there would be approximately 90 direct onsite construction jobs and 200 secondary jobs over a three-year period.

1.2.3.2 Working Conditions

In 2005, the Covanta WTE Facility began participating in the Occupational Safety and Health Administration's (OSHA) Safety and Health Achievement Recognition Program (SHARP). The purpose of the program is to recognize exemplary injury and illness prevention programs (US Department of Labor, 2017).

In addition, since 2008 the Covanta WTE Facility has participated in the Oregon Department of Consumer and Business Services, OSHA Voluntary Protection Program (VPP). The VPP program has been put in place to recognize workplaces with excellent safety and health management systems and promotes these employers as model workplaces. The VPP program does not replace legal requirements under Oregon OSHA; rather it requires participants to go above and beyond these requirements.

The Covanta WTE Facility reached VPP STAR status in 2008. This is the highest level of status that can be obtained under the program. STAR status is designated for exemplary worksites (Oregon OSHA):

- Implemented comprehensive, successful safety and health management systems; and,
- Achieved injury/illness rates below their industry's national average.

Covanta provided HDR with their VPP record from 2013-2015 (Figure 15). Its three-year average Total Case Injury Rate for Injuries and Illness (TCIR) was 2.73, which was 20% lower than the national average. Their three-year average Days Away from Work, Restricted Work Activity, and/or Job Transfer Rate (DART) of 0.92 was 50% lower than the national average (Figure 15).

Therefore, based on its safety record and the recognition of STAR status in the Oregon OSHA VPP program, working conditions from a physical health and safety standpoint appear to be excellent.

Although statistics were not provided, during the site visit on October 13, 2016, with Matt Marler we heard that the facility has a very low turnover rate of employees and has a preference to promote employees from within when possible. This is an indicator of satisfaction with working conditions and the work environment.

An additional 10 permanent positions will be added to the expanded Covanta WTE Facility. Based on Covanta's participation in the Oregon OSHA VPP program it was assumed that the employees will receive necessary health and safety training for the positions to be filled. Based on the existing facility's track record of retention it was assumed that the employees would have good job satisfaction and remain employed for several years.

1.2.3.3 Local Economic Contribution

Covanta reported to HDR that the County currently receives between $2 million and $4 million in direct contributions annually from the Covanta WTE Facility. Direct contributions include revenue sharing, property and payroll taxes, and community contributions.

Covanta estimates that the project would generate $440 million in economic activity during construction – the majority of which will be spent in the United States. Should the proposed expansion move forward, Covanta has committed to complete a more detailed economic impact study as part of its project development process.

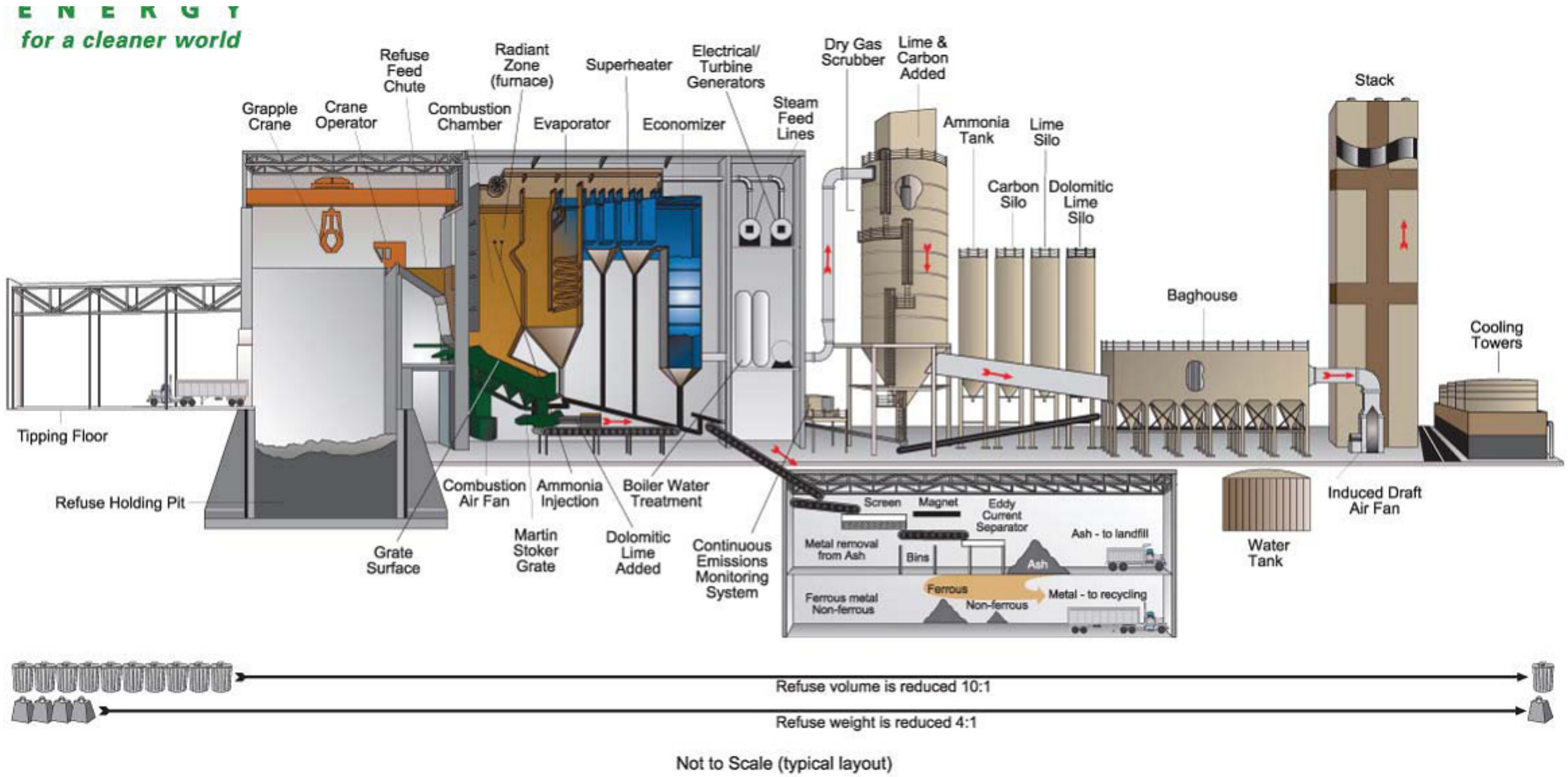


Figure 2. Schematic of a Typical Waste-to-Energy Facility
(http://www.co.marion.or.us/PW/ES/disposal/Pages/mcwef.aspx)(http://www.co.marion.or.us/PW/ES/disposal/Pages/mcwef.asp

2 Health Impact Assessment Methodology

The World Health Organization (WHO) defines health as "*a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*" (WHO, 1948). The Oregon Health Authority (OHA) also subscribes to this laudable goal of health attainment.

The OHA is one of the leading state agencies in the US employing HIA to evaluate policy and programs for both their potential negative health impacts and those aspects that may lend to positive outcomes on health. From the Oregon Health Authority website:

> "*Health Impact Assessment, or HIA, has been defined as 'a combination of procedures, methods, and tools by which a policy, program, or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population' (Gothenburg Consensus Statement, 1999). The key element that makes HIA different from traditional public health assessment is that its approach is prospective. Ideally, the health impacts of a proposal are assessed before a final decision is made, allowing the results of the HIA to be considered in the decision making process. The ultimate goal of HIA is utilize objective information to minimize the negative health impact and maximize the positive health impacts of a project or policy.*"
>
> *(OHA, 2017)*

The book "*Health Impact Assessment in the United States*" notes that although there is considerable variability, several key features appear across almost all definitions and tools (Ross et al., 2014):

1. Main purpose is to inform decision making,
2. Follows a structured but flexible process, and,
3. Examines the full range of relevant impacts to health (i.e., chemical, physical, social, etc.).

This Rapid HIA (further referred to as HIA in this document) was undertaken using a variety of guidance documents, recent scientific publications in the field of HIA and professional experience. Two primary guidance documents were relied on:

> Health Impact Assessment: Oregon's Practitioner Toolkit – A handbook for conducting Rapid HIAs (2nd Edition), Oregon Health Authority, January 2015.
>
> Minimum Elements and Practice Standards for Health Impact Assessment. Version 3, September 2014. Bhatia R, Farhang L, Heller J, Lee M, Orenstein M, Richardson M and Wernham A.

The HIA is intended to incorporate a wide range of potential health determinants. It includes environmental factors and the social determinants of health. This collection of factors related to health status ranges from biological characteristics (i.e., age, gender, genetics, etc.), to socioeconomic factors (i.e., education, income, lifestyle factors, etc.), as well as distribution of health impacts and overall perceptions of well-being (Figure 3).

Figure 3. Examples of the Social and Environmental Determinants of Health Considered in HIA (OHA, 2015)

This HIA consists of five steps: Screening, Scoping, Assessment, Recommendations and Reporting. Metro may wish to undertake monitoring and evaluation of the HIA in the future (Figure 4).

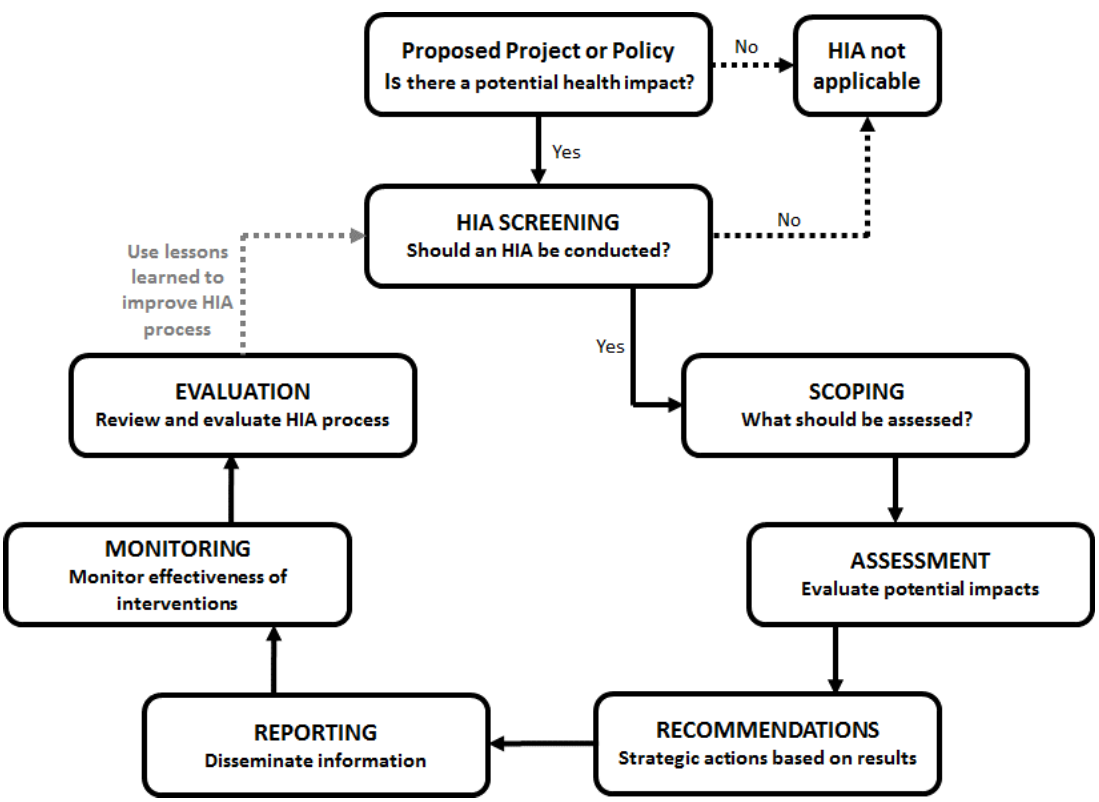


Figure 4. The HIA Assessment Process (McCallum et al., 2015)

In addition, the North American HIA Practice Standards Working Group (Bhatia, 2010), identified a minimum number of elements that must be included in an HIA in order to distinguish it from other processes. Accordingly, an HIA must:

- Inform the decision-making process around a proposed policy, program or project and be conducted prior to the decision being made;
- Employ a systematic analytical process that:
  - Includes a scoping phase that fully considers potential impacts on health (including social, environmental and economic determinants) and identifies key issues for analysis;
  - Encourages and uses stakeholder feedback;
  - Establishes baseline health conditions;
  - Relies on the best available evidence to evaluate different aspects of the health impact (e.g., likelihood, magnitude, distribution, etc.); and,
  - Makes conclusions and recommendations based on a transparent and context-specific evaluation of the evidence while acknowledging the data sources, strengths and limitations of evidence, uncertainties and methodological assumptions.
- Identify appropriate recommendations (i.e., mitigation measures, design alternatives, etc.) to protect and promote health;
- Propose a plan to monitor or track the implementation with respect to the health determinants of concern; and,
- Include a transparent and comprehensive reporting process.

2.1 Steps in Conducting an HIA

The following provides the methodology used for each of the steps in the HIA. The results of each step are provided in subsequent sections.

2.1.1 Screening

The first step of any HIA process is screening to determine whether this type of assessment is warranted based on a review of available evidence. Key questions that are answered in this step include, "Is an HIA feasible, what form should it take and how much effort will be required?" The screening tool developed by McCallum et al. (2016a) was used to document the rationale for conducting this HIA.

2.1.2 Scoping

The purpose of the scoping step is to plan the overall approach to the HIA including methods, contents and logistics. The scoping of the HIA involves determining the issues of highest priority (based on established evidence and stakeholder input) and identifies the assessment population/area. This was achieved through the use of the scoping tool developed by McCallum et al. 2016b to guide the decision-making. This Microsoft Excel-based tool allows for priority ranking of over 50 determinants of health and allows for consideration of applicability to the project, budget and available information. In addition, the geographic and temporal boundaries are established.

2.1.3 Assessment

The assessment step characterizes potential impacts (positive or negative) and identifies the likelihood of their occurrence. There are a number of ways that assessments in HIAs can be undertaken. Based on the results of the scoping step two approaches were used in the assessment: evaluation of top priority determinants using qualitative matrix approach and a qualitative discussion of lower priority determinants.

2.1.3.1 Decision Matrix Assessment Approach

The decision matrix approach involves working through a series of factors - magnitude, frequency, duration and reversibility – to arrive at characterizing the potential for a negative or positive impact of the project on each determinant of health (McCallum et al., 2015a and McCallum, 2017). Each of these factors has a series of definitions that allow the assessor to select based on information and data available (Table 3).

Table 3. Definitions for Characterizing Effects (McCallum, 2017)

Magnitude: what is the severity of the effect on human health?	
Low	The effect is minor and does not pose a hazard/benefit to health; health status will not change from baseline.
Medium	The effect is detectable and poses a minor to moderate hazard/benefit to health; health status could change from baseline.
High	The effect is severe and poses a major hazard/benefit to health; health status will change from baseline.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Reversible	The effect is reversible (effect stops once exposure removed) and people will be able to recover or adapt to the change with relative ease, may require support. For positive effects, the improvement is temporary.
Irreversible	The effect is not reversible (effect continues once exposure is removed) people are not likely to recover or adapt to the changes, even with additional support. For positive effects, the improvement is permanent.
Frequency: how often is the effect expected to occur?	
Low	The effect occurs rarely, if ever.
Medium	The effect may occur occasionally.
High	The effect occurs on a continuous basis.
Duration: what would be the duration of the effect, if it were to occur?	
Short-Term	A short-term (acute) effect, lasting from days to weeks.
Long-Term	A long-term (chronic) effect, lasting from months to years.

Upon completion of the assessment of each of the determinants the characterization of the potential impact is then determined through the matrix in Figure 5.

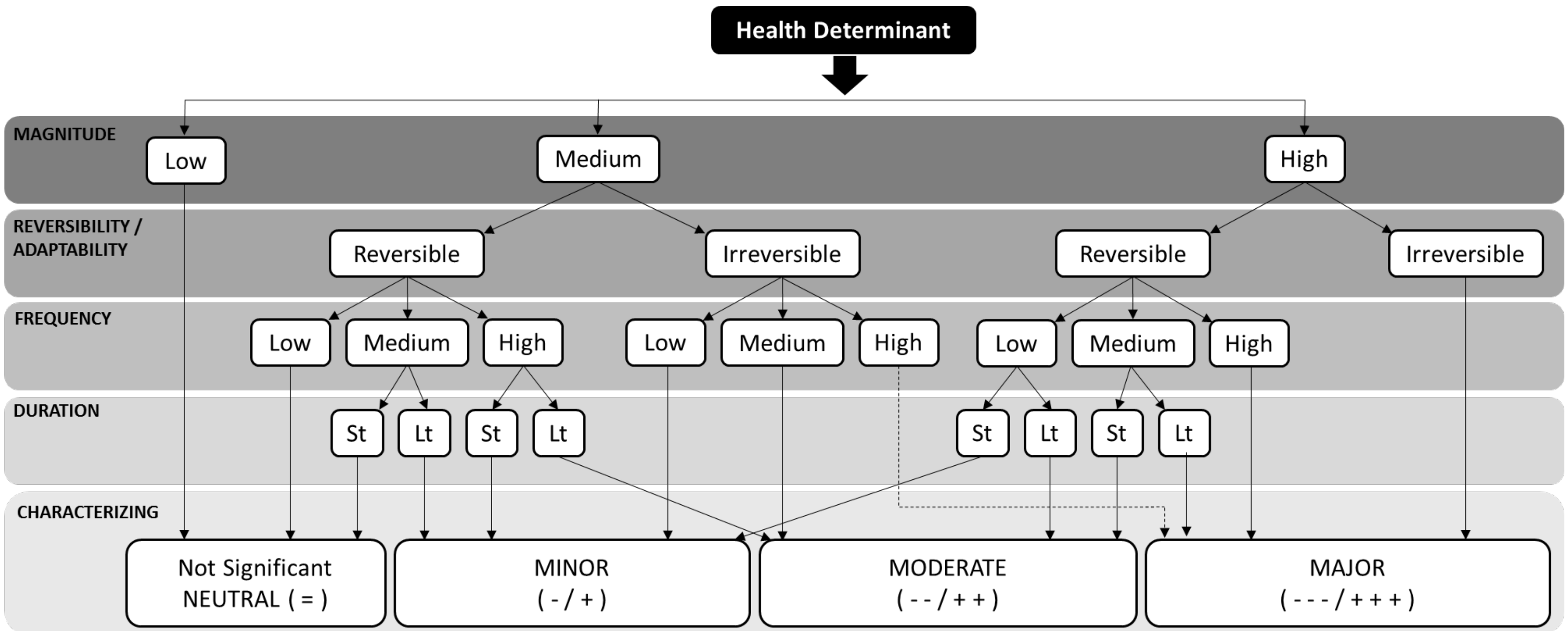


Figure 5. Decision Matrix for Characterizing of Effects (McCallum, 2017)

Although this approach requires subjective professional judgment to be applied by the assessor, it allows for transparency in how effects on health are characterized. It allows stakeholders and decision makers to examine how assessments of health were made. In the event that there is disagreement then discussion can be had on how alternative outcomes could be reached.

In addition, although an effect could be considered minor through to major it is also prudent to provide a determination of likelihood of the effect occurring. A major health impact (either positive or negative) that is likely to occur would be meaningful; however, if it was only unlikely to occur it could be afforded less weight in the overall determination of the project's potential impact on health.

The definitions for likelihood or probability of the impact occurring are:

- Unlikely: The impact is anticipated to occur rarely, if ever. This classification is appropriate for those situations where impacts are not zero but they are limited to very rare occurrences, catastrophic events, or highly unlikely system failures.
- Possible: The impact may occur, but the probability is less than 50%.
- Probable: The impact will likely occur, and the probability is greater than 50%.

The final stage is to provide a determination of the uncertainty associated with the evaluation of the health impacts. This allows the reader to understand the level of comfort or certainty that the assessor has with the determination of characterization of the effect. The following definitions are used in this HIA:

- High: A high level of uncertainty (i.e., low level of confidence) is associated with the determination of significance as a result of <u>moderate data or information gaps</u> and/or a low level of confidence associated with the assessment methods and approach.
- Medium: A medium level of uncertainty (i.e., moderate level of confidence) is associated with the determination of significance as a result of <u>minor data or information gaps</u> and/or a moderate confidence associated with the assessment methods and approach.
- Low: A low level of uncertainty (i.e., high level of confidence) is associated with the determination of significance as a result of <u>negligible data or information gaps</u> and/or a high level of confidence associated with the assessment methods and approach.

2.1.3.2 Assessment of Lower Priority Determinants

Those determinants that were given a lower priority ranking are discussed briefly as to what, if any, potential impact they may have on health. This is common in HIA where resources and efforts are placed on higher priority determinants.

2.1.4 Recommendations

Based on the findings of the assessment, recommendations are made to enhance potential positive impacts and mitigate potential negative health outcomes. Additional studies or data collection that may inform the decision process during later stages is also discussed.

2.1.5 Reporting

Unique to this HIA is that two options – Landfill and WTE – for managing of Metro MSW are being evaluated. Therefore, the report contains a comparison of the outcomes of the HIA assessment of each option. The report also contains a plain language summary for ease of dissemination of information to the public and stakeholders. It will be provided to Metro Council for its consideration during deliberations on how to manage 200,000 tpy of MSW.

2.2 Health Equity

A fundamental tenet of an HIA is the consideration of health equity in the assessment of determinants of health. The Society of Practitioners of Health Impact Assessment's (SOPHIA) Equity Working Group has provided a number of guidance documents and tools for incorporating equity throughout HIA's. They provide the following definitions for consideration:

> ***Health Equity -*** *in health implies that ideally everyone should have a fair opportunity to attain their full potential and, more pragmatically, that no one should be disadvantaged from achieving this potential, if it can be avoided. (Whitehead, 1992)*
>
> ***Communities facing inequities*** *- This term was chosen to describe communities that are facing impacts of a decision with implications for equity, and that may have historically faced negative impacts from previous decisions.*

In 2016 Metro released its "Strategic plan to advance racial equity, diversity and inclusion" and it contains the following:

> *Everyone in the Portland metropolitan region should benefit from quality jobs, stable and affordable housing, safe and reliable transportation, clean air and water, and a healthy environment.*

Equity through Metro's perspective is founded on the understanding that historically marginalized communities (e.g. communities of color, individuals with disabilities, LGTBQ, low-income communities, youth, older adults, etc.) face disproportionately negative outcomes in every aspect of social well-being (e.g. homeownership, health outcomes, income, education, access to parks, access to transportation, etc.). In particular, communities of color face even greater inequities due to the culmination of negative impacts produced by previous discriminatory practices and policies.

Within the HIA, equity is an integral part of not only social and economic issues, but can also be impacted by environmental factors. It is crosscutting and equity components are related to almost all of the health determinants within this HIA. However, given that this is a Rapid HIA the majority of available data could not be disaggregated (e.g., by race, age, income, disability). Therefore, it is difficult in most cases to illustrate impacts to those who have been historically marginalized and disproportionate impacts on communities of color. However, where possible this has been incorporated to the HIA.

The HIA attempts to address equity issues through the identification of 'Vulnerable or Sensitive Populations' for each health determinant. For example, environmental contaminants may have a disproportionate impact on the youth, elderly and those with pre-existing medical conditions. Each determinant of health clearly identifies these populations at the beginning of each section and attempts to determine how the waste management option may impact their health.

3 Screening

Through a series of exploratory calls with Metro it was determined that an HIA could be an appropriate vehicle to help to characterize the potential health negatives and positives when considering whether to dispose 200,000 tpy of MSW in a distant landfill or to an expanded Covanta WTE Facility.

The formal screening to determine feasibility of conducting an HIA was conducted with the "Health Impact Assessment (HIA) Screening Tool: A Value vs. Investment Approach" (McCallum et al., 2016). The tool was first evaluated by OEHM and then final outcome was reached during a conference call with Metro. The screening approach is broken down into five sections.

Section A: Is HIA a Viable Option?

The first step of the screening tool is to follow the flow diagram (Figure 6) to determine if HIA is a viable option for the undertaking.

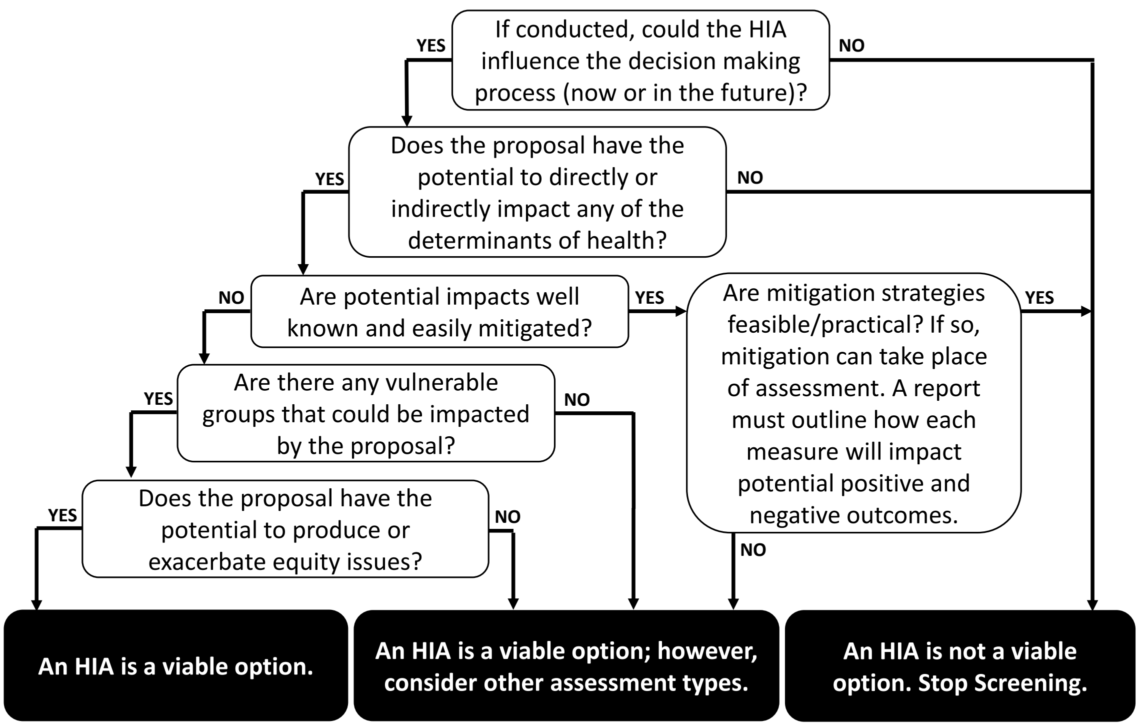


Figure 6. Flow Diagram to Determine if HIA is a Viable Option (McCallum et al, 2016a)

It was determined through answering the series of questions that the HIA could influence the decision-making process, that the either waste disposal option could impact determinants of health, that the impacts are known, there are potential vulnerable populations in the area, and that the disposal options could have the potential to exacerbate equity issues. Therefore, HIA was determined to be a viable option for this project.

Section B: What Type of HIA is Most Applicable if one is to be Undertaken?

It was determined that a qualitative (decision matrix) Rapid HIA should be undertaken in a consultative manner. A more quantitative site-specific analysis was determined to be beyond the scope of this comparative analysis.

Section C: Is HIA Practical from an Investment vs. Value Perspective?

The next step of the HIA screening tool provides a simple analysis of the investment required to conduct the HIA versus the potential value of the process to determine the practicality of conducting an HIA for the project/policy proposal. Five questions, each pertaining to the level of investment required and the value one would derive from the HIA, were answered. The result is a numeric score for each. The investment score was 7, while the value score was determined to be 15 and therefore the HIA was determined to be practical to provide overall value to the undertaking (Figure 7).

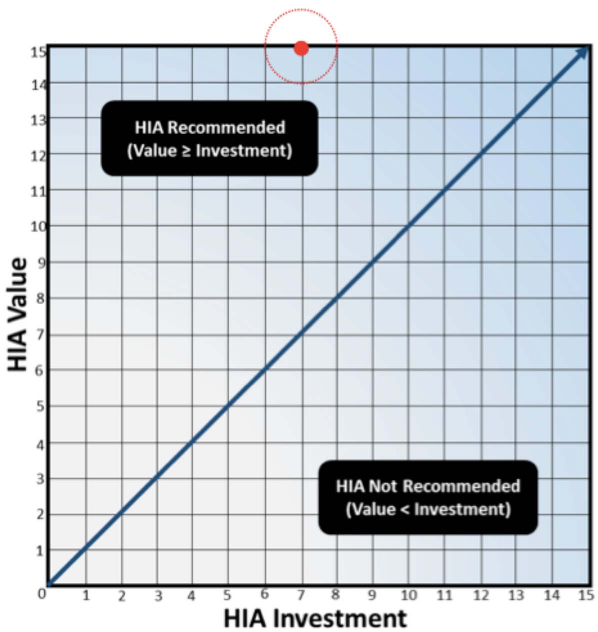


Figure 7. Value v Investment Score for Metro HIA

Section D: Are There Extenuating Factors to be Considered?

There were no extenuating factors that were considered that would suggest an HIA would not be a useful tool for evaluating potential health issues associated with the evaluating the two disposal options.

Section E: Final Recommendations and Conclusions

Through the use of the HIA screening tool it was determined that a semi-quantitative Rapid HIA would be appropriate to ascertain potential health impacts associated with each of the two disposal options for managing 200,000 tpy of Metro MSW.

4 Scoping

The purpose of the scoping step is to plan the overall approach and what will be evaluated in the HIA. Scoping the HIA properly ensures that the issues of highest priority (based on established evidence and stakeholder input) for determinants of health are included along with identification of the assessment population/area.

The scoping was undertaken using the following guidance:

- Health Impact Assessment: Oregon's Practitioner Toolkit – A handbook for conducting Rapid HIAs (2nd Edition), January 2015.
- Minimum Elements and Practice Standards for Health Impact Assessment. Version 3, September 2014. Bhatia R, Farhang L, Heller J, Lee M, Orenstein M, Richardson M and Wernham A.
- Prioritizing Health: A Systematic Approach to Scoping Determinants in Health Impact Assessment. Frontiers in Public Health. August 2016, Volume 4, Article 170. McCallum, LC, Ollson, CA, Stefanovic, IL.

Scoping is a critical stage in the HIA processes as it lays the foundation for the assessment. Figure 8 illustrates the key elements for consideration. This section of the report outlines the engagement of stakeholders that was undertaken and how that information was used in developing the scope of the Metro HIA for WTE considerations.

FIGURE 1 | Key factors involved in HIA scoping step (6).

Figure 8. HIA Scoping Step Considerations (McCallum et al, 2016)

4.1 Scope Overview

4.1.1 HIA Goal and Anticipated Use of the HIA Outcome

Goal of the HIA

The objective of the HIA is to evaluate the potential health impacts and benefits of managing 200,000 tpy of Metro's MSW through either Landfill or WTE. This assessment considers a Generic Landfill with landfill gas management and energy production located 150 miles from Portland. It also evaluates the option of transporting MSW to an expanded Covanta WTE Facility, 50 miles south of Portland. Each of these options is assessed separately and then the HIA provides a comparative analysis, where possible, of the two disposal methods. This HIA presents the issues and provides recommendations for mitigation of potential concerns or enhancement considerations for positive health outcomes.

Anticipated Use of the HIA Outcome

The HIA is being prepared for Metro's Property and Environmental Services Department. It will serve to inform Metro on the relevant issues in evaluating MSW management options. This report seeks to provide Metro Council an evaluation that is transparent in its origin and method of evaluation, so that it can make a decision of how best to manage 200,000 tpy of MSW.

4.1.2 The HIA Team and Roles and Responsibilities

Dr. Christopher Ollsson of OEHM, led the HIA with support from technical staff at HDR. The Project Manager for the undertaking was Mr. Tim Raibley of HDR. In addition, Metro Property and Environmental Services and the Multnomah County Health Department provided support and information to the HIA.

4.1.3 Stakeholder Engagement

The initial scoping of the HIA was conducted through a series of conference calls in August 2016 with Metro. Concurrently, Metro developed a stakeholder engagement strategy. The initial scoping determined the goals and objectives of the HIA, timelines, spatial and temporal considerations and discussion of determinants of health to be included.

On October 14, 2016, a Scoping Stakeholder Engagement Workshop (Stakeholder Working Group) was held at Metro. This one-day workshop brought together a diverse group of stakeholders that included Metro staff, community interest groups, a representative from Marion County, and the HIA consultants. The objective of the workshop was to introduce the HIA project to the stakeholders, but most importantly to solicit feedback on scope, prioritization of determinants of health, and identification of vulnerable populations.

Metro kept the Stakeholder Working Group, including those who could not attend, informed throughout the HIA of its progress. Metro provided the draft report to stakeholders to provide comment on the results and findings of the HIA.

Table 4. Stakeholder Workshop Participants

Stakeholder Group	Representing
HIA workshop Facilitator	Multnomah County Health Department
Stakeholders	Oregon Environmental Justice Task Force Neighbors for Clean Air Oregon Physicians for Social Responsibility Multnomah County Health Department Tri-County Health Officer Oregon Health Authority Marion County
Metro Staff	Property and Environmental Services
HIA Workshop Minutes	Property and Environmental Services
HIA Consultants	HDR Ollson Environmental Health Management

4.2 Determinants of Health

The determinants of health to be included in the HIA were developed through consultation at the Stakeholder Workshop. An Excel-based spreadsheet scoping tool (McCallum et al, 2016) was used to finalize the determinant list and assign priority ranking. Consensus on priority for each of the determinants was reached amongst the workshop participants.

A total of 68 determinants were considered and are broadly captured under five major factors:

> Environmental (22), Social and Economic (21), Access to Services (9), Lifestyle and Behavioral (7), Biological and Additional Equity (9)

The Excel-based tool allows for priority ranking of determinants of health and allows for consideration of applicability to the project, budget and available information. Figure 9 provides an overview of the mechanics of the scoping tool. The workshop participants provided ranking input for the level of Public Concern. OEHM completed the remaining fields on potential impact on health and data availability, which led to the overall priority designation.

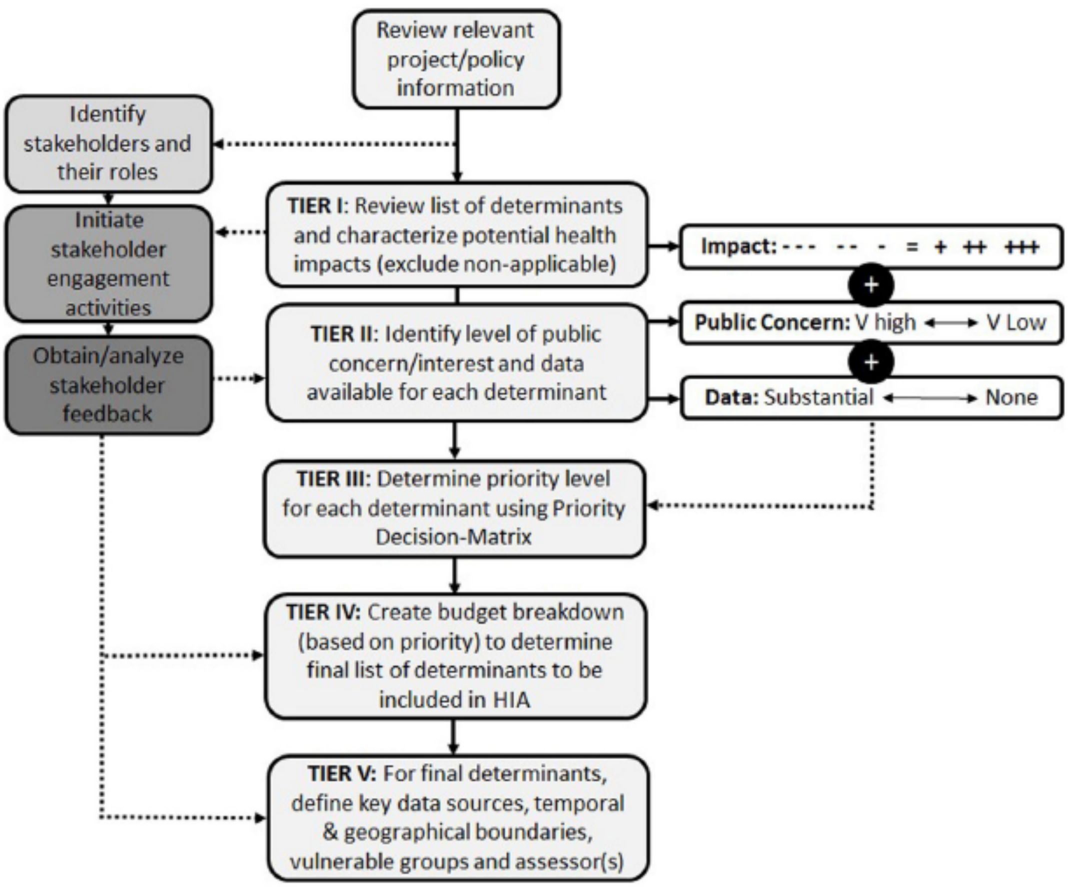


Figure 9. HIA scoping tool overview: a systematic tiered approach to prioritizing health determinants for inclusion in the HIA (McCallum et al. 2016).

Forty out of the possible 68 determinants of health were considered relevant to the assessment. The participants ranked these from low to very high priority for public concern. The following provides a brief overview of each of the categories of determinants of health.

Priority 1, 2 and 3 determinants of health were retained for inclusion in the HIA. However, resource allocation priority was given to those with higher priority (1 and 2) for decision matrix evaluation and those of lower priority (3) were discussed briefly in text.

4.2.1 Environmental Factors

The scoping tool provides a list of 23 environmental determinants of health that could be considered in an HIA. Table 5 provides the list of determinants of health and their relative priority ranking. In general major concerns surrounding WTE facilities is the airborne chemical emissions, resulting ash, greenhouse gas (GHG) emissions, and those around potential accidents and malfunctions. For landfill, the major concern also surrounds the potential for environmental release of airborne chemicals, leachate to groundwater, surface water run-off and accidents or malfunctions.

In addition, consideration of the distant Landfill hauling (150 miles) and what potential benefit may exist to a shorter haul route to the Covanta WTE Facility (50 miles and 36 miles to ash disposal) is provided.

Table 5. Environmental Determinants of Health Assessed in the HIA.

Determinants	Potential Impact on Health	Public Concern/ Interest	Data Availability	Priority
Environmental Factors				
Air quality (pollutants, dust, smog etc)	---	Very High	Substantial	1A
Greenhouse gas (GHG) emissions	---	Very High	Substantial	1A
WTE Ash	---	High	Substantial	1A
Accidents / Spills / Injury	---	High	Partial	1B
Soil quality	--	High	Substantial	2A
Traffic volume and safety	--	Very High	Partial	2B
Surface water quality	--	Very High	Partial	2B
Groundwater quality	--	High	Partial	2B
Seismic	--	High	None	2D
Odor	-	Very High	Substantial	3A
Changes in road structure	-	High	Partial	3B
Prevalence of vermin/vectors	--	Medium	Partial	3B
Virus / pathogen exposure	-	High	Very Limited	3C
Litter and waste disposal	-	Low	Partial	4B
Hunting/fishing grounds (access and quality)	-	Medium	Partial	4B
Availability of land resources, including agriculture (use/process requirements)	-	Medium	Partial	4B
Availability of water resources (use/process requirements)	-	Low	Partial	4B
Changes in built environment	-	Low	Partial	4B
Noise levels	-	Low	Partial	4B
Visual impact (aesthetic)	-	Medium	Partial	4B
Electromagnetic Fields (EMF)	=	Low	Substantial	5A
Vibration	=	Low	Substantial	5A
Light pollution	=	Low	Very Limited	5C

4.2.2 Social and Economic Factors

The scoping tool provides a list of 21 social and economic determinants of health that could be considered in an HIA, of which 11 were selected for inclusion in this HIA (Table 6).

Political involvement ranked highest given that Metro Council will be responsible for deciding which disposal option to pursue. In addition, consideration was given to what might be the concerns of Marion County, where the expanded facility is proposed to be located. Employment and economic considerations also rated high.

Table 6. Social and Economic Determinants of Health Assessed in the HIA.

Determinants	Potential Impact on Health	Public Concern/ Interest	Data Availability	Priority
Social and Economic Factors				
Political Involvement	+++	Very High	Substantial	1A
Employment	++	Very High	Substantial	2A
Working conditions	++	High	Substantial	2A
Local economic growth	++	Very High	Partial	2B
Public safety / perception of safety	-	High	Partial	3B
Property values	-	High	Partial	3B
Childhood development (stimulating/enriching environment)	+	Very High	Partial	3B
Regional economic growth	+	High	Partial	3B
Food security - Home Garden	-	Medium	Substantial	4A
Community and social cohesion	-	Medium	Partial	4B
Quality of education/literacy	+	Medium	Partial	4B

4.2.3 Access to Services Factors

Two of the nine access to services factors were included in the HIA (Table 7). They include child care/daycare and education. The primary consideration for their inclusion in the HIA was given the proximity of the Covanta WTE Facility to both the local elementary school and a nearby daycare facility.

Table 7. Access to Services Determinants of Health Assessed in the HIA.

Determinants	Potential Impact on Health	Public Concern/ Interest	Data Availability	Priority
Access to Services				
Child care/daycare	-	Medium	Partial	4B
Education	+	Medium	Partial	4B

4.2.4 Lifestyle and Behavioral Factors

None of the lifestyle or behavioral factors were identified as being of concern by the workshop participants.

4.2.5 Biological and Additional Equity Factors

It became clear throughout the workshop that participants desired heavy emphasis on biological and social equity factors in the HIA. Similar to the access to services factors these issues were dealt with through the lens of vulnerable populations. In addition, a discussion on equity issues in the HIA is provided.

Table 8. Biological and Additional Equity Determinants of Health to be Assessed in HIA.

Determinants	Potential Impact on Health	Public Concern/ Interest	Data Availability	Priority
Biological and Equity Factors				
Ethnicity/ race/	--	Very High	Partial	2B
Age	-	High	Substantial	3A
Socio-Economic Status (SES)	+	Very High	Partial	3B
Neighbourhood stigma	-	Low	Very Limited	4C

4.3 Vulnerable or Sensitive Populations

A key factor in conducting any HIA is determining the potential vulnerable or sensitive populations that may be disproportionately impacted, either positively or negatively, by the proposed undertaking. In addition to disproportionate impacts, the HIA evaluates whether there is an opportunity to reduce existing disparities and/or correct historic injustices.

Workshop Participants identified a number of vulnerable populations for consideration in the HIA. They include:

> Brooks and Generic Landfill Residents, Persons of Low Socio-economic status, children, elderly, *communities along the haul routes,* communities of color, WTE Facility Workers, and Landfill Workers

4.4 Temporal and Geographic Boundaries

It is important to understand the temporal and geographic boundaries that are included in the HIA. Waste management options are planned over long periods of time to provide certainty in a regions ability to dispose of their waste for decades to come. This also translates into the need to consider the geographic boundaries of area that could be affected over that period.

4.4.1 Temporal Boundary

Management of MSW requires a long-term contractual commitment for disposal of waste. It was assumed that either option for disposal of 200,000 tpy of MSW would be for a 20-year period.

4.4.2 Geographic Boundaries

With modern WTE facilities the primary environmental concern is their potential to impact local air quality. The scientific literature on air quality modeling and potential health impacts has demonstrated that the maximum point of impingement of emission impact tends to be within one mile of such facilities. Given the Covanta WTE Facility's proximity to Brooks, Oregon it is the primary community that could be impacted environmentally, socially and economically.

The Generic Landfill is located in the Columbia Gorge, with the haul route along the I-84 corridor. No specific community was identified for consideration in the HIA. Instead consideration of Generic Landfill buffer zone and potential influence on local communities was generically assessed.

4.5 Comparative Assessment of Distant Landfill and Expanded WTE Facility

The HIA provides separate assessment of each of the two disposal options and then provides a comparative analysis, where possible, of the two disposal methods. This HIA presents the issues and provides recommendations for mitigation of potential concerns or enhancement considerations for positive health outcomes.

4.6 Data Sources and Availability

OEHM conducted a review of the data availability for the determinants of health, vulnerable populations and temporal and geographic areas to be considered in the HIA. This included information retrieved by Metro's Research Center. It was determined there is a considerable amount of generic and some site-specific data that was incorporated into the HIA. Overall, data availability is sufficient to conduct the HIA and to provide conclusions and recommendations that should provide Metro with a comprehensive report upon which to make informed decisions.

The Assessment phase of the HIA provides details of the data sources relied on for each determinant of health and the level of certainty around the data used. The Uncertainties and Limitations section of the report clearly details report uncertainties.

4.7 Summary of HIA Scoping

The scoping of the two waste disposal options provided clear goals and objectives for the HIA. Determinants of health to be evaluated were established through an effective Stakeholder Workshop. Vulnerable populations to be considered were identified. The temporal boundary of the HIA will be considered over the next 20 years. Geographic boundaries will focus on the communities of Brooks and a distant Generic Landfill in eastern Oregon.

5 Population Demographics and Health

5.1 Population Demographics

Information for baseline demographics was obtained from the US Census Bureau through the American FactFinder website (https://factfinder.census.gov). The last census was conducted in 2010, with the next census scheduled for 2020. The American Community Survey provides multi-year estimates of statistics and the 2011-2015 five-year estimates were used in the HIA.

Given that a Generic Landfill was assessed no population statistics were retrieved for this option.

Statistics were retrieved by OEHM and checked against those provided by Metro Research Center for:

Brooks CDP, Marion County and the State of Oregon.

The Marion EFW Facility is located in the unincorporated community of Brooks, in Marion County, Oregon. Brooks is a census-designated place (CDP) by the US Census Bureau. It is located approximately 50 miles south of Metro off of the I-5 (Figure 10).

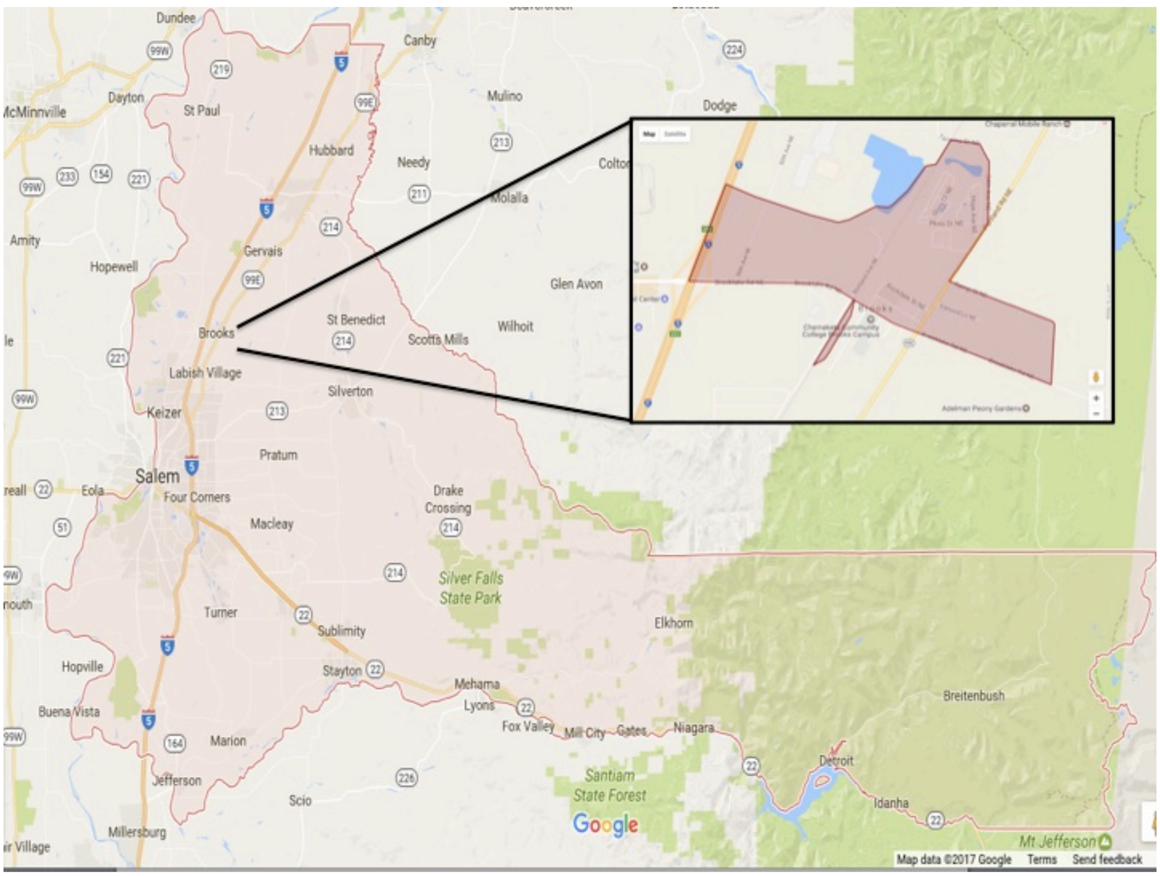


Figure 10. Unincorporated Community of Brooks, Marion County, Oregon

Table 9 provides the summary demographic statistics for the area of interest. It is important to note that there is a considerable margin of error provided in the data for Brooks, compared to that of the county level and that of the State of Oregon. This is due to the fact that Brooks has a relatively small population, hence increasing the uncertainty associated with the predictions.

Brooks (997) has very small population and is a small community. This does somewhat restrict the ability to make broad assumptions about the community. In general, population age demographics for Brooks include a higher percentage of youth (32%) and lower percentage of elderly (4%) than the Marion County or Oregon. In addition, Brooks is estimated to have an overall lower female population (43%) as compared to the other areas.

Brooks is more racially diverse than Marion County or Oregon, with only 76% identifying as white alone. Of the reporting categories it can be seen that 21% report being of two or more races, which is almost double that of Oregon and four times the rate of Marion County. The Hispanic or Latino population is less than both the Oregon and almost four times lower than Marion County.

In addition, 3.1% of the population of Brooks is estimated to be American Indian, which is greater than the approximate 1% for Marion County and Oregon. This estimated statistic by the US Census Bureau should be viewed with some caution given the high degree of uncertainty associated with making predictions in such a small population size. That said for the purposes of the HIA it was assumed that there was a significant American Indian population living within the community.

Education level, income, and housing are all components of social determinants of health. Social determinants of health refer to the role that our social environment and economic situation play in shaping our health, as social and economic factors are the single largest predictor of health outcomes, compared to clinical health care, health behaviors, and the physical environment. Brooks (95%) has a higher level of high school graduates than Marion County (84%) or Oregon (90%). The percent that achieved a bachelor's degree or higher is consistent between Brooks and Marion County and is 8% lower compared to Oregon as a whole.

The mean income level in Brooks ($67,458) was higher than Marion County ($61,647) and similar to that of Oregon ($69,040). Brooks (18.2%) and Marion County (18.4%) were reported to have a higher percentage of persons living below the poverty level than Oregon (16.5%) as a whole. The unemployment rates were obtained from the Bureau of Labor Statistics for 2015 and could only be obtained at the county and state level. Marion County levels were consistent with the State average.

The homeownership rate in Brooks (81%) was considerably higher than that of either Marion County (60%) or Oregon (60%). Brooks is a combination of single-unit homes (65%) and mobile homes (34%).

Overall, demographics indicate that Brooks does not appear to be especially vulnerable to negative health outcomes traditionally associated with poverty, low income, unemployment and low educational attainment. That said there is a higher population of youth and those reporting to be of two or more races that necessitates their consideration in the HIA as potential vulnerable populations and equity considerations.

Table 9. Demographic Summary (US Census, 2015)

2015 Census Estimates	Brooks CDP	Marion County	Oregon
Population	977	323,259	3,939,233
Persons under 20 years	32%	28%	24%
Persons 20-64 years old	65%	58%	60%
Persons 65 years and over	4%	14%	15%
Female persons	43.4%	50.2%	50.5%
Race			
White alone, percent	76%	82%	85%
Black or African American alone	0%	1.0%	1.8%
American Indian and Alaska Native alone	3.1%	1.1%	1.2%
Asian alone	0%	1.8%	4.0%
Native Hawaiian and Other Pacific Islander alone	0%	0.8%	0.4%
Other	0.8%	8.4%	3.4%
Two or more races	21%	5.2%	12%
Ethnicity			
Hispanic or Latino, percent	8.3%	25.3%	12.3%
Education			
High school graduate or higher, percent of persons age 25+	95%	84%	90%
Bachelor's degree or higher, percent of persons age 25+	23%	22%	31%
Income			
Median Income persons 25+	$72,833	$48,432	$51,243
Mean Income persons 25+	$67,458	$61,647	$69,040
Persons below poverty level	18.2%	18.4%	16.5%
Unemployment rate (2015 Bureau of Labor Statistics)		5.6%	5.2%
Home			
Households	246	113,996	1,533,430
Homeownership rate	81%	60%	61%
Housing units in single-unit structures	65%	68%	68%
Housing units in multi-unit structures	1%	23%	23%
Housing units mobile homes	34%	8.5%	9%

5.2 Discussion on County Health

Providing detailed site-specific baseline community health or epidemiological data is outside of the scope of this HIA. Brooks is served by Marion County Public Health Services. It is focused on improving the delivery of quality health services and on community-based prevention efforts. County health specifics are not provided for the Generic Landfill option.

Specific health indicators or baseline community health are not available for Brooks given its small population size. Therefore, only county data is reported and data is not available beyond the population as a whole. This data was retrieved from the Oregon Health Authority – Oregon County Data registry (accessed January 2017). This registry allows for age-adjusted factors and disease outcomes to be compared between Marion County and Oregon.

Table 10 provides general health risk and protective factors among adults. These are good indicators of overall baseline health status of communities and the state as a whole. Many of the risk and protective factors for the Marion County are similar to statewide results. However, obesity rates are higher in Marion County than those in Oregon. Of note is that Marion County residents appear to have a slightly higher prevalence of "any risk factors" than Oregon. Therefore, obesity rates appear to be a potential risk factor of concern in Marion County.

Table 10. Health risk and protective factors among adults, by county, 2010-2013

Health Factors	Marion County	Oregon
	%	%
Consumed 7 or more sodas per week	15.5	13.3
Current Cigarette Smoking	19.0	19.0
Binge drinking within past month	16.6	17.7
Obese	32.7	25.9
High Blood Cholesterol	31.5	31.8
High Blood Pressure	27.5	27.7
No Physical Activity outside of work within past month	23.2	18
Any risk Factors	82.4	77.5
Reducing Salt Intake	40.9	37.3
Consumed fruits and vegetables five or more times a day	21.2	21.9
Meets CDC guidelines for physical activity	19.6	25.1

Given that both WTE and Landfill have the potential to release pollutants into the environment it is important to understand the incidence rate of chronic diseases in the population. This is also a good overall indicator of health outcomes in the communities of interest. Table 11 was compiled from age-adjusted data from the Oregon Health Authority.

In general the chronic disease rate in Marion County is similar to that of Oregon. Of particular importance when considering emissions from a WTE facility are pre-existing rates of asthma, cardiovascular disease, and chronic obstructive pulmonary disease (COPD). The rates of these conditions in Marion County appear to be consistent with that of Oregon.

Table 11. Age-Adjusted Chronic disease among Oregon adults, County Comparison 2012-2015 (Oregon Health Authority)

Condition	Marion County	Oregon
	%	%
Arthritis	25.2	24.3
Asthma	10.7	10.9
Cancer Survivors	8.1	7.9
Cardiovascular Disease	8.0	7.1
COPD	6.1	5.8
Coronary Heart Disease	3.6	3.5
Depression	26.5	25.2
Diabetes	10.1	8.6
Disability	25.8	25.5
Heart Attack	4.0	3.5
Stroke	2.9	2.6
One or more Chronic Disease	55.5	53.2

The Oregon Health Authority also reports on the cancer sites diagnosed by county on a rate per 100,000 population. Marion County does appear to have a higher incidence rate of all cancers over that of Oregon. For 2009-2013 those rates were:

- Oregon 446.6
- Marion County 465.9

Overall, Marion County appears to have a higher level of obesity and related risk factors, such as diabetes than that of Oregon. However, these are not health outcomes that are directly exacerbated by emissions from a WTE facility. Rates of respiratory and cardiovascular disease appear to be similar at the county and state level. However, it is these pre-existing conditions that make individuals more susceptible to airborne emissions from WTE facilities.

5.3 Discussion of Vulnerable and Sensitive Populations

Participants in the Stakeholder Workshop identified the following vulnerable or sensitive populations. They have not been provided in any order of priority or importance. The HIA considers each of these populations in assessing the individual determinants of health.

Brooks Residents: The Covanta WTE Facility is located in the community of Brooks, Oregon. The proposed expansion of the existing facility would double the size of the tonnage of MSW that would be processed on an annual basis. Therefore, both potential negative and positive impacts of the expanded facility would most likely be felt in the community.

Persons of Low Socio-economic status: Overall, demographic indicators show that Brooks does not appear to be disproportionately vulnerable to negative health outcomes traditionally associated with poverty, low income, unemployment and low educational obtainment. However, nearly 1 in 5 Brooks residents live in poverty. This population could be impacted, either positively or negatively, by the socio-economics of the proposed expansion of the Covanta WTE Facility. Given the limited information at this stage this vulnerable population should be assessed in more detail if the project was to move forward.

Children: Given that the primary environmental concern with any WTE facility or landfill is chemical emissions to the environment, children are a potential vulnerable population. Airborne contaminants have the potential to disproportionately impact children, for example they are more prone to asthma onset than the general population. In addition, both the Brooks Elementary School and the Willamette Valley Christian School (and associated daycare) are located within one-half mile of the Covanta WTE Facility.

Elderly: The elderly are potentially more vulnerable to ambient air quality conditions.

Communities Along the I-5 / I-84 Haul Routes: The HIA investigates the potential impact of additional haul truck traffic along the I-5 corridor and potential for increase in accident rates and exhaust emissions. It will also consider the I-84 haul route to existing landfill.

Communities of Color: The HIA provides commentary on potential impacts on communities of color. Brooks does have a greater percentage of the population reporting two or more race heritage.

Native Americans: Review of the US Census data suggested that there may be a population of Native Americans living in the Brooks community. At the time of reporting it is not known if there are culturally important sites and natural resources in the nearby areas of either Brooks or the Generic Landfill.

WTE Facility Workers: A number of issues surrounding the potential additional staff required for the proposed expanded WTE facility are evaluated.

Landfill Workers: Working conditions and employment at Landfill are evaluated.

College students – Chemeketa Community College Brooks Campus / Northwest University Salem Campus: these college campuses are located in close proximity to the proposed expansion of the Covanta WTE Facility. Opportunities for training or internship programs are evaluated.

Agricultural Local Landowners and Workers: The WTE facility is located in a semi-rural area of Oregon. In addition to local crop and agricultural activities there are also a number of food packing companies in the area. Concerns could arise with respect to WTE facility emissions.

Communities Surrounding the WTE ash receiving landfill: Ash from the Covanta WTE Facility is currently used as daily cover at the Coffin Butte Landfill located north of Corvallis. One of the workshop participants felt it was important to assess the potential concerns of the community surrounding the landfill.

5.4 Discussion on Health Equity

Given that the Covanta WTE Facility is located in Brooks, the Marion County Health Equity Report: Making the Difference (2013) was consulted to bolster consideration of potential equity concerns in the HIA. From the report:

> *Quick Facts about Marion County's social determinants and their impact on health, 2013:*
>
> - *Race/Ethnicity: Marion County is becoming more ethnically and racially diverse than Oregon in general, especially in terms of its Hispanic/Latino community, Native Hawaiian and Other Pacific Islander, and those of another race. Woodburn and Salem currently have the highest percentage of persons of different ethnicities.*
> - *Age: Marion County has a greater ratio of persons under 18 than Oregon, many of whom are at poverty level. Woodburn has the highest proportion of youth in relation to its adult population.*
> - *Gender: The percentage of women in Marion County without a husband, with children, and living in poverty is increasing.*
> - *Morbidity/Disease: Two-thirds of Marion County adults are overweight or obese; however, the levels of obesity are concentrated in specific geographic areas.*
> - *Environment: Food deserts, lack of sidewalks, and lack of rural parks are all contributing to Marion County's high obesity and overweight issue.*
> - *Woodburn and Salem are the most disadvantaged in terms of low median household income and high poverty rate. They are also the areas in which a high number of adverse social determinants are present.*
> - *Woodburn has the highest percentage of persons who are foreign-born and speak a language other than English at home. Salem has the second highest percentage in both of these categories. Foreign birth frequently correlates with lack of health insurance, disproportionately affecting persons who are not citizens. Other languages spoken at home also correlates with disproportionately high poverty levels and low education achievement.*
> - *Depending on the type of prevention screening, 14%-45% of persons who should be screened are not. This is most likely to impact groups whose social determinants affect health insurance coverage.*
> - *Chronic disease caused the loss of 3,930 years of potential life in 2010 and is one of the leading causes of early death.*
> - *Possibly due to a combination of food deserts and a high number of social determinants, the youth in northern Marion County are most likely to be receiving free or reduced lunch.*

In making waste management decisions another area of equity that needs to be considered is that of environmental justice. Although the residents of Metro are generating the waste, the proposal for diversion of 200,000 tpy involves shipping it out of region to a WTE facility located in a neighboring county. There are those who believe that waste should be managed within the borders of the region in which it is generated and that it is inequitable to have another community dispose of that waste. Although this is a valid viewpoint, it does not consider that it may be a 'willing host community' that wishes to economically benefit from this undertaking. As long as there is not an undue risk or disproportionate impact on the willing host community they not be able to make decisions on what is acceptable to them.

Health equity and social environmental justice were considered at a high level in this HIA. A more focused study could be completed if the proposed expansion of a WTE facility was to be undertaken. This would benefit from broader stakeholder survey (e.g., community of Brooks) and incorporate inputs from the formal socio-economic evaluation.

6 Assessment of Waste to Energy Management Option

6.1 Environmental Factors for Assessment WTE

Environmental emissions and their potential impact on health are a significant consideration in the expansion of a WTE facility. There is no question that the historic practice of thermal treatment (incineration) of waste involved considerable release of contaminants to the environment. However, changes in state and federal regulations for permitting of modern facilities have resulted in significant pollution reduction to the environment. Likewise, there has been a significant amount of monitoring and reporting of releases of such facilities in recent years, which is codified in their operating permit requirements.

This is not to say that WTE facilities are without environmental releases that could be of potential concern to health outcomes. This section provides an assessment of how environmental factors could potentially influence health. The intention of this HIA was not to conduct site-specific detailed chemical emissions and modeling for potential health impacts to surrounding communities. Rather assessment is done using available information and scientific knowledge of operating facilities reported in the literature. This should not be construed as replacing the need for detailed permitting activities through the DEQ that will seek to ensure the protection of health.

During the scoping exercise four Priority 1 determinants were identified for assessment:

> Air Quality, Greenhouse Gas Emissions, WTE Ash Disposal and Accidents and Malfunctions

In addition, Electricity Production is included in the assessment.

In addition, second priority was to be afforded to:

> Soil Quality, Traffic Volume and Safety, Surface Water Quality, and Seismic Events

A number of other environmental factors were identified as lessor priority given that they were unlikely to have a significant negative or positive effect on health. Their potential impact is discussed briefly in the text.

6.1.1 Air Quality

The most significant potential for chemical release from a WTE facility to the environment is airborne emissions from the combustion process. As described in Section 1.2.2.1, flue gas is sent through an air pollution control (APC) system that is intended to significantly reduce emissions of acid gases, organics, dioxins and furans (PCCD/F) heavy metals, particulates, as well as other pollutants to environmentally acceptable permitted levels.

No air quality modeling exercise was undertaken to analyze the potential ground level point of impingement levels that could be expected from the proposed expansion of the Covanta WTE Facility. Instead, a review of air quality from the existing WTE facility is provided. Also, a review of likely permit requirements for airborne emissions is provided to understand how health may be impacted. Vehicle emissions associated with waste hauling are assessed in Section 6.1.8.

Potential Impact on Health of Airborne Emissions

Undue exposure to elevated concentrations of criteria air pollutants and hazardous air pollutants can result in a wide range of both short-term (acute) health impacts and long-term (chronic) health impacts. Although there are numerous chemicals that are emitted from WTE facilities, regulatory authorities, including the USEPA and the DEQ, have prioritized a number of surrogate chemicals for monitoring. The levels set for emission of these chemicals and resulting ground level concentrations are benchmarked against air quality standards.

It is beyond the scope of the HIA to provide an assessment of all of the chemicals of potential concern. During the stakeholder workshop emissions of nitrogen dioxide (NO_2) and particulate matter were identified as a priority. NO_2 is typically a priority pollutant of concern from stack release for WTE facilities. This is both because it is generated in significant quantities in the combustion process and because it is a priority criteria air pollutant in many airsheds. NO_2 and $PM_{2.5}$ are discussed in more detail in the HIA.

Vulnerable or Sensitive Population

There are geographic, pre-existing health conditions, and demographic considerations that need to be considered for vulnerable or sensitive populations. The USEPA uses the term "at-risk" to encompass these groups in terms of air quality exposure. The Literature Review indicated that the highest modeled ground level concentrations of contaminants typically occur within one mile of the stack. Therefore, all citizens of nearby Brooks would be considered potentially at-risk population that needs to be considered.

Both children (<20 years) and the elderly (>65 years) are considered at-risk populations for exposure to airborne contaminants. This is because the human respiratory system is not fully developed before the age of 20 and children are intrinsically at greater risk for respiratory effects. The elderly typically have weakened immune function, impaired healing, and decreased pulmonary and cardiovascular function. Therefore, these two age demographics are considered at-risk populations (USEPA, 2016).

Both the Brooks Elementary School and the Willamette Valley Christian School are located less than one-half mile from the Covanta WTE Facility. The Chemeketa Community College Brooks campus that hosts special facilities for training emergency services, fire protection and criminal justice is also located within a half mile of the facility.

Finally, those with preexisting chronic conditions such as asthma, cardiovascular disease and COPD are also at-risk populations. Although, Brooks does not appear to have a higher incidence rate than the rest of Oregon, it is these individuals that would be most susceptible to airborne chemical exposure.

6.1.1.1 Baseline Air Quality

The starting point for evaluating how the addition of chemicals into the atmosphere may impact health is the determination of a baseline or understanding of the current levels of airborne contaminants in an airshed. Review of Oregon DEQ's air monitoring network indicates that ozone is the only pollutant for which a monitor is located in the vicinity of the Covanta WTE Facility. For all other criteria pollutants, the nearest monitoring site with a complete set of data is located in Portland.

The HDR Air Quality Team assembled historic ambient monitoring data obtained from Oregon DEQ's 2015 Oregon Air Quality Data Summaries, July 2016 (http://www.deq.state.or.us/aq/forms/2015AQDataSummaryReport.pdf) and USEPA's Monitor Report for criteria pollutants (https://www.epa.gov/outdoor-air-quality-data/monitor-values-report). In the event of a discrepancy between the Oregon DEQ and USEPA information, the USEPA data was used.

Although relying on a monitoring site located in an urban area is not ideal, the pollutant concentrations at the monitoring sites are expected to be equal to or higher than the concentrations in the more rural Marion County location of the WTE facility. This expectation is confirmed by information in Table 6 of Oregon DEQ's 2015 Oregon Air Quality Data Summaries that includes $PM_{2.5}$ concentrations for a more rural Salem site that were determined using a non-Federal Reference Method (and, therefore, are informational only), which are consistently lower than the concentrations at the more urban Portland site.

Therefore, use of the Portland ambient monitoring information is likely a conservative (high) representation of the air quality in Brooks. However, it is recognized that there may be concern about the local influence that the existing Covanta WTE Facility has in the area.

Marion County is designated as an Attainment Area for all National Ambient Air Quality Standards (NAAQS) and Oregon Ambient Air Quality Standards. Table 12 provides the ambient air quality standards that are applicable in Oregon. These standards were compared to available concentrations of baseline air quality data. The NAAQS (40 CFR part 50) has set standards for six criteria air pollutants. It identifies both:

> **Primary Standards**: to provide public health protection, including "sensitive" populations such as asthmatics, children and the elderly; and,
>
> **Secondary Standards**: to provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation and buildings.

Any expansion of the Covanta WTE Facility will need to demonstrate that the increase in emissions would not exceed the NAAQS. However, there are a number of different air quality standards and toxicological reference values (TRVs) used around the world to evaluate exposure of people to airborne contaminants. It is acknowledged that there are often trade-offs in setting standards that are protective of health, while still being obtainable or achievable.

For example, there maybe no threshold "safe level" of exposure to particulate matter <2.5 µm ($PM_{2.5}$). $PM_{2.5}$ exposure is associated with exacerbation of asthma and an increase in hospital admissions. In addition, increased mortality rates from cardiovascular and respiratory diseases are well documented in large urban centers. The most susceptible groups include people with pre-existing lung or heart disease, older adults and children.

The World Health Organization (WHO) stated "research has not identified thresholds below which adverse effects do not occur" (WHO, 2006). As such, WHO (2006) indicates that ambient air quality guidelines for $PM_{2.5}$ may never be fully protective of human health:

> *"As thresholds have not been identified, and given that there is substantial inter-individual variability in exposure and in the response in a given exposure, it is unlikely that any standard or guideline value will lead to complete protection for every individual against all*

possible adverse health effects of particulate matter. Rather, the standard-setting process needs to aim at achieving the lowest concentrations possible in the context of local constraints, capabilities and public health priorities."

The USEPA has set their annual average $PM_{2.5}$ level at 12 µg/m^3, which is similar to that of the 10 µg/m^3 set by the WHO. Therefore, these standards are set in an attempt to protect public health, while acknowledging that there are practical constraints to setting lower standards.

Table 12 provides the ambient air quality standards that would be applicable to any expansion of the Covanta WTE Facility. In addition, Oregon State Air Toxics Program (ODEQ Rule 340-246-0090) provides a list of 52 chemicals and associated ambient benchmarks. As provided in the rule:

> *(1) Purpose. Ambient benchmarks are concentrations of air toxics that serve as goals in the Oregon Air Toxics Program. They are based on human health risk and hazard levels considering sensitive populations. Ambient benchmarks are not regulatory standards, but reference values by which air toxics problems can be identified, addressed and evaluated. The Department will use ambient benchmarks as indicated in these rules, to implement the Geographic, Source Category, and Safety Net Programs. Ambient benchmarks set by the procedures described in this rule apply throughout Oregon, including that area within the jurisdiction of the Lane Regional Air Protection Agency. Ambient benchmarks are subject to public notice and comment before adoption by the Commission as administrative rules.*

The ATP is not directly applicable in standard permitting of an expansion of a WTE facility in Oregon. The ATP does not cover the NAAQS criteria air pollutants, with the exception of lead. The lead ATP ambient benchmark of 0.15 µg/m^3 is the same as the NAAQS rolling three month average.

Table 12. Ambient Air Quality Standards Applicable in Oregon

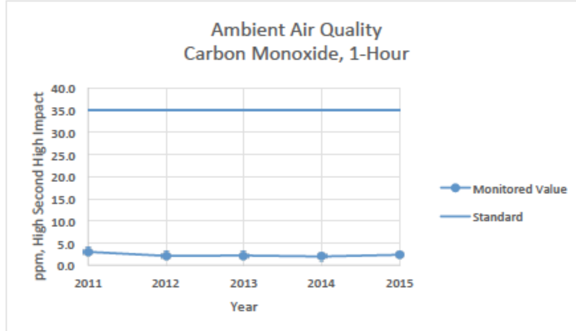
Pollutant	National Primary	National Secondary	Oregon
Inhalable Particulate Matter (PM_{10})			
24-hour average (µg/m^3)	150[a]	150[a]	150[a]
Fine Particulate Matter ($PM_{2.5}$)			
Annual arithmetic mean (µg/m^3)	12.0[b]	15.0[b]	12.0[b]
24-hour average (µg/m^3)	35[c]	35[c]	35[c]
Sulfur Dioxide (SO_2)			
Annual average (ppm)	–	–	0.02[d]
24-hour average (ppm)	–	–	0.10[e]
3-hour average (ppm)	–	0.5[e]	0.50[e]
1-hour average (ppb)	75	–	0.75[f]
Carbon Monoxide (CO)			
8-hour average (ppm)	9[e]	–	9[e]
1-hour average (ppm)	35[e]	–	35[e]
Ozone (0_3)			
8-hour average (ppm)	0.070[g]	0.070[g]	0.075[g]
Nitrogen Dioxide (NO_2)			
Annual average (ppb)	53[d]	53[d]	53[d]
1-hour average (ppb)	100[h]	–	100[h]
Lead (Pb)			
Rolling 3-month average (µg/m^3)	0.15[d]	0.15[d]	0.15[d]

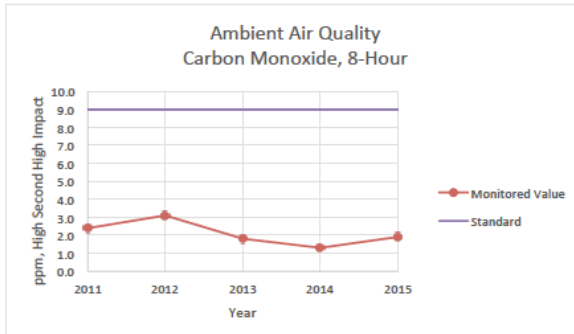
µg/m^3 – micrograms per cubic meter.
ppm – parts per million.
PM_{10} – particles smaller than 10 micrometers in mass-mean diameter.
$PM_{2.5}$ – particles smaller than 2.5 micrometers in mass-mean diameter.
[a] Not to be exceeded more than once per year on average over 3 years.
[b] To attain this standard, the 3-year average of the weighted annual $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed the standard.
[c] To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed the standard.
[d] Not to be exceeded.
[e] Not to be exceeded more than once per year.
[f] To attain this standard, the 3-year average of the annual 99th percentile of the daily maximum 1-hour average concentrations at each monitoring site must not exceed the standard.
[g] To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour ozone concentrations measured at each monitor within an area over each year must not exceed the standard.
[h] To attain this standard, the 3-year average of the 98th percentile of the 1-hour daily maximum concentrations at each monitoring site must not exceed the standard.

The following provides a summary of baseline regional air quality.

Carbon Monoxide

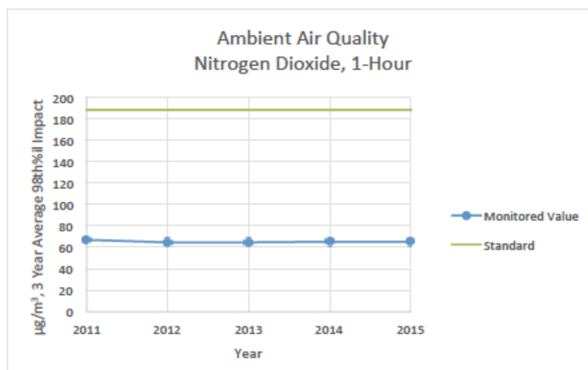
Two ambient monitoring sites are currently operated in Oregon for carbon monoxide. However, one of those sites has only been in operation since 2014. Monitoring results for the site operated in all of the past five years (Site ID 410510080 located at 5824 SE Lafayette in Portland, OR) are summarized in the following chart, which represents the design value for each of the last five years. The design value for both averaging periods is the highest second high impact that occurred in each year (i.e., the standard is not to be exceeded more than once per year). Carbon monoxide levels, both 1-hour and 8-hour, are considerably below their respective standards. The second site (Site ID 410670005) is located at Taulatin Bradbury Ct

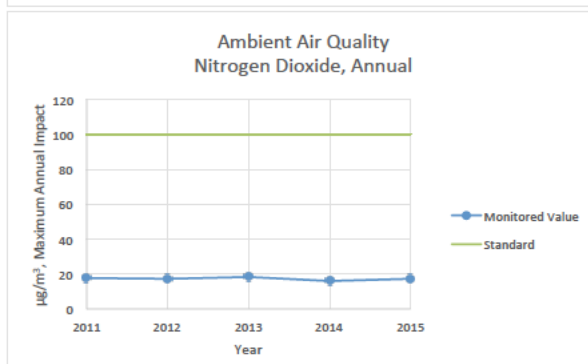




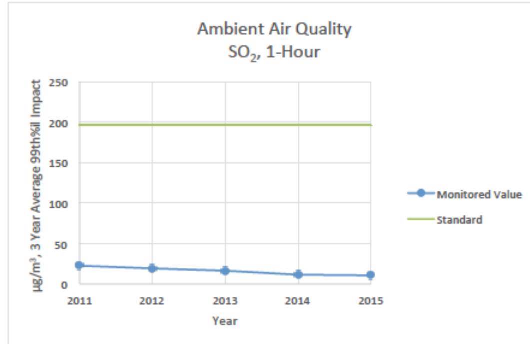
Nitrogen Dioxide

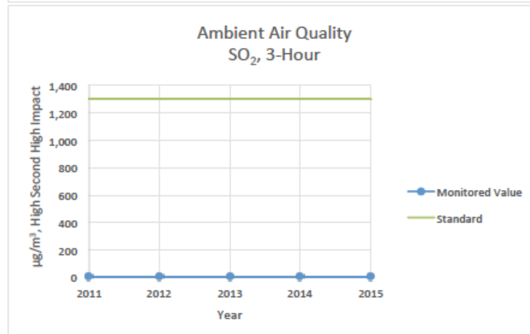
Two ambient monitoring sites are currently operated in Oregon for NO_2. However, one of those sites has only been in operation since 2014. Monitoring results for the site operated in all of the past seven years (Site ID 410510080 located at 5824 SE Lafayette in Portland, OR) are summarized in the following chart, which represent the design value for each of the last five (5) years. The design value is the three-year average 98th percentile value for the 1-hour standard and the maximum annual average for the annual standard. The monitored concentrations of NO_2 are well below the 1-hour and annual average standards. This is of particular significance given that NO_2 is a primary contaminant of concern from WTE facilities.





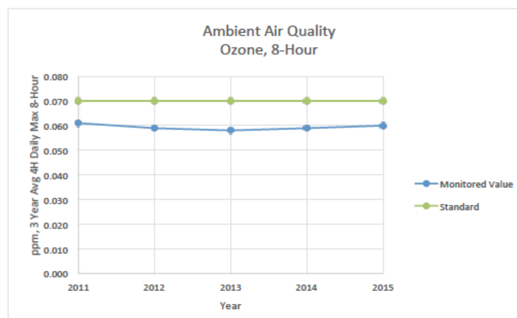
Sulfur Dioxide





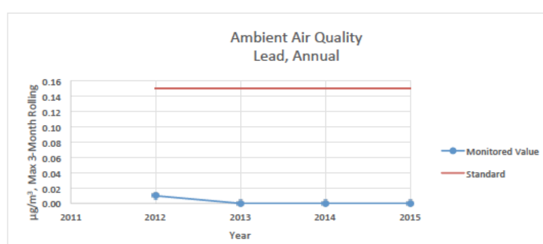
One ambient monitoring site is currently operated in Oregon for sulfur dioxide (SO_2). Monitoring results for this site (Site ID 410510080 located at 5824 SE Lafayette in Portland, OR) are summarized in the following charts, which represent the design values for each of the last five years. The design value for the 1-hour standard is the 99th percentile 1-hour daily maximum values averaged over 3 years and for the 3-hour standard is the highest second high impact that occurred in each year. Concentrations of SO_2 are well below standards.

Ozone



A number of ambient monitoring sites are currently operated in Oregon for ozone, the nearest of which is the Turner monitor (Site ID 41047004 located at the Cascade Junior High in Salem). The following chart summarizes the design value for each of the last five years, which is the three year average of the fourth highest daily maximum 8-hour ozone value. Ozone levels are approaching the 8-hour standard.

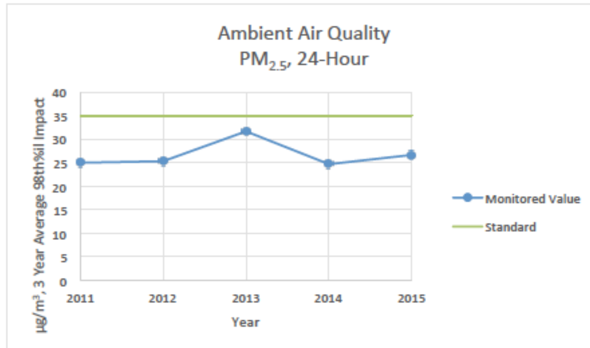
Lead

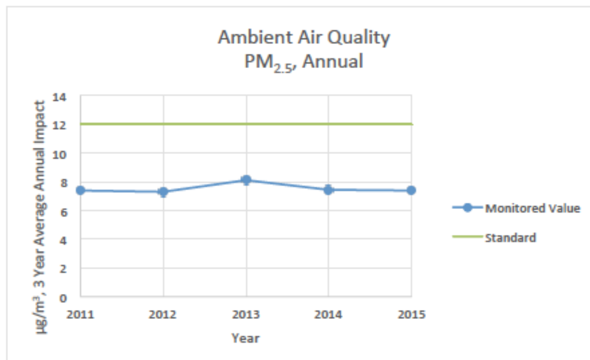


One ambient monitoring site is currently operated in Oregon for lead (Site ID 410510080 located at 5824 SE Lafayette in Portland, OR). However, that site has only been in operation since 2011. The monitoring results summarized in the following chart represents the design value for each of the last four years, which is the highest rolling 3-month average impact that occurred in each year. Lead levels are well below the standard.

PM2.5

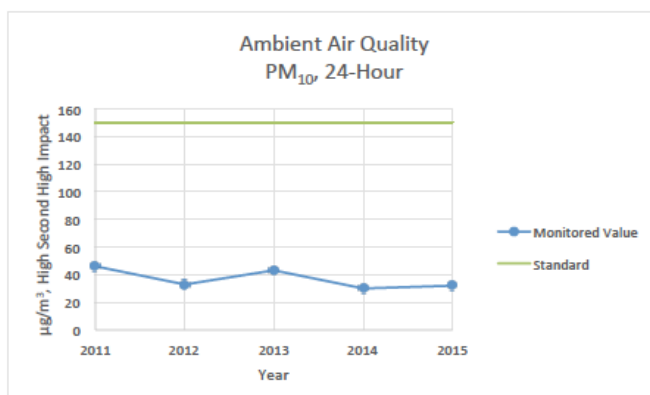
A number of ambient monitoring sites are currently operated in Oregon for $PM_{2.5}$. Monitoring results for the nearest site (Site ID 410510080 located at 5824 SE Lafayette in Portland, OR) are summarized in the following charts, which represent the design values for each of the last five years. The design value for the 24-hour standard is the 98th percentile daily values averaged over three years and for the annual standard is the annual mean averaged over three years. Although the 24-hour $PM_{2.5}$ concentration approaches the standard, the annual average is lower.





PM10

A number of ambient monitoring sites are currently operated in Oregon for PM_{10}. Monitoring results for the nearest site (Site ID 410510080 located at 5824 SE Lafayette in Portland, OR) are summarized in the following charts, which represent a conservative estimate of the design values for each of the last five years. The 24-hour standard is not to be exceeded more than once per year on average over 3 years. To be conservatively high, the values reported are the high second high value for each year. The PM_{10} ambient air concentrations were well below the standard.



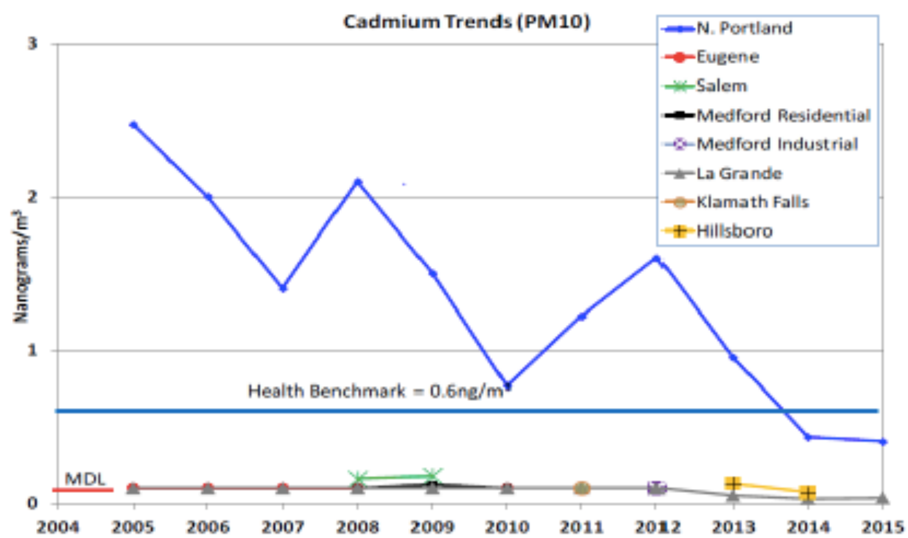
Hazardous Air Pollutants

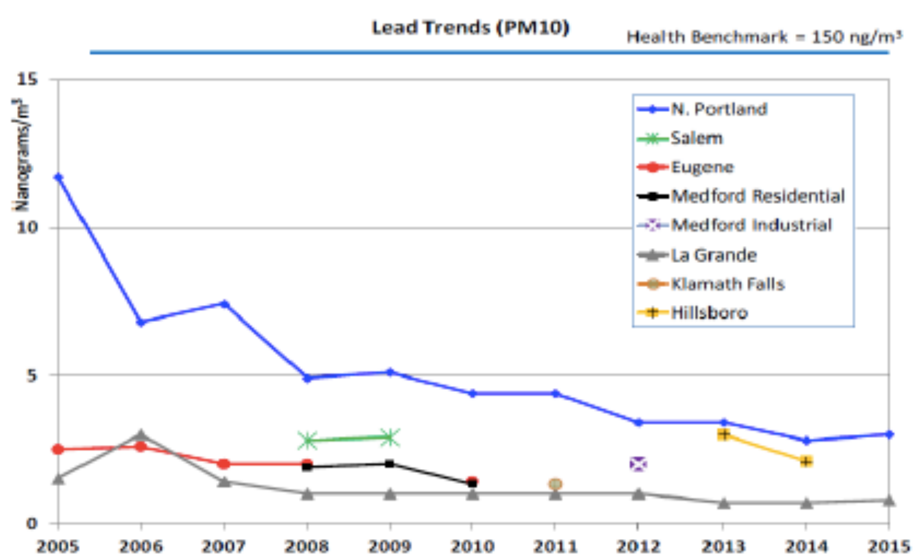
While the USEPA and ODEQ data contains ambient monitoring information for a number of hazardous air pollutants (HAP), only the following are currently regulated by 40 CFR Part 60, Subpart Eb (the rule anticipated to apply to the Marion County facility expansion being evaluated):

- cadmium, dioxins/furans, hydrogen chloride, lead, and mercury

Of these, the only pollutants for which data is available are cadmium and lead. The information summarized for each these HAP represents that compound analyzed on a PM_{10} ambient monitor catch. The following plots were obtained from Oregon DEQ's 2015 Oregon Air Quality Data Summaries, July 2016 (http://www.deq.state.or.us/aq/forms/2015AQDataSummaryReport.pdf.)

Concentrations were benchmarked against the Oregon ATP Ambient Benchmark Concentrations.





Summary of Baseline Air Quality

Overall, the concentration of the criteria air pollutants and HAPs are likely below ambient air quality standards in the area surrounding the Covanta WTE Facility. It is recognized that this finding is limited by the fact that there are not air quality stations located in the immediate vicinity the Covanta WTE Facility and instead the majority of data was taken from Portland air quality stations. However, Brooks is in an area that has been designed "Attainment" under NAAQs. In the event that Metro Council determines that it wishes to pursue the commitment of 200,000 tons per year of MSW to the Covanta WTE Facility a site-specific baseline air quality program could be considered to ascertain existing levels of airborne contaminants in Brooks.

6.1.1.2 Current Conditions

The Covanta WTE Facility Oregon DEQ Title V Operating Permit 24-5398-TV-01 dictates stack emission limits and testing requirements. The emission limits for criteria pollutants CO, SO_2, and NO_x are determined through the use of continuous emissions monitoring systems (CEMS). The remaining pollutants (i.e., PM, Cd, Pb, Hg, HCl, and dioxin/furan) are tested at the stack annually to demonstrate compliance.

Covanta provided a summary table of the annual stack emissions reporting from the existing Covanta WTE Facility from 2013 to 2016 for the HIA (Table 13). The results reflect the two existing boiler units and include an average for the four years of testing. The results show the facility is operating within its allowable permit limits for all constituents tested. In most instances, the results were well below their permitted limits, in some cases 90% or more below. The only pollutant that was approaching the limit was NO_x, although it was still 13% beneath its limit. This is not surprising, given that NO_x does tend to be the pollutant of most concern emitted by WTE facilities.

Table 13. Annual Stack Emissions Results for the Covanta WTE Facility (2013-2016)

Pollutant	Boiler	Units	2013	2014	2015	2016	Average	Limit	Percent Below Limit
Filterable Particulate	Unit 1	mg/dscm7	5.64	10.8	6.42	2.82	6.4	**25.0**	74.3
	Unit 2	mg/dscm7	7.05	6.09	5.31	2.80	5.3	**25.0**	78.8
Total Particulate	Unit 1	gr/dscf 12%CO2	0.00914	0.00927	0.00749	0.00394	0.00746	**0.1**	92.5
	Unit 2	gr/dscf 12%CO2	0.00651	0.00716	0.00668	0.00465	0.00625	**0.1**	93.8
SO2*	Unit1	ppmdv7	5	9	8	TBD	7	**29 or 85%**	76
	Unit 2	ppmdv7	6	9	8	TBD	8	**29 or 85%**	72
NOx**	Unit 1	ppmdv7	177	178	178	TBD	178	**205**	13
	Unit 2	ppmdv7	177	178	178	TBD	178	**205**	13
CO***	Unit 1	ppmdv7	12	10	9	TBD	10	**100**	90
	Unit 2	ppmdv7	11	11	9	TBD	10	**100**	90
HCl	Unit 1	ng/dscm7	12.8	27.8	23.30	6.51	17.6	**29 or 95%**	39.3
	Unit 2	ng/dscm7	8.42	8.91	3.43	5.48	6.6	**29 or 95%**	77.2
Dioxin/Furan	Unit 1	ng/dscm7	0.518	NT	0.525	NT	0.522	**15**	96.5
	Unit 2	ng/dscm7	NT	0.372	NT	0.832	0.602	**15**	96.0
Mercury	Unit 1	ug/dscm7	<9.87	<10.5	<1.59	<1.53	<5.87	**50 or 85%**	<88.3
	Unit 2	ug/dscm7	<1.25	<1.69	<1.14	<1.33	<1.35	**50 or 85%**	<97.3
Lead	Unit 1	ug/dscm7	2.34	29.6	1.59	3.13	9.2	**200**	95.4
	Unit 2	ug/dscm7	2.43	1.74	1.21	3.84	2.3	**200**	98.8
Cadmium	Unit 1	ug/dscm7	0.197	2.79	0.373	0.857	1.054	**20**	94.7
	Unit 2	ug/dscm7	0.17	0.345	0.292	<0.471	0.269	**20**	98.7

* SO2 emission values are the average of 24-hr daily geometric mean values for the calendar year
** NOx emission values are the average of 24-hr daily values for the calendar year
*** CO emission values are the average of 4-hr values for the calendar year

As detailed in Section 1.2.2.1 of the HIA the Oregon DEQ has conducted biannual inspections of the Covanta WTE Facility since 2006 and has found it to be in compliance with all permit conditions. Therefore, the existing Covanta WTE Facility meets all of the requirements of a modern WTE facility.

6.1.1.3 Project Impact

An expansion of the existing Covanta WTE Facility will require an air quality permit and will be subject to applicable federal and state regulations at that time. The air emission limits that will ultimately be imposed on the expansion facility will be a combination of USEPA New Source Performance Standards (NSPS) requirements found in 40 CFR Part 60 and those associated with the ODEQ air quality construction permitting program.

However, it is recognized that in 2016 Oregon adopted a new initiative to review the industrial air toxics regulations and launched Cleaner Air Oregon. At the time of reporting, it is believed that the Oregon DEQ and OHA have begun a rulemaking process to propose human health risk-based rules for industrial facilities. It is not known at this point how this rulemaking may affect any proposed expansion of the Covanta WTE Facility.

An expansion of the Covanta WTE Facility is expected to be classified as a new large unit (i.e., > 250 tpd design capacity) that is subject to 40 CFR Part 60, Subpart Eb. Table 14 summarizes the current emission limits contained in Subpart Eb, as well as the limits currently applicable to Marion County's existing two units that are subject to the requirements of 40 CFR Part 60, Subpart Cb and construction permit imposed limits. Both Subpart Eb and Subpart Cb are currently under review by USEPA and revisions are expected. However, similar to the Cleaner Air Oregon initiative, there are no details available to predict what those revised limits may be.

Based on the permitted emissions of the existing Covanta WTE Facility and the anticipated emissions of an expansion, an expansion is anticipated to trigger the Prevention of Significant Deterioration (PSD) preconstruction air permitting requirements for all of the pollutants regulated by Subpart Eb. This will involve a Best Available Control Technology (BACT) review that evaluates all technically and economically feasible control options for each PSD regulated pollutant. The control option that is technically feasible, economically feasible, and results in the highest level of control is chosen as BACT and will be a limit included in the air construction permit. BACT limits can be no less stringent than any otherwise applicable requirement (e.g., NSPS limits) and are determined on a case-by-case basis to account for the unique characteristics of a given project.

As part of a BACT analysis, control options (and associated permit limits) that have been demonstrated in practice must be evaluated. To that end, a number of jurisdictional sources of potential WTE facility stack emission limits were reviewed and are summarized in Table 14. The standards were obtained from USEPA, the current Covanta WTE Facility permit limits, recently permitted facility in Palm Beach Florida, the European Union (EU) Incineration Directive, and the recently built Covanta Durham York Energy Centre near Toronto.

The Palm Beach expansion recently began operation and is the most recent large unit Municipal Waste Combustor (MWC) facility to begin operation in the United States. Also included for informational purposes are emission limits from the European Union (EU) Incineration Directive and the emission limits for the Durham York Energy Centre (DYEC) located in Ontario, Canada, which also recently began operation. Although the DYEC would be classified as a small unit MWC (subject to the requirements of 40 CFR Part 60, Subpart AAAA instead of Subpart Eb) in the US, its emission limits may be informative in the context of limits that will be reviewed as part of the BACT analysis for a Covanta WTE Facility expansion.

Care must be taken when reviewing the emission limits summarized in Table 14 to account for differences in compliance averaging times, determination methods, location-specific conditions or requirements, and the economic feasibility of achieving the limits. For instance, trying to impose the DYEC's CO limit (that is on a 24-hour averaging basis) onto a 4-hour block average (which is the typical basis for US limits) would result in a much more stringent limit than would be evident by just comparing the absolute values of the limits (i.e., 49 ppm compared to 100 ppm). Another example is the dioxin and furan limits of the EU Incineration Directive and the DYEC. Those limits are on a toxic equivalent (TEQ) basis, which multiplies the mass emissions of specific dioxin and furan congeners by a toxic equivalency factor (TEF) to result in a toxicity-weighted mass of the mixture. In contrast, dioxin and furan limits in the US are on a total mass basis. There is no direct conversion between dioxin and furan results on a total mass basis and those on a TEQ basis (although USEPA indicates that a limit of 13 ng/dscm total mass is equal to about 0.1 to 0.3 ng/dscm TEQ).[11] As such, the TEQ-based limits listed for the EU Incineration Directive and the DYEC are roughly equivalent to the total mass limits of Subpart Eb and the Palm Beach BACT limit. Finally, the NOx limit imposed on the Palm Beach facility is based on a case-by-case determination that the use of selective catalytic reduction (SCR) is BACT. This may or may not be the case for a Marion County WTE expansion because the economic feasibility of SCR must be accounted for in the BACT analysis.

In addition, Covanta provided Anticipated Covanta WTE Facility expansion limits for initial consideration (Table 14). It is noted that these have not been discussed with the Oregon DEQ, have not gone through the BACT assessment and are for illustrative purposes only for consideration in the HIA. In most cases, the proposed stack emission limits are below those of current USEPA limits and are in line with Palm Beach and DYEC WTE facilities. For many of the pollutants it would result in a significant reduction in proposed emission limits than currently regulated for the existing Covanta WTE Facility.

The information summarized in Table 14 is used as boundary conditions in the HIA to anticipate the emission limits that could be set by regulatory agencies. As stated previously, the limits can be no higher than those of Subpart Eb, effective at the time the air permit is being developed. Further, it is reasonable to assume that the limits will likely be no lower than the most stringent of those listed. The emission limits provided in Table 14 were developed by the jurisdictions based on air modeling of these emissions from facilities to ensure that resulting maximum ground level concentrations of contaminants would meet their health-based ambient air quality objectives. However, any proposed emissions standards for the expanded Covanta WTE Facility should ensure that they also meet current ground level air quality standards.

In addition, it is recognized that these emission limits cover only some of the potential chemicals that are emitted from such facilities. Jurisdictions from around the world use this list of chemicals as surrogates for the host of chemicals that are emitted from the facility. This is based on air

[11] Federal Register, Volume 60, No. 243, December 19, 1995. Available at https://www.gpo.gov/fdsys/pkg/FR-1995-12-19/pdf/95-30257.pdf, see footnote b of Table 1).

quality modeling and monitoring of the additional chemicals that have been conducted for operating facilities. The Literature Review provides details on scientific air quality and health risk assessment studies that have been completed that demonstrate by using these monitored surrogate emissions standards for chemicals that the remaining chemicals (e.g., additional metals) would also meet ground level health-based air quality objectives.

Table 14. International Emission Standards for WTE Facilities.

Parameter	US EPA 40 CFR Part 60 Subpart Eb		Current Marion WTE Facility		Palm Beach Renewable Energy Facility		EU Incineration Directive		Durham-York Energy Centre		Anticipated Marion WTE Facility Expansion	
Carbon Monoxide (CO)	100	ppmdv 4-hr block arithmetic average	100	ppmdv 4-hr block arithmetic average	100	ppmdv 4-hr block arithmetic average	56	ppmdv daily avg. value	50	ppmdv 24-hr geometric mean	100	ppmdv 4-hr block arithmetic average
					80	ppmdv 30-day rolling average	112	ppmdv half-hourly avg. in any 24-hr period				
							168	ppmdv 10-min average				
Particulate Matter (PM)	20	mg/dscm	25	mg/dscm	12	mg/dscm	13	mg/dscm daily average	13	mg/dscm	12	mg/dscm
Cadmium (Cd)	10	µg/dscm	20	µg/dscm	10	µg/dscm			10	µg/dscm	10	µg/dscm
Lead (Pb)	140	µg/dscm	200	µg/dscm	125	µg/dscm			71	µg/dscm	125	µg/dscm
Mercury (Hg)	50	µg/dscm, or	50	µg/dscm, or	25	µg/dscm	64	µg/dscm	21	µg/dscm	25	µg/dscm
	85%	Removal	85%	Removal								
Sulfur Dioxide (SO_2)	30	ppmdv 24-hr geometric mean, or	29	ppmdv 24-hr geometric mean, or	24	ppmdv 24-hr geometric mean	25	ppmdv daily average	19	ppmdv 24-hr geometric mean	24	ppmdv 24-hr geometric mean
	80%	Removal	75%	Removal								
Hydrogen Chloride (HCl)	25	ppmdv, or	29	ppmdv, or	20	ppmdv	9	ppmdv daily average	9	ppmdv 24-hr geometric mean	20	ppmdv
	95%	Removal	95%	Removal								
Dioxin/Furan	13	ng/dscm (total mass)	15	ng/dscm (total mass)	10	ng/dscm (total mass)	0.13	ng/dscm (TEQ)	0.086	ng/dscm (I-TEQ)	10	ng/dscm (total mass)
Nitrogen Oxides (NOx)	150	ppmdv 24-hr daily arithmetic average	205	ppmdv 24-hr daily arithmetic average	50	ppmdv 24-hr daily arithmetic average	137	ppmdv daily average	92	ppmdv rolling 24-hr arithmetic average	45	ppmdv 12 month rolling average

Parameter	US EPA 40 CFR Part 60 Subpart Eb	Current Marion WTE Facility	Palm Beach Renewable Energy Facility		EU Incineration Directive		Durham-York Energy Centre		Anticipated Marion WTE Facility Expansion	
			45	ppmdv 12 month rolling average						
Volatile Organic Compounds (VOC)			7	ppmdv					7	ppmdv (as CH_4)
Ammonia Slip (NH3)			10	ppmdv					20	ppmdv
Total Organic Compounds (TOC)					12.9	mg/dscm daily average				
Hydrogen Fluoride (HF)					1.3	mg/dscm daily average			3.5	ppmdv
Cadmium + Thallium (Cd + Th)					0.064	mg/dscm daily average				
Sum of (As, Ni, Co, Pb, Cr, Cu, V, Mn, Sb)					0.643	mg/dscm daily average				
Organic Matter							71	mg/dscm		
PM_{10}									35	mg/dscm
$PM_{2.5}$									35	mg/dscm
H_2SO_4									5	ppmdv

NOTES:

1. All values are at 20°C, 1 atmosphere of pressure and corrected to 7% O_2.
2. The West Palm Beach dioxin/furan limit will be adjusted to 0.75 to 10 ng/dscm after completion of initial performance test.
3. A netting analysis will be performed to determine if additional control of NOx emissions from Units 1 and 2 can be achieved such that the net increase in NOx emissions for the facility can be limited to less than 40 tpy, In this case, a higher permit limit for NOx will be possible.

Table 15 provides an estimate of the tons per year of emissions that could be expected from the 200,000 tpy expansion of the Covanta WTE Facility. It indicates the pollutants that will require attention during assessment of BACT and selection of stack emission limits.

Table 15. Total Emissions in Tons per Year Estimated for Release from the Expansion of the Covanta WTE Facility

Marion EfW Facility Expansion						
PTE Based on Covanta Provided Anticipated Emission Limits						
		Annual Facility Throughput:	200,000	tpy		
		Unit Size:	600	tpd		
		Waste Heat Content:	5,000	Btu/lb	(Covanta Assumption)	
	Heat Input		250	MMBtu/hr		
			2,000,000	MMBtu/yr		
	Anticipated Limit		Equivalent	Emissions		
Pollutant	Value	Units [a]	lb/MMBtu [b]	lb/hr	tpy	
CO	100	ppm	0.105	26.1	105	
NOx	45	ppm	0.077	19.3	77.3	
SO2	24	ppm	0.057	14.3	57.4	
PM	12	mg/dscm	0.011	2.69	10.8	
PM10	35	mg/dscm	0.031	7.86	31.4	
PM2.5	35	mg/dscm	0.031	7.86	31.4	
VOC (as CH4)	10	ppm	0.006	1.49	5.98	
Lead	125	µg/dscm	1.12E-04	0.03	0.11	
Cadmium	10	µg/dscm	8.98E-06	0.002	0.009	
Mercury	25	µg/dscm	2.25E-05	0.006	0.022	
Fluorides (as HF)	3.5	ppm	0.003	0.65	2.61	
Sulfuric Acid Mist	5	ppm	0.018	4.57	18.3	
Dioxin/Furan	10	ng/dscm	8.98E-09	2.25E-06	8.98E-06	
HCl	20	ppm	0.027	6.81	27.2	
Ammonia Slip	20	ppm	0.013	3.17	12.7	

[a] All values corrected to 7% O2.

[b] Calculated using the methodology in 40 CFR Part 60, Appendix A-7, Method 19.

Understanding the Influence of BACT Controlled WTE Facility Emissions on Ambient Air Quality

Although not typically a requirement to conduct ambient air quality measurements surrounding operating WTE facilities, there have been a number of international reviews and scientific publications on the results of air monitoring around such facilities. A review conducted by Jacques Whitford, 2009 concluded the following:

> *In general, high volume air samplers were sited downwind of a facility and within its modelled chemical depositional range. In many studies, a control location was set up in an area predicted to be outside of the zone of influence of the incinerator. This allowed the researchers to compare the ground level concentrations of chemicals within the zone of influence of the facility to background conditions. Dioxins and furans, trace metals and volatile organic compounds (VOCs) were the most commonly measured chemicals.*
>
> *The literature review determined that facilities that had upgraded or modern pollution control technology do not appear to be a significant source of chemicals detected in*

ambient air surrounding the incineration facility. However, older MWI [municipal waste incinerators] facilities or hazardous waste facilities appear to in some cases have been a significant contributor to ambient levels of chemicals in the air surrounding these facilities.

The zone of potential influence of the facilities studied appears to be no greater than 2 km from the stack, with the majority of research focused in areas less than 0.5 km from the facilities. Baseline or control locations formed a critical part in all of the studies.

The scientific literature of modeling and monitoring ground-level monitoring of ambient air surrounding WTE facilities has demonstrated that there has not been a demonstrable increase of pollutants in areas surrounding the facility. The Literature Review should be consulted for further details of this international body of scientific evidence. An assessment of how deposition of airborne chemical emissions and their loading into the environment is provided in the Soil Quality section in Section 6.1.6 of the HIA.

Therefore, any proposed expansion of the Covanta WTE Facility of 200,000 tpy of MSW would follow the same trend. This would be especially true if the proposed stack emissions criteria are implemented. In addition, given that existing or baseline air quality surrounding the facility is likely below existing ambient air quality standards, it is not anticipated that the expansion of the facility would result in appreciable, measurable ground level pollutant concentration increases.

Understanding of Health Impacts in Relation to Air Emissions of BACT Controlled WTE Facilities

The Literature Review (HDR, 2017) conducted for this project reviewed the potential health impact from air quality emissions of modern BACT-controlled WTE facilities. Coupled with exposure results from air quality monitoring programs, a review of air quality health risk assessments and health surveillance programs surrounding WTE facilities determined that there was not a predictive or actual increase in health issues, including for those in vulnerable or sensitive “at-risk” populations such as children or the elderly.

That said, it is acknowledged that the existing Covanta WTE Facility emits levels of NO_x that are relatively close to permitted levels. Both the 1-hr and annual average NO_2 concentrations at existing monitoring stations indicate ambient levels well below air quality standards. While the existing facility maybe approaching the permitted emission levels, it is likely that ground level NO_2 concentrations are within ambient air quality standards.

Low levels of NO_2 in the air can irritate the eyes, nose, throat and lungs (ATSDR, 2002). Higher concentrations of NO_2 can result in changes in pulmonary function due to inflammation of lung tissue. Exposure to NO_2 can have a more pronounced effect on the health of individuals with pre-existing respiratory conditions, such as asthma, chronic obstructive pulmonary disease or bronchitis. Short term NO_2 exposure is strongly associated with asthma exacerbation (i.e., wheezing, cough, use of medication) among children and the elderly (USEPA, 2008).

The NO_2 1-hour National Ambient Air Quality Standard (NAAQS) for acute (short-term) exposure is 100 ppb (188 μg/m³), calculated as the 98th percentile of 1-hour daily maximum concentrations, averaged over 3 years, to protect against respiratory effects triggering asthma. The USEPA annual (chronic) NAAQS for NO_2 is 53 ppb (100 μg/m³). The NO_2 NAAQS was developed in 1971 (USEPA, 2010) and has been subsequently upheld through a number of scientific and regulatory reviews between 1971 and 2010. In 1996, the annual standard was maintained by the USEPA on the basis that, in combination with the short-term standard, the annual standard was protective of both the potential short-term and long-term human health effects of NO_2 exposure (USEPA, 2008). The most recent edition of the Final Rule (USEPA, 2010) indicates that the annual standard was upheld due to the uncertainty associated with the potential long-term effects of NO_2. These standards were further supported in the 2016 USEPA Integrated Science Assessment for Oxides of Nitrogen – Health Criteria (2016 Final Report).

Therefore, if the expansion of the WTE facility employs modern APC Systems to control the release of NO_x (e.g. selective non-catalytic reduction (SNCR), selective catalytic reduction (SCR)), and resulting ground level concentrations surrounding the facility do not exceed their NAAQS then health impacts are not expected to occur.

In addition to the BACT analysis, a PSD permit application is required to include a dispersion modeling demonstration of compliance with the NAAQS and PSD increment consumption limits for all criteria air pollutants for which PSD is triggered. This demonstration is performed by modeling the impact of facility emissions at receptors placed on and beyond the facility site boundary. These receptors could include the local schools and other places of "at-risk" populations.

Based on the anticipated permit limits and the resulting mass emissions, air dispersion modeling of the following criteria pollutants is expected:

- NO_x, SO_2, PM_{10}, $PM_{2.5}$

The modeled results will be required to demonstrate that predicted ground-level concentrations of pollutants meet the NAAQS ambient air objectives. This, in combination with the international peer-reviewed literature on air quality and health monitoring assumes that chemical releases will not result in a marked increase in ambient air quality. Therefore, vulnerable populations (children, elderly and those with pre-existing health conditions) will not experience an unacceptable increase in either non-carcinogenic (e.g., asthma) or carcinogenic (e.g., lung cancer) effects.

The assessment of air quality effects assumes that an expansion of the Covanta WTE Facility will be required to meet the health-based NAAQS and other relevant health-based ambient air quality benchmarks (Table 16).

Table 16. Assessment of Air Quality Effects of WTE

Magnitude: what is the severity of the effect on human health?	
Low	The effect is minor and does not pose a hazard to health; health status will not change from baseline.
	Rationale: Although there will be pollutant emissions from the facility, prior to development the facility will have to go through a BACT review, and emission standards would be in line with those throughout the world. In addition, model results of surrogate chemicals will need to demonstrate compliance with health-based NAAQS or other air quality objectives.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Reversible	The effect is reversible given that no increase potential health impact is expected over baseline.
	Rationale: Although there will be chemical emissions to the Brooks airshed, they would be at a quantity that is low enough to pose a negligible chronic risk to health. In addition, even if there are exceedances of standards, they would be expected to be short-term, and potentially only resulting in acute, reversible respiratory symptoms.
Frequency: how often is the effect expected to occur?	
High	The effect occurs on a continuous basis.
	Rationale: There would ongoing release of pollutants to the environment throughout operations
Duration: what would be the duration of the effect, if it were to occur?	
Short-term	A short-term (acute) effect, lasting from days to weeks.
	Rationale: Given that emissions will have to meet stringent stack emission permit levels and demonstrate compliance with NAAQS or other health-based standards. The international scientific literature has demonstrated that proper stack emission limits result in negligible change in ground level chemical concentrations.
Overall Effect Characterization	
Neutral (=)	The analysis results in a neutral or negligible effect on health. This assumes that emissions standards are based on BACT and that proper facility monitoring is in place and that NAAQS or other suitable health-based ambient air quality criteria are met at the maximum point of impingement.
Likelihood: What is the probability of the impact occurring?	
Probable	The impact will likely occur. The probability of its occurrence is greater than 50%.
	This will be covered by the permit requirements of the facility expansion.

The assessment of Air Quality determined that sending 200,000 tpy of MSW to the Covanta WTE Facility could result in a **'neutral effect.'** Although any expansion of the Covanta WTE Facility would result in an increase in pollutant stack emissions from the facility, they would be expected to meet stringent regulatory limits and ground-level NAAQS.

The likelihood of occurrence was deemed '**probable**' given that the emissions from the facility are a certainty. Overall there is a low level of uncertainty in this assessment given that there is considerable literature on air quality and health surrounding BACT-designed and permitted WTE facilities.

In the event that Metro elects to proceed with sending 200,000 tons per year to the Covanta facility, it is recommended that the Best Available Control Technology (BACT) analysis and a dispersion modeling demonstration of compliance with the National Ambient Air Quality Standards (NAAQS) and the Prevention of Significant Deterioration (PSD) increment consumption limits for all criteria air pollutants for which PSD is triggered be conducted. This would serve to confirm the assumptions in this assessment and is anticipated to be required as part of the regulatory process.

Additional studies Metro may wish to consider include:

1. Baseline Ambient Air Quality Monitoring in Brooks. There was no site-specific ambient air quality monitoring data available in the vicinity of the existing Covanta WTE Facility. To ascertain the actual existing ambient concentration of chemicals in the airshed a detailed pre-construction baseline air monitoring program could be undertaken for a one year period. Consideration should be given to collecting a broad suite of chemicals beyond those that are merely envisioned for regulated stack emissions standards. A monitoring plan should be developed that would conform with EPA and DEQ requirements. Such a program would likely require 18 months to design, implement and report.

2. Detailed Air Quality Dispersion Modeling – Metro could consider requiring a more detailed air quality dispersion modelling than may be required under the routine permitting requirements. This would involve inclusion of a broader list of chemicals of concern (50 plus) than only those that have stack emission permitted levels. The modeling plan should be developed in accordance to EPA and DEQ requirement and would likely involve the use of the more sophisticated CALPUFF dispersion model. Stack emissions data would include proposed regulatory emissions limits and use of chemical stack test data for the additional chemicals from a similar designed facility. It could include specific requirements for modeling Start-up and Shut-down conditions, where chemical release could be higher than during normal operating conditions. The modeling domain would include the point of maximum modeled ground level concentrations and isopleths (predicted concentrations) of chemicals further from the facility. The resulting ground level concentrations would be compared to existing ambient air quality objectives and deposition rates of chemicals to the soil would also be provided as input to the human health risk assessment.

3. Human Health Risk Assessment (HHRA) – in some jurisdictions an expansion of a WTE facility has required the conduct of a detailed quantitative multiple pathway (including biomagnification into food and water) HHRA to be undertaken. This would involve input from the baseline ambient air quality program and the detailed air quality dispersion modeling of the broader list of chemicals selected for analysis. Such an undertaking would use the most up-to-date toxicity reference values for both inhalation and oral exposure. For example, any new information published from Clean Air Oregon initiative would be considered. It will evaluate the risk to the local population of the baseline ambient air quality, the expanded Covanta WTE Facility emissions alone, and then a cumulative effects analysis on how expansion of the facility would impact health in combination with existing conditions. Exposures would result in risk quantification benchmarked on hazard quotients (non-cancer chemicals) and incremental lifetime cancer risk (ILCR) (e.g. probability of 1 additional cancer case in a population of 100,000 or 1,000,000 people). The results could be used to ascertain if regulatory stack emissions are sufficient to protect health or if more stringent standards should be used to regulate the proposed expanded facility. It would include Start-up and Shut-down conditions. A focus on health equity for sensitive sub-populations, the elderly, children, those with pre-existing

conditions would be undertaken. This assessment would provide additional details on the expanded list of chemicals that would be released from the facility to ensure that they would not impact the people of Brooks.

4. Best Practices for Monitoring - although the AQ/HHRA reports would have to demonstrate no appreciable risk to people from exposure to chemical emissions from the expanded facility, a review of international best practices on facility monitoring can be completed. This would involve review of engineering practices for stack monitoring/sampling, and the need for ground-level monitoring of air, water, and soil. This could guide the monitoring program for an expanded Covanta WTE Facility.

6.1.2 Greenhouse Gas (GHG) Emissions

Greenhouse gas (GHG) emissions will result from any MSW management option. The amount or contribution of GHG from options is calculated using units of metric tons of carbon dioxide equivalent (MTCO2e). The resulting MTCO2e for each management option of MSW would be dependent not only on the emissions from the option itself, but also on the emissions from haul vehicles transporting the waste to the destination associated with each option.

Potential Impact on Health of GHG Emissions

GHG emissions are important, as they are a contributor to climate change and global warming. This in turn can potentially lead to a myriad of negative health outcomes (Figure 11). These negative health consequences will vary by geographic region and are likely to have greater impact on low-income countries (Haines, 2006).

Governments around the world have been exploring strategies and implementing targets to reduce their GHG emissions. The December 2015 Paris climate conference (COP21) was an attempt to legally bind 197 countries to a set of performance metrics under a global climate agreement. Along with 126 other countries, the US has ratified the agreement, which became binding in November 2016. In addition to national goals, many municipal governments have set their own targets for GHG reduction.

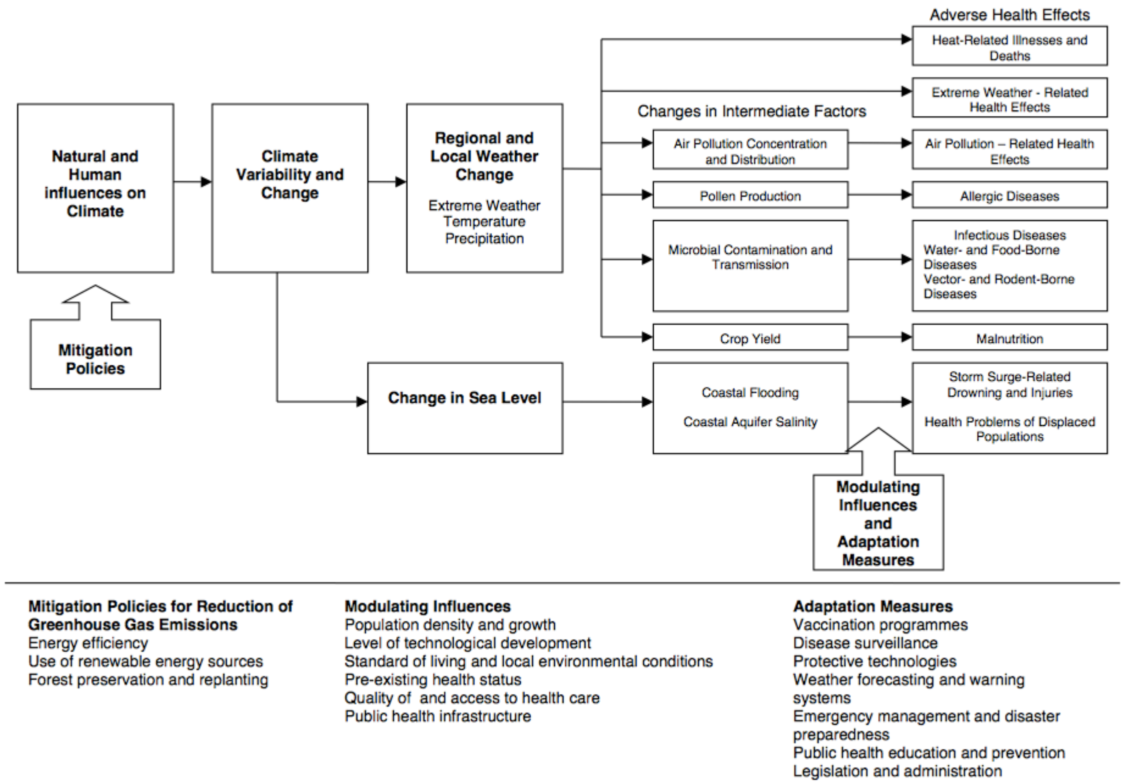


Figure 11. Potential health effects of climate change and variability (from Haines et al, 2006)

Vulnerable or Sensitive Populations

In 2014, the Oregon Health Authority released their Oregon Climate and Health Vulnerability Assessment (OHA, 2014). The social vulnerability assessment identified 11 indicators, together grouped as 'social vulnerability' that would make people more vulnerable to climate change:

- Birth outcomes, Children, Chronic Disease, Educational attainment, Foreign-born population, Isolated older adults, Older adults, Race and ethnicity, Socio-economic status, Tenure, Unemployment

Brooks, along with much of Marion County, was identified as being in the 'high' category for the composite social vulnerability index. This ranking provides an association between natural hazards and indication of potential social vulnerability.

6.1.2.1 Current Conditions

As part of the Green Metro initiative, Metro Council has set an "ambitious target for internal operations to be sustainable within one generation" (Metro, 2016). One of the stated goals is:

- Greenhouse gas emissions – reduce direct and indirect greenhouse gas emissions to 80 percent below 2008 levels

6.1.2.2 Project Impact

HDR completed a "Comparative Greenhouse Gas Analysis" for the current undertaking (1

1). It compared the GHG emissions between transporting 200,000 tpy of MSW from Portland to a Generic Landfill 150 miles away to that of diverting the same quantity to the Covanta WTE Facility located in Brooks Oregon, 50 miles away. It also included the transportation of ash 36 miles to the Coffin Butte Landfill. Two approaches were used to compare the scenarios; the Waste Reduction Model (WARM) method and the Municipal Solid Waste Decision Support Tool MSW-DST method. The following describes the approaches (HDR, 2017):

> *WARM was created by the USEPA as a streamlined life-cycle GHG accounting tool to help managers and policy makers understand and compare the emissions and offsets resulting from different materials management options (e.g., landfill disposal, composting, etc.) for materials commonly found in the waste stream. Only anthropogenic emissions are considered as GHG emissions in WARM. (USEPA, 2016).*
>
> *Another tool for modeling GHG emissions is the Municipal Solid Waste Decision Support Tool (MSW-DST). MSW-DST was created by the RTI, with co-funding by USEPA, as a comprehensive LCA tool to help solid waste planners evaluate the cost and environmental aspects of integrated solid waste management strategies, one aspect of which is a GHG emissions analysis. Based on review of the MSW-DST supporting documentation, only anthropogenic emissions are considered as GHG emissions by the model.*

The HDR report indicated for both modeling exercises that:

> *As WARM and MSW-DST generated conflicting answers to the question of which waste management scenario would result in fewer GHG emissions, HDR can make no definitive recommendation on which scenario would have the lesser impact on climate change. It is recommended that Metro consider the results of this GHG emissions modeling as indicative of the potential effects of each waste management scenario, with the understanding that these are broad estimates based on broad assumptions and there are limitations in the models used. Furthermore, as there is not yet consensus among the developers of the models, it should be noted that these results are not replicable across different models, even though each model may be well documented and widely used in a certain geographic or academic setting.*

There is disagreement between the two modeling approaches as to the net GHG account for WTE facilities. This is due to inherent differences in model assumptions, inputs and calculations. For the WTE option, the WARM model predicts annual emissions of 21,320 MTCO2e, while the MSW-DST method predicts a slight annual emissions credit, or sink, of -906 MTCO2e output. This a significant discrepancy in model output, with the latter suggesting that WTE facilities are a solid waste management strategy that provides a net benefit for GHG reduction.

However, caution is recommended to decision makers not to place too much emphasis, one way or another, on the HIA findings for GHG given the scientific uncertainty in estimating GHG for waste management options.

Given the discrepancy and uncertainty in the approaches it was determined that GHG emissions could be either positive or negative. It is under this premise that the potential health impacts were assessed (Table 17).

Table 17. Assessment of Greenhouse Gas (GHG) Effects for WTE.

Magnitude: what is the severity of the effect on human health?	
Low	The effect is minor and does not pose a hazard/benefit to health; health status will not change from baseline.
	Rationale: The GHG report provides conflicting results either positive or negative.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Not Applicable	
Frequency: how often is the effect expected to occur?	
Not Applicable	
Duration: what would be the duration of the effect, if it were to occur?	
Not Applicable	
Overall Effect Characterization	
Neutral (=)	The analysis provides inconclusive results for the WTE analysis.
Likelihood: What is the probability of the impact occurring?	
Possible	The positive impact will likely occur, the probability is less than 50%.
	The results of the comparative analysis indicate that regardless of the method used that there would be either a neutral or minor increase in GHG from the WTE option.

The assessment of GHG determined that diversion of 200,000 tpy of MSW to the Covanta WTE Facility could result in a **'neutral effect.'** It is not known at this point the extent to which GHG emissions from a single WTE facility could actually affect climate change.

The likelihood of occurrence was deemed '**possible'** given the results of the GHG report indicate a net neutral in GHG emissions if waste were to be diverted to the expanded WTE facility. Overall there is a high level of uncertainty in this assessment given the uncertainty in the results of the GHG report that was prepared specifically for this undertaking.

It is recommended that further discussions between the interested parties being undertaken in the future in an attempt to reach consensus on the best approach for determining GHG impacts.

6.1.3 WTE Ash and Landfill

The combustion process at the Covanta WTE Facility results in the generation of ash that is sent off-site for use as landfill day cover.

Potential Impact on Health of WTE Ash

Improper characterizing, handling or storage of WTE ash could lead to impacts to soil or groundwater at landfills receiving the material. For example, the blowing of the uncontained ash material used as day cover could theoretically result in an increase in soil chemical concentrations. Improper leachate control could result in the impact to local groundwater. In this event it would be unlikely that residents would come into contact with impacted soil (assumed to be within the boundaries of the landfill). However, it is possible if groundwater was impacted and there were nearby potable residential wells that people could be exposed to a number of contaminants.

Vulnerable or Sensitive Populations

The Coffin Butte Landfill is located 10 miles north of Corvallis, Oregon and approximately 3 miles north of Adair Village. The area surrounding the landfill is forest and agricultural land, with residents located nearby. In addition, the E.E. Wilson Wildlife Area is located one-half mile to the east of the landfill. Vulnerable or sensitive populations would include those residents that are located nearest the Coffin Butte landfill.

6.1.3.1 Current Conditions

At the Covanta WTE Facility flue gas is sent through the air pollution control system that removes acid gases, heavy metals, organics and particulate. The particulates collected in the bag house filters are referred to as fly ash. It is placed on the same conveyor system that collects the bottom ash from the boiler. The result is an ash from the solid waste. After ferrous and non-ferrous metals are recovered, the ash is approximately 25-30% by mass and 10% by volume of the original waste material.

Marion County is responsible for ash disposal from the facility. In the first quarter of 2017, approximately 110 tpd of ash was transported 36 miles by 4.35 trucks per day, Monday to Friday, and used as day cover at Coffin Butte Landfill. Prior to its use as day cover at the Coffin Butte Landfill it was disposed of in Ash Cell III at the North Marion County Disposal Facility, located approximately 10 miles north of Brooks.

The Covanta WTE Facility ash is tested monthly for the Toxicity Characteristic Leaching Procedure (TCLP) and the EPA's *Guidance for the Sampling and Analysis of Municipal Waste Combustion Ash for the Toxicity Characteristic*. This is done to ensure that it can be demonstrated to be non-hazardous, with low leachable potential of chemicals in the ash, and appropriately used as day cover.

In 2002, Roffman Associates completed "Municipal Waste Combustion Ash, Soil and Leachate Characterization Monofill – Cell No. III – Twelfth and Thirteenth Years Study" for the North Marion County Disposal Facility. The field program involved:

- Collection of ash samples and analysis for metals, dioxins and furans and geochemical parameters;
- Collection of leachate samples from Cell No. III and analysis for metals, dioxins and furans and geochemical parameters; and,
- Collection of soil samples at four previously established location surrounding the cell and one background location to evaluate effects from blown ash. Samples were collected from the top inch and analyzed for metals, dioxins and geochemical parameters.

They reported:

- Ash samples contained metal concentrations similar to previous studies and contained only low levels of dioxin and furans, with the 2,3,7,8-TCCD TEQ less than residential soil standards.
- Soil samples were not impacted by dioxins and furan or metals. The concentrations of chemicals were within the range of the background samples and regional and national levels.
- The leachate contained non-detectable concentrations of dioxins and furans and all metal concentrations were well below and less than 10% of the TCLP Maximum Allowable Limits.

This study supports the use of the Covanta WTE Facility ash as day cover for landfill. In addition, Covanta supplied the results of the past 15 years of TCLP of their ash to HDR (Table 18). The maximum detected concentrations of all chemicals were less than the Maximum Allowable Limit.

In fact, many of the samples contained non-detectable concentrations of metals, and the average concentration (including samples below their analytical detection limit) was at least an order of magnitude below the standards.

Table 18. Summary of Results for TCLP Testing of Covanta WTE Facility Ash (2002-2016)

Metal	Number of Samples	Maximum Allowable Limit	Maximum Detected Concentration	Mean Concentration
	n	mg/L	mg/L	mg/L
As	160	5	0.5	<0.057
Ba	160	100	2.8	<0.687
Cd	160	1	1.0	<0.166
Cr	160	5	0.3	<0.057
Pb	160	5	3.4	<0.118
Hg	160	0.2	<0.001	<0.001
Se	160	1	0.5	<0.067
Ag	160	5	0.5	<0.064

Based on the results of the 2002 investigation of Cell No. III and the past 15 years of TCLP testing, the ash from the Covanta WTE Facility meets the requirements to be used as day cover in landfill. Local residents and vulnerable populations would not have been impacted by the current practice of placing Covanta WTE Facility ash in the Coffin Butte Landfill as there would have been no exposure to chemicals contained in the ash.

6.1.3.2 Impact of Expansion of the WTE Facility

The proposed 200,000 tpy expansion of the Covanta WTE Facility would result in the generation of approximately an additional 150 tpd of ash. For the purpose of the HIA it was assumed that disposal would continue to the Coffin Butte Landfill. Disposal of the ash would require an additional six daily truck trips leaving the facility (Monday to Friday).

Similar to current operations all ash removed from the facility would have to be TCLP tested to confirm that it is non-hazardous. This would be a requirement for disposal at any offsite landfill that would receive WTE ash. Given that only MSW will be accepted from Metro, the composition of the ash is expected to be consistent with ash currently generated at the facility. Therefore, although facility expansion would result in a doubling of the ash produced on an annual basis it could likely be used as landfill day cover. Incineration of MSW results in ash that is only 10% of the volume of the original material that would require landfilling.

An assessment of the potential of the additional production and disposal of WTE ash is provided in Table 19. It assumes that ash material will pass the TCLP test and be designated as non-hazardous material that will either be disposed of in landfill or used as landfill cover. It will not impact local groundwater or soil and there would be no pathway for exposure to off-site residents.

Table 19. Assessment of WTE Ash Effects.

Magnitude: what is the severity of the effect on human health?	
Low	The effect is minor and does not pose a hazard/benefit to health; health status will not change from baseline.
	Rationale: WTE ash will be non-hazardous and historical testing of the Covanta WTE Facility ash that was concentrated into a single landfill cell indicated no impact to surrounding soil and low leachability that would not impact surrounding groundwater.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Not Applicable	Not Applicable
	Rationale: No effect is predicted
Frequency: how often is the effect expected to occur?	
Not Applicable	Not Applicable
	Rationale: No effect is predicted
Duration: what would be the duration of the effect, if it were to occur?	
Not Applicable	Not Applicable
	Rationale: No effect is predicted
Overall Effect Characterization	
Neutral	Although ash would be produced as a result of the expansion of the facility it would be non-hazardous. In addition, the incineration of MSW results in a 90% reduction in the material required to be landfilled.
Likelihood: What is the probability of the impact occurring?	
Probable	The neutral impact will likely occur, the probability is greater than 50%.
	The expansion will result in an increase in ash production.

The assessment of WTE determined that diversion of 200,000 tpy of MSW to the expanded WTE facility could result in a **'neutral'** health effect. Although an additional 150 tpd of ash would be generated, it would be non-hazardous and could be landfilled or beneficially reused as landfill day cover, in place of soil. Therefore, there would be no impact to local residents surrounding the Coffin Butte Landfill.

The likelihood of occurrence was deemed '**probable**' given that ash would be produced as part of the expanded operations. Overall there is a low level of uncertainty in this assessment given that it is supported by the results of TCLP data for the existing ash generated at the facility and the results of the 2002 North Marion County Disposal Facility study.

Although no additional mitigation measures are recommended, there is potential for enhancement that could be considered. Over the past decade there has been considerable investment and investigation into additional beneficial reuses of WTE ash. The two main areas of research and demonstration projects appear to be with use as aggregate and in the production of cement. Covanta and Marion County are encouraged to pursue ongoing research in these areas of beneficial reuse in Oregon.

6.1.4 Production of Energy

The energy produced at WTE facilities is considered a 'renewable energy' by Oregon. The energy is sold through a power purchase agreement (or similar contracting vehicle) to power homes and businesses. Although, it is recognized that the City of Portland and Multnomah County recently passed resolutions that exclude WTE from being counted toward renewable energy in their energy portfolios.

Potential Impact on Health of Energy Production

WTE energy production has the benefit of supplying electricity to the grid that can partially offset the need for additional non-renewable sources of energy production. Given that facility emissions have been accounted for in the Air Quality assessment, if emissions are at an acceptable level then energy production that could be recovered from necessary waste diversion could be considered either to have a neutral or positive impact on health through replacement of non-renewable derived energy.

Vulnerable or Sensitive Populations

No vulnerable or sensitive populations were identified for the production of energy from the WTE facility.

6.1.4.1 Current Conditions

The Oregon Department of Energy provides information on the electricity mix that supplies power to the state (ODOE, 2017; Figure 12). The largest electricity generation is from hydropower, while the state's Renewable Portfolio Standard requires that 50% of the electricity provided by the largest utilities come from renewable resources by 2040.

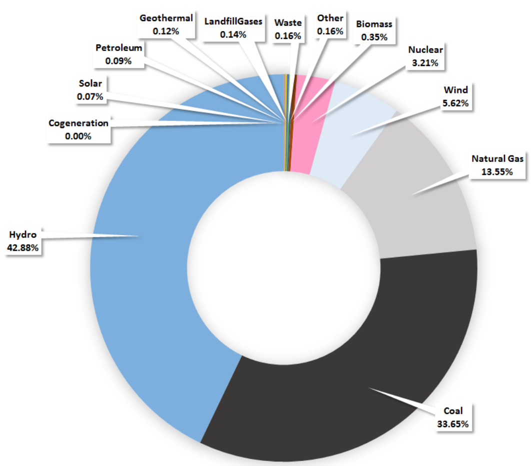


Figure 12. Oregon Electricity Mix

ODOE considers WTE to be a renewable energy. The Western Renewable Energy Generation Information System issues Renewable Energy Certificates (RECs) to the Covanta WTE Facility. The current Covanta WTE Facility generates 13.1 MW of electricity. This is the equivalent energy to power over 13,000 homes. It is sold to Portland General Electric that supplies energy solely to Oregon customers.

6.1.4.2 Project Impact

Covanta has reported that expansion of the facility would result in an increase of an additional 13 MW of electricity production. This would be considered by the ODOE as contributing to an increase in renewable energy production in the state. Overall, the health impact assessment of electrical generation was assessed assuming that there is a potential benefit of this energy over that of the use of non-renewable sources of generation. An assessment of the potential of the additional production energy from expansion of WTE is provided in Table 20.

Table 20. Assessment of Production of Energy Effects for WTE.

Magnitude: what is the severity of the effect on human health?	
Medium	The effect is detectable and poses a minor to moderate hazard/benefit to health; health status could change from baseline.
	Rationale: The increase in energy production could offset the need for some non-renewable based electricity generation.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Irreversible	For positive effects, the improvement is permanent.
	Rationale: Over the life of the project electricity would be generated for approximately 13,000 homes a year.
Frequency: how often is the effect expected to occur?	
Medium	The effect may occur occasionally
	Rationale: Although it would be through the duration of the project it is recognized that it is only 13 MW of electricity.
Duration: what would be the duration of the effect, if it were to occur?	
Long-term	The effect occurs on a continuous basis.
	Rationale: It would be through the 20 year life of the project.
Overall Effect Characterization	
Moderate (++)	The analysis results in a moderate positive effect on health.
Likelihood: What is the probability of the impact occurring?	
Probable	The impact will likely occur, the probability is greater than 50%.
	Rationale: In the event that the expansion of the WTE facility is undertaken it will result in the generation of electricity.

The assessment of WTE production of energy determined that an expansion of 200,000 tpy of MSW to the Covanta WTE facility could result in a **'moderate positive effect'**. This is based on the increase of production of renewable energy over that of non-renewable sources of electricity generation.

The likelihood of occurrence was deemed '**probable**' given that energy would be produced as part of the expanded operations. Overall there is a low level of uncertainty in this assessment given that Covanta expects to be able to produce 13 MW of electricity.

Although no additional mitigation measures are recommended, there is potential for enhancement that could be considered. In addition to electricity production there are other options for use of the thermal energy produced. Covanta should be encouraged to explore options to expand thermal energy sale to nearby business or the town of Brooks.

6.1.5 Accidents and Malfunctions

As with any industrial facility there is a potential for accidents, malfunctions or operations of the facility in less than ideal (upset) conditions at WTE facilities. For WTE facilities the most significant of the accident events would be fire at the facility. In addition, it is possible that there could be a malfunction of the air pollution control (APC) equipment.

Potential Impact on Health as a Result of Accident or Malfunction

Although major fire or major industrial release from WTE facilities maybe rare, if it were to occur there is a potential for physical injury or death in workers or those living in the surrounding community. Upset conditions related to the APC releases would be short-term and although unlikely to result in significant acute health impacts it is possible that reversible respiratory inflammations could occur. This was addressed in the Air Quality Section 6.1.

<u>*Vulnerable or Sensitive Populations*</u>

The WTE facility workers and residents of Brooks would be considered vulnerable populations given their proximity to the facility if a major event was to occur.

6.1.5.1 Current Conditions

Since beginning operations there have been only a few minor fires that have occurred on the tipping floor at the Covanta WTE Facility. It is Covanta's policy to call the fire department for any fire, regardless of the size or magnitude. Over the past five years they have had no such occurrences. However, in 2012 there was an exterior fire at the facility. An acetylene bottle with a failed gasket, located near the exterior of the baghouse, caught fire due to the friction of acetylene escaping the gasket. Covanta began applying water and the fire department was called and continued to apply firewater until it was extinguished. No injuries occurred as a result of the incident.

6.1.5.2 Project Impact

Although rare, fires have occurred within these areas of WTE facilities causing extensive damage to facilities. As with any industrial complex, fighting such fires can be challenging given the height of the buildings, layout, and that access to the pit and tipping floor.

Two recent fires have occurred at WTE facilities in the United States. In December 2016 the tipping floor of the Montgomery County Resource Recovery Facility in Dickerson, Maryland, caught fire. It was reported that although the fire was quickly contained it took eleven days to fully extinguish. The root cause determined that the fire originated in waste on the tipping floor and quickly spread to the pit. A specific ignition source was not determined. On February 2, 2017, the Fairfax County Waste to Energy Facility experienced a similar fire, where waste on the tipping floor caught fire and spread to the waste pit. The fire was reportedly contained but took several days to extinguish because it had spread to the pit. No injuries to staff or the public were reported.

No issues were identified with the landfill ash component of the WTE facility. Although fires or seismic events could occur at the receiving landfill the ash is used as inert day cover (similar to topsoil) and events at the landfill would not be exacerbated by the WTE ash material.

With any WTE facility there is a potential to have upset conditions or malfunction of the APC systems. This would typically occur during initial setup of operations or after prolonged maintenance of the facility. During these events it is possible that the facility is not operating under ideal operating conditions, especially during Start-up and Shut-down, and that release of pollutants above permitted levels could occur. For example, during commissioning of the Durham York Energy Centre (DYEC) stack tests of Boiler #1 indicated exceedance of dioxin and furans above permitted levels (DYEC, 2016). Although they did not meet the stringent stack emissions requirements, it was reported that levels did not pose a health risk. After development of an abatement plan Boiler #1 was restarted and after further stack testing they received Environmental Compliance Approval (ECA) from the Ontario Ministry of the Environment and Climate Change in November 2016. Therefore, it is imperative that continuous stack monitoring and stack testing be completed to ensure compliance with emissions levels.

Overall, the health impact assessment was conducted on assumption that an accident or malfunction could occur, such as a fire at the facility. It also took into consideration the close proximity of Brooks to the facility. An assessment of the potential of the accidents and malfunctions from expansion of the Covanta WTE Facility is provided in Table 21.

Table 21. Assessment of Accident and Malfunction Effects for WTE.

Magnitude: what is the severity of the effect on human health?	
High	The effect is severe and poses a major hazard to health; health status will change from baseline.
	Rationale: If a fire was to occur then it could pose a major hazard to the facility or nearby Brooks.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Irreversible	The effect is not reversible (effect continues once exposure is removed) people are not likely to recover or adapt to the changes, even with additional support.
	Rationale: In the event of a fire or other accident it is possible that the outcome could include injury of workers or nearby residents.
Frequency: how often is the effect expected to occur?	
Not Applicable	
Duration: what would be the duration of the effect, if it were to occur?	
Not Applicable	
Overall Effect Characterization	
Major (---)	In the event of a fire or major industrial accident at the facility there is a potential to have a major negative effect on the health of the workers or nearby residents.
Likelihood: What is the probability of the impact occurring?	
Unlikely	The impact is anticipated to occur rarely, if ever. This classification is appropriate for those situations where impacts are not zero but they are limited to very rare occurrences, catastrophic events, or highly unlikely system failures.
	Rationale: Although fires or other major industrial failures can occur at WTE facilities they are rare occurrences.

The assessment of WTE accidents and malfunctions determined that an expanded WTE facility could result in a **'major negative effect.'** This is because such an event could potentially lead injuries or death.

The likelihood of occurrence was deemed '**unlikely**' given that such occurrences are rare and a significant event leading to injury or property loss have not occurred over the past 30 years of operation of the Covanta WTE Facility. Overall there is a high level of uncertainty in this assessment given that detailed occurrence rates or failure rates are not available for these occurrences.

Covanta WTE Facility reported that it is continuously improving and reviewing its fire response procedures and equipment. It is recommended that if the Covanta WTE Facility is to be expanded that consideration be given to equipping the facility with the latest fire protection measures.

6.1.6 Soil Quality

A common public concern surrounding WTE operations is that atmospheric release of contaminants could impact local soil quality. Although most North American WTE facilities do not have a requirement for soil quality monitoring, there are a number of European studies that have been completed.

Potential Impact on Health from Exposure to Impacted Soil

Inadvertent ingestion of potentially impacted soil or uptake into garden produce would be considered secondary exposure pathways if soil had elevated concentrations of chemicals surrounding WTE facilities.

Vulnerable or Sensitive Populations

In the event that soil was impacted from aerial emissions from the Covanta WTE Facility then children at the two nearby schools and workers on agricultural lands in the area would be considered potentially vulnerable populations.

6.1.6.1 Current Conditions

No soil quality data has been collected around the Covanta WTE Facility. This is not unexpected as there are no regulatory requirements for collection of such data. Collection of such data is not typically required throughout North America.

6.1.6.2 Project Impact

The doubling of the Covanta WTE Facility would result in an increase of stack chemical emission. For those chemicals that are persistent or have long half-lives there will be some deposition onto soil in the local environment. Although there will be additional loading of these chemicals (e.g., metals and PCDD/F) into the surrounding environment it is important to understand the extent to which they accumulate over the life of a facility. The potential risk that they pose to people in the environment is dependent on their resulting concentration and hence the level of exposure that one can predict. Although these chemicals may have the ability to bioaccumulate, if their concentration in soil is sufficiently low, any such accumulation would not pose a health risk.

The Literature Review (HDR, 2017) provided details of a number of soil sampling and risk assessment programs that have been conducted on European WTE facilities that have been operational for some time. The most well-known research group in this field is that headed by Dr. Jose Domingo from Spain. Dr. Domingo has been conducting environmental investigations surrounding European WTE for well over a decade. His research group has consistently reported that levels of PCDD/Fs, PCB, and metals do not significantly accumulate in soil samples surrounding modern WTE facilities. This includes collection of soil samples surrounding facilities as large as that being proposed. The levels are sufficiently low that any bioaccumulation or magnification in the food chain would not pose an unacceptable risk to nearby residents.

The most comprehensive human health and ecological risk assessment (HHERA) for the proposed DYEC WTE Facility was published by Ollson et al. (2015) (further details provided in the literature review). These risk assessments included the deposition of chemicals into the surrounding soil for the life of the facility. A multi-media assessment that examined the resulting soil concentrations, uptake into plants, garden produce, fish, and wild game was conducted. The results were consistent with operating facilities that have been monitored, whereby although chemicals will be deposited in the environment they will be at very low concentrations. The resulting risk assessment determined that the levels would not pose an undue risk to people or the environment (i.e., non-cancer chemicals below benchmarks and cancer causing chemicals a risk of less than 1 person exposed in 1,000,000 of getting cancer).

An assessment of the potential of chemical impacted soil from expansion of the Covanta WTE Facility is provided in Table 22. Overall, the health impact assessment was conducted on assumption that there would not be a significant measurable change in soil concentrations surrounding an expanded facility.

Table 22. Assessment of WTE Soil Quality Effects for WTE.

Magnitude: what is the severity of the effect on human health?	
Low	The effect is minor and does not pose a hazard/benefit to health; health status will not change from baseline.
	Rationale: Local soil will not be impacted by chemical release of aerial emissions.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Not Applicable	
Frequency: how often is the effect expected to occur?	
Not Applicable	
Duration: what would be the duration of the effect, if it were to occur?	
Not Applicable	
Overall Effect Characterization	
Neutral	Soil would not be measurably impacted by airborne chemical release from an expanded facility. Therefore, there would be no health impact.
Likelihood: What is the probability of the impact occurring?	
Probable	The neutral impact will likely occur, the probability is greater than 50%.
	The expansion will result in aerial emissions that will not impact the soil.

The assessment of WTE determined that diversion of 200,000 tpy of MSW to the expanded WTE facility would result in a **'neutral'** effect on soil impact and human health.

The likelihood of occurrence was deemed '**probable**' given that chemical stack emissions will occur but not significantly impact the local soil conditions. Overall there is a low level of uncertainty in this assessment given that it is supported by the results of almost two decades of scientific investigation and literature.

As provided in the Air Quality recommendations a further review of international best practices for environmental monitoring around WTE facilities could be undertaken if the proposed expansion of the Covanta WTE Facility were to be approved. .

6.1.7 Traffic Volume and Safety

For the purposes of the HIA a haul distance from Metro Region to the Covanta WTE Facility was estimated at 50 miles, with an additional 36 miles from the WTE facility to ash disposal landfill.

The Oregon Department of Transportation (DOT) releases annual reports on transportation volume on major highways and roadways in the state. The HIA considers both the potential for accidents to occur and vehicle emissions (Section 6.1.8) that occur from haul distances round trip, consistent with DOT statistics.

Potential Impact on Health from Hauling of MSW

The hauling of waste could potentially impact health through potential crashes along the haul route if significant increase in traffic is seen. Truck vehicular accidents could result in serious injury or fatalities.

Vulnerable or Sensitive Populations

As demonstrated below, there are no businesses or homes located between the interstate exit and the Covanta WTE Facility. Vulnerable populations would include those driving the interstate haul routes.

6.1.7.1 Current Condition

Currently the Covanta WTE Facility receives almost all of its waste from Marion County and the Coffin Butte ash-receiving landfill is located in Benton County. Covanta reports that approximately 100 vehicular trips daily are associated with the operation of the current facility. This includes MSW and other waste delivery vehicles, ash disposal vehicles, employee vehicles and the occasional delivery of reagents to the facility.

6.1.7.2 Project Impact

The expansion of the Covanta facility would require about 30 truck trips per day from the Metro region, using a 26-ton payload vehicle as the larger vehicles (34-ton payload) used for landfill haul would not be compatible with the tipping floor of the WTE facility and about 6 daily vehicle trips for ash disposal (36 miles one-way to landfill), using a 26-ton payload vehicle. This is the equivalent of almost 446,000 one-way and 892,000 round-trip vehicle miles traveled to haul 200,000 tpy of MSW to the Covanta WTE Facility and 40,000 tpy of ash to a landfill.

For the purpose of the HIA only the MSW haul route along the I-5 corridor was considered. The Annual Average Daily Traffic (AADT) volume along the corridor between Portland and Brooks is 109,000 vehicles a day (Oregon DOT, 2016). The highway is along relatively flat terrain and outside of the Metro area is primarily along agricultural land. The increase of 30 waste truck trips a day along I-5 is negligible considering the overall volume of traffic.

The Interchange at exit 263 sees over 4000 exits on a daily basis (Oregon DOT, 2016) and the addition of 30 trucks would also be negligible. The travel distance from the exit to the Covanta WTE Facility is less than 1 mile. There are no residential areas, schools or other vulnerable populations between the I-5 corridor exit and the Covanta WTE Facility and hence no susceptible or vulnerable populations for vehicle strike concerns.

The Oregon DOT also publishes statistics on 12 Truck Safety Corridors in the state where higher than average truck crashes occur (Table 23). Corridors 3,4 and 5 are along the proposed I-5 haul route. The corridor truck safety corridor accident rates for Corridor 3 is in the median range of the 12 areas, with Corridors 4 and 5 at the higher end. In addition, between 8 – 15 (expanded and existing) truck trips will occur daily from the Covanta WTE Facility the Coffin Butte Landfill located at 29175 Coffin Butte Rd, Corvallis, Oregon. This is approximately 36 miles from the WTE facility and also located in Corridor 3.

For 2015, the Oregon DOT estimated that there were 0.39 large truck crashes (commercial motor vehicle at fault crashes) per million vehicle miles traveled (VMT). Note this is the accident rate for Oregon interstates as a whole and does not specifically account for the corridors that would be traveled from the Metro Region to the Covanta WTE Facility.

Table 23. Truck Crashes by Year

	Corridor	2011	2012	2013
1	Siskiyou Summit -- I-5, MP2-9	9	9	7
2	Weaver to Roberts Mountain -- I-5, MP108-117	0	8	7
3	Salem -- I-5, MP252-260	6	5	9
4	Tualatin to Portland, Marquam Bridge -- I-5, MP289-300	15	17	24
5	West Linn to Clackamas -- I-205, MP8-14	9	15	16
6	Hood River to Mosier -- I-84, MP63-73	5	1	4
7	Emigrant Hill, aka Cabbage Hill -- I-84, MP219-228	4	11	7
8	Ladd Canyon -- I-84, MP270-278	4	3	6
9	Nelson Point to Weatherby -- I-84, MP331-340	3	2	5
10	North Bend to Coos Bay -- US101, MP233-243	2	3	2
11	Eugene -- I-5, MP168-208, and Lane County -- OR58, MP1-62	22	29	35
12	Deschutes County -- US20, Sisters to Bend and Bend to 10 miles east of Bend US97, Terrebonne to LaPine, Deschutes County	8	11	12

Given that that the total VMT for expansion of the WTE facility is under one million VMT per year it would be less than 1 accident expected a year. An increase in truck traffic to the Covanta WTE Facility for Traffic Volume and Safety is provided in Table 24.

Table 24. Assessment of Traffic Volume and Safety Effects for WTE.

Magnitude: what is the severity of the effect on human health?	
Medium	The effect is detectable and poses a minor to moderate hazard to health; health status could change from baseline.
	Rationale: The overall increase of truck traffic on the I-5 corridor is negligible compared to existing traffic volumes. The increase of VMT would likely result in less than one accident per year.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Irreversible	The effect is not reversible.
	Rationale: In the unlikely event that a traffic accident was to occur it is possible it could be fatal.
Frequency: how often is the effect expected to occur?	
Low	The effect occurs rarely, if ever.
	Rationale: It is anticipated that accident frequency would be less than one per year.
Duration: what would be the duration of the effect, if it were to occur?	
Long-term	A long-term (chronic) effect, lasting from months to years.
	Rationale: The additional truck traffic would last for the 20-year life of the expansion of the WTE facility.
Overall Effect Characterization	
Minor (-)	Overall, the increase in truck traffic is likely to result in a probability of less than one accident per year, over a 20-year period.
Likelihood: What is the probability of the impact occurring?	
Unlikely	The impact is anticipated to occur rarely, if ever.
	Given that there would be an insignificant increase in traffic volume and that less than one accident per year would be expected it is unlikely to occur.

It was determined that the increase in truck traffic to an expanded Covanta WTE Facility could have a **'minor negative effect'** on health. This is because the increase in traffic volume would be insignificant and less than one accident a year would be anticipated based on DOT statistics. No susceptible or vulnerable populations were identified between the I-5 interchange and the WTE facility. The likelihood of occurrence was deemed **'unlikely'** given the low potential for truck accidents. Overall there is a medium level of uncertainty in this assessment given that a more in depth probabilistic assessment was not performed.

No further recommendations or mitigation measures are considered.

6.1.8 Haulage Vehicle Emissions

As discussed in Section 6.1.7 Traffic Volume and Safety there would be 892,000 round trip VMT per year from Metro Region to the Covanta WTE Facility and includes the distance for ash disposal. This assessment considers the effect on vehicle emissions on health.

Potential Impact on Health from Hauling of MSW

If there is a potential significant increase in vehicle emissions it could have an impact on the health of residents located in close proximity to the interstate.

Vulnerable or Sensitive Populations

Those living along the interstate corridors, especially children and elderly, could be especially vulnerable to adverse changes in air quality.

6.1.8.1 Current Conditions

The trucks used to transfer the waste to the existing Covanta WTE Facility emit a number of air pollutants, including criteria pollutants, greenhouse gases, and hazardous air pollutants (HAP). The existing condition was not assessed.

6.1.9 Project Impact

Table 25 provides the emissions calculations inputs for truck hauling from Metro Region to the Covanta WTE Facility and the additional haulage of ash to landfill. Emissions estimates and diesel consumption need to be expressed in annual number of truck ton (waste) – miles. It can be seen that 174,720 of gallons of diesel would be required on an annual basis for round trip travel. It is recognized that trucks would be returning empty.

Table 25. Emission Calculation Inputs for Truck Hauling for WTE

Parameter	***Calculation Inputs***
A. Distance (round trip) from Metro Region to Covanta WTE Facility	100 miles
B. Annual number of truck freight ton-miles for 200,000 tpy	10,000,000
C. Annual gallons of diesel (based on round trip distance)	130,000
D. Distance (round trip) from Covanta WTE Facility to Coffin Butte Landfill	72 miles
E. Annual number of truck freight ton-miles for 40,000 tpy ash	1,440,000
F. Annual gallons of diesel	18,720

[1] Per a modal comparison study performed by TTI, in cooperation with NWF (http://www.nationalwaterwaysfoundation.org/study/FinalReportTTI.pdf), the emission factors used for $PM/PM_{10}/PM_{2.5}$, NO_x, CO, VOC, and CO_2 are based on the amount of freight hauled one way (i.e., the emission factors account for a full truck hauling one way and an empty truck returning).
[2] Per the TTI report, the diesel usage was calculated based on an average fuel efficiency of 6.0 mile/gal, and round trip travel.

The annual emission estimates for hazardous air pollutants from trucks is provided in Table 26. The potential increase volume of traffic on I-5 is negligible in comparison to the overall volume of traffic. Any impairment of existing near-road air quality would not be attributable to the negligible increase in traffic. There would be no measurable change in ground level criteria air pollutants or HAP concentrations, even immediately adjacent to the interstate.

Table 26. Truck Hauling Emission Estimates for the expanded WTE facility, including Ash Disposal.

Pollutant	Diesel			
	Emission Factor			ton/yr
	Number	Units	Source	
PM	0.06	g/ton-mile	A	0.76
PM_{10}	0.06	g/ton-mile	A	0.76
$PM_{2.5}$	0.06	g/ton-mile	A	0.76
NO_x	1.45	g/ton-mile	A	18.29
SO_2	0.001515	lb/MMBtu	B	0.016
CO	0.37	g/ton-mile	A	4.67
VOC	0.10	g/ton-mile	A	1.26
Greenhouse Gas				
CO_2	171.83	g/ton-mile	A	2,167
N_2O	6.0E-04	kg/mmBtu	C	0.014
CH_4	3.0E-03	kg/mmBtu	C	0.07
CO_2e	NA	NA	NA	2,173
Hazardous Air Pollutants				
Acetaldehyde	2.52E-05	lb/MMBtu	B	0.0003
Acrolein	7.88E-06	lb/MMBtu	B	0.0001
Benzene	7.76E-04	lb/MMBtu	B	0.0080
Formaldehyde	7.89E-05	lb/MMBtu	B	0.0008
Naphthalene	1.30E-04	lb/MMBtu	B	0.0013
POM	2.12E-04	lb/MMBtu	B	0.0022
Toluene	2.81E-04	lb/MMBtu	B	0.0029
Xylene	1.93E-04	lb/MMBtu	B	0.0020
TOTAL HAP				0.0175

NOTES:
A - Emission factor from Table 4 of the TTI report (see Inputs table).
B - Emission factors for large diesel engines obtained from Fifth Edition AP-42, Section 3.4 (10/96).
C - 40 CFR pt. 98 - Mandatory Greenhouse Gas
Reporting, Tables A-1, C-1, and C-2
D - CO2e conversion factor CO2x1, N2)x298, CH4x25

Transportation of waste to an expanded Covanta WTE for Vehicle Emissions is provided in Table 27. Given the insignificant increase and traffic volume along I-5 and that there would not be a measurable increase in ground level HAP concentrations it is not anticipated that there would be an impact on resident's health. The consumption of diesel fuel will be discussed in the comparative analysis between WTE and Generic Landfill.

Table 27. Assessment of Haulage Vehicle Emissions Effects for WTE.

Magnitude: what is the severity of the effect on human health?	
Low	The effect is minor and does not pose a hazard to health.
	Rationale: Although HAP emissions would increase along the I-5 corridor it is not anticipated that it would result in a measurable increase in ground level concentrations.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Not Applicable	
Frequency: how often is the effect expected to occur?	
Not Applicable	
Duration: what would be the duration of the effect, if it were to occur?	
Not Applicable	
	.
Overall Effect Characterization	
Neutral (=)	The increase in traffic volume will have a negligible impact on local air quality.
Likelihood: What is the probability of the impact occurring?	
Probable	The impact will likely occur, the probability is greater than 50%.
	There will be an increase in vehicle emissions along the I-5 corridor

The expansion of the WTE facility is likely to have a **'neutral effect'** on health for vehicle emissions. This was largely based on the fact that although emissions will increase they will be negligible in comparison to existing conditions. The likelihood of occurrence was deemed **'probable'** given that there would be an increase in vehicle emissions on I-5 over a 20-year period. Overall there is a low level of uncertainty in this assessment given that appropriate calculations were made for pollution estimates.

No mitigation measures or enhancement opportunities were identified.

6.1.10 Seismic Activity

A detailed investigation of seismic activity and how it could impact the proposed expansion of the Covanta WTE Facility is beyond the expertise of the authors and the scope of the HIA. Therefore, the health assessment provided in this section should be viewed at best as a qualitative interpretation of information provided.

Potential Impact on Health from Hauling of MSW

The potential for the expanded Covanta WTE Facility to impact health would depend on the magnitude of the earthquake and the extent of damage to the facility. It is anticipated that if a significant event would occur that it would be only one factor in risk to health as damage to other buildings and facilities would occur.

Vulnerable or Sensitive Populations

Those living in Brooks would be considered to be potentially vulnerable to any earthquake impact on the physical structure at the facility and could result in fire or other upset conditions.

6.1.10.1 Current Conditions

Oregon is, in general, an area that is susceptible to earthquakes from three sources:

1. shallow crustal events within the North American Plate;
2. deep intra-plate events within the subducting Juan de Fuca Plate; and,
3. the off-shore Cascadian Subduction Zone.

Brooks has been designated by FEMA as being in D Seismic Design category. This categorization indicates that there could be very strong shaking that would result in slight damage in specially designed structures and considerable damage in ordinary substantial buildings with partial collapse.

The US Geological Survey (USGS) provides a tool that allows for Earthquake Probability Mapping. A simulation was run for Brooks to determine the probability of a magnitude 6 and above earthquake occurring over the next 20 years (Figure 13). It was determined that there was approximately a 5% probability that such an event would occur.

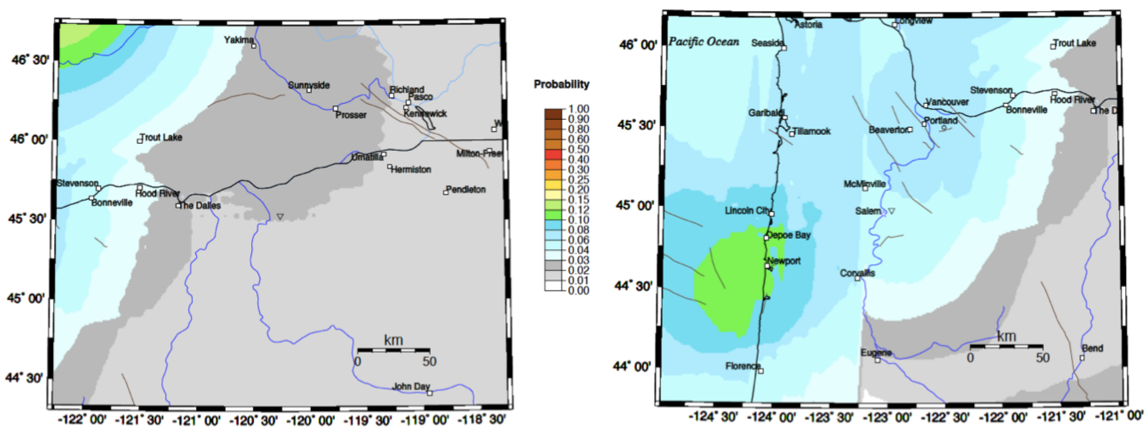


Figure 13. Earthquake Probability Map of a Magnitude 6.0 Occurring over next 20 year.

Through a similar simulation it was determined that there was a <1% probability of a magnitude 7 or above earthquake occurring over the next 20 years in the Brooks area. These are merely predictions of probability and do not preclude the event from occurring during the life of the project. In February 2017, the City Club of Portland reported "*According to leading Cascadia experts, the likelihood of the next big earthquake occurring sometime in the next 50 years is 14 to 20 percent.*" However, the energy released at the fault would dissipate as it travels 200 miles inland to Brooks. The report also stated "*Chris Goldfinger, a professor of geology and geophysics at Oregon State University, is a leading expert on the Cascadia Subduction Zone. He told your committee that the felt experience in the city would be similar to a 5.0 or 6.0 earthquake.*" (City Club, 2017). This is consistent with predictions made above.

The following are the definitions for magnitude of earthquake:

6.1 to 6.9	May cause a lot of damage in very populated areas
7.0 to 7.9	Major earthquake. Serious damage

The Marion County Natural Hazards Mitigation Plan (2011) Volume II Hazard Annex – Earthquakes provides relevant information on earthquake issues for the county. It was determined that the county's vulnerability to earthquakes is high, meaning that an earthquake would impact more than 10% of the population and the regional assets.

6.1.10.2 Project Impact

In the event that the proposed expansion of the Covanta WTE Facility was to be built it would be in an area that is vulnerable to seismic activity. In the event of a minor earthquake it is possible that there could be minor damage to the building. It is theorized that one area of potential risk would be to the cement lined garbage pit. If this was to occur it is possible that cracks in the foundation could lead to leachate from the pit to local groundwater.

In the event of a magnitude 6 or 7 earthquake it is possible that significant damage to the physical structure could occur. This could lead to building collapse or fire within the facility. However, it is noted that under such conditions it is likely that there would also be significant damage and issues in the surrounding community of Brooks. Regardless, the focus of the HIA is on the facility itself.

The assessment of potential health impact of a seismic event causing damage to the WTE facility was predicated on a relatively low potential for occurrence of a magnitude 6 or greater earthquake occurring in Brooks over the next 20 years (Table 28).

Table 28. Assessment of Seismic Activity Effects for WTE.

Magnitude: what is the severity of the effect on human health?	
High	The effect is severe and poses a major hazard to health; health status will change from baseline.
	Rationale: If a magnitude 6 or greater earthquake was to manifest in the area of Brooks significant damage to the WTE facility could occur.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Irreversible	The effect is not reversible (effect continues once exposure is removed) people are not likely to recover or adapt to the changes, even with additional support.
	Rationale: In the event of an earthquake it is possible that the outcome could include injury of workers or nearby residents.
Frequency: how often is the effect expected to occur?	
Not Applicable	
	Rationale:
Duration: what would be the duration of the effect, if it were to occur?	
Not Applicable	
	Rationale:
Overall Effect Characterization	
Major (---)	In the event of a major earthquake near the facility there is a potential to have a major negative effect on the health of the workers or nearby residents.
Likelihood: What is the probability of the impact occurring?	
Unlikely	The impact is anticipated to occur rarely, if ever. This classification is appropriate for those situations where impacts are not zero but they are limited to very rare occurrences, catastrophic events, or highly unlikely system failures.
	Rationale: Although the WTE facility is located in a high risk area for earthquakes probability assessment indicates a less than 5% magnitude 6 earthquake and <1% magnitude 7 earthquake occurring.

The assessment of WTE seismic activity determined that an expanded WTE facility could result in a **'major negative'** effect. This is because such an event could potentially lead injuries or death.

The likelihood of occurrence was deemed '**unlikely**' given the low probability of a significant magnitude earthquake occurring over the next 20 years. Overall there is a high level of uncertainty in this assessment given that a detailed earthquake analysis by experts was not within the scope of this HIA.

In terms of potential mitigation measures, Marion County has adopted the International Building Code that includes regulations that address seismic hazards. In addition, the Oregon State Building Code has six levels of design and engineering specifications that are applied to the expected degree of ground motion and site conditions that could be experienced during earthquakes. Although the code requires a site-specific hazard report for only critical facilities it could be considered for any expansion of the WTE facility.

6.1.11 Surface Water Quality

Another source of environmental emissions from the Covanta WTE Facility is that of water discharge. Water usage is significant at the facility and numerous permits govern emission limits and control its release.

Potential Impact on Health from Exposure to Impacted Surface Water

If WTE facility water contains elevated concentrations of chemicals in environmental discharge it could impact local waterway, fishing and water use.

Vulnerable or Sensitive Populations

In the event that the point of discharge of WTE facility water impairs local waterway it would be those who fish that would be most at risk.

6.1.11.1 Current Conditions

Water usage and disposal can be significant in a WTE facility. Used sanitary water from the facility is discharged to the local sanitary system. NPDES Waste Discharge Permit 101240 regulates the wastewater from the Covanta WTE Facility boiler blowdown, cooling tower blowdown and the demineralizer backwash. The Covanta WTE Facility discharges approximately 80,000 to 100,000 gallons of water per day. This water is first collected in a neutralization tank where pH is adjusted and then it is directed to the on-site sump. Daily monitoring at the sump is required for pH, flow, and residual chlorine. In addition, total suspended solids and total dissolved solids are monitored monthly.

The facility is permitted to discharge to the Willamette River (outfall number 001) via an approximately 7 mile long pipe. An example of the January 2015 results is provided in Figure 14. The results show the facility is operating with its allowable permit limits in terms of quantity/loading rates and its quality/concentration limits.

The Covanta WTE Facility has a storm water retention pond that is discharged under the NPDES Stormwater Discharge Permit 1200-z permit. Site stormwater is conveyed via onsite ditches to the stormwater retention pond. Approximately twice a year the pond is discharged to a roadside ditch (along the south side of Brooklake Road), which eventually discharges to Little Pudding River. The facility is required to test the stormwater prior to discharge and meets general and sector specific requirements under the NPDES Stormwater Discharge Permit 1200-z.

The Covanta WTE Facility had a NDPES 101240 wastewater inspection in 2015 and a NPDES 1200-z inspection in 2016. Both inspections were passed by the facility.

PERMITTEE NAME/ADDRESS (Include Facility Name/Location if Different)
NAME Covanta Marion, Inc.
ADDRESS 4850 Brooklake Rd. NE
Brooks, OR 97305

FACILITY LOCATION Brooks OR 97305

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

(2-16) 101240 PERMIT NUMBER | (17-19) 001 DISCHARGE NUMBER

MONITORING PERIOD
FROM YEAR 2015 MO 01 DAY 01 TO YEAR 2015 MO 01 DAY 31
(20-21) (22-23) (24-25) (26-27) (28-29) (30-31)

Form Approved.
OMB No. 2040-0004
Approval expires 05-31-98

☐ Check here if No Discharge

NOTE: Read Instructions before completing this form

PARAMETER (32-37)		(3 Card Only) QUANTITY OR LOADING (46-53) AVERAGE	(54-61) MAXIMUM	UNITS	(4 Card Only) QUALITY OR CONCENTRATION (38-45) MINIMUM	(46-53) AVERAGE	(54-61) MAXIMUM	UNITS	NO. EX (62-63)	FREQUENCY OF ANALYSIS (64-68)	SAMPLE TYPE (69-70)
Flow	SAMPLE MEASUREMENT	0.1049	0.1162	MGD						7/7	Total
	PERMIT REQUIREMENT	0.15	0.30								
pH	SAMPLE MEASUREMENT				6.7		8.0				Cont.
	PERMIT REQUIREMENT				6.0		9.0				
Temperature	SAMPLE MEASUREMENT							deg. F		7/7	Grab
	PERMIT REQUIREMENT				NMI	NMI	NMI				
Total Residual Chlorine	SAMPLE MEASUREMENT					0.25	0.31	mg/L		7/7	Grab
	PERMIT REQUIREMENT				N/A	0.4	0.6				
Total Suspended Solids	SAMPLE MEASUREMENT				1.0	1.0	1.0	mg/L		1/31	Grab
	PERMIT REQUIREMENT				N/A	N/A	N/A				
Total Dissolved Solids	SAMPLE MEASUREMENT				542	542	542	mg/L		1/31	Grab
	PERMIT REQUIREMENT				N/A	N/A	N/A				
	SAMPLE MEASUREMENT										
	PERMIT REQUIREMENT										

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER
Darby Randklev
Facility Manager
TYPED OR PRINTED

I CERTIFY UNDER PENALTY OF LAW THAT THIS DOCUMENT AND ALL ATTACHMENTS WERE PREPARED UNDER MY DIRECTION OR SUPERVISION IN ACCORDANCE WITH A SYSTEM DESIGNED TO ASSURE THAT QUALIFIED PERSONNEL PROPERLY GATHER AND EVALUATE THE INFORMATION SUBMITTED. BASED ON MY INQUIRY OF THE PERSON OR PERSONS WHO MANAGE THE SYSTEM, OR THOSE PERSONS DIRECTLY RESPONSIBLE FOR GATHERING THE INFORMATION, THE INFORMATION SUBMITTED IS, TO THE BEST OF MY KNOWLEDGE AND BELIEF, TRUE, ACCURATE, AND COMPLETE. I AM AWARE THAT THERE ARE SIGNIFICANT PENALTIES FOR SUBMITTING FALSE INFORMATION, INCLUDING THE POSSIBILITY OF FINE AND IMPRISONMENT FOR KNOWING VIOLATIONS.

SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE AREA CODE	NUMBER	DATE YEAR	MO	DAY
503	393-0890	2015	02	02

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

EPA Form 3320-1 (10-96) (REPLACES EPA FORM T-40 WHICH MAY NOT BE USED.) PAGE OF

Figure 14. Covanta WTE Facility National Pollution Discharge Elimination System – Discharge Monitoring Report, January 2015.

6.1.11.2 Project Impact

The doubling of the Covanta WTE Facility would result in an increase in water usage and wastewater discharge. Covanta would be required to file a change to their NPDES Waste Discharge Permit 101240 and abide by their NPDES 1200-z permit requirements. Any increase in water discharge and associated chlorine chemical release and temperature would have to undergo stringent state review by the Oregon DEQ. Therefore, it would not be anticipated to pose a risk to human health. An assessment of the potential of wastewater and stormwater discharge from expansion of the Covanta WTE Facility is provided in Table 29. Overall, the health impact assessment was conducted on assumption that there would not be a significant measurable change in surface water chemical concentrations from facility discharge.

Table 29. Assessment of WTE Waste Water Discharge Effect for WTE.

Magnitude: what is the severity of the effect on human health?	
Low	The effect is minor and does not pose a hazard to health; health status will not change from baseline.
	Rationale: Local water quality will not be impacted by chemical release of wastewater or stormwater discharge.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Not Applicable	
Frequency: how often is the effect expected to occur?	
Not Applicable	
Duration: what would be the duration of the effect, if it were to occur?	
Not Applicable	
Overall Effect Characterization	
Neutral	Surface water would not be measurably impacted by wastewater/stormwater chemical release from an expanded facility. Therefore, there would be no health impact.
Likelihood: What is the probability of the impact occurring?	
Probable	The neutral impact will likely occur, the probability is greater than 50%.
	The expansion will result in increased wastewater/stormwater discharge that will not impact waterways.

The assessment of WTE determined that diversion of 200,000 tpy of MSW to the expanded WTE facility would result in a **'neutral'** effect on surface water impact and human health.

The likelihood of occurrence was deemed '**probable**' given that increased water discharge will occur but not significantly impact the surface water. Overall there is a low level of uncertainty in this assessment given that it is supported by the requirement of state approval through permit applications.

No mitigation measures or enhancement opportunities were identified.

6.1.12 Discussion on Additional Environmental Considerations

Given that this is a Rapid HIA not all determinants of health could be assessed in detail. However, this is consistent with even detailed quantitative HIAs where the focus is on those determinants that could have the highest potential for negative/positive influences on health and public interest. In terms of scoping the following were assigned a low priority based on their potential for only minor negative impacts on health:

- Odor, groundwater quality, change in road structure, and virus/pathogen exposure

Each of these determinants of health is not anticipated to affect health of populations living around an expanded Covanta WTE Facility. A brief qualitative discussion of each is provided below.

6.1.12.1 Odor

In addition to the control of emissions from the combustion process, the Covanta WTE Facility must also control the potential for odors from the handling and storage of putrescible wastes. It reuses the air from the tipping floor and waste storage areas of the plant in the combustion process. This air is drawn through large louvers typically located above the waste storage areas and injected directly into the combustion process. The high temperatures associated with the combustion process are sufficient to destroy the odors before exiting the stack. Therefore, odor is not anticipated to be a potential health concern with expansion of the Covanta WTE Facility.

6.1.12.2 Groundwater Quality

WTE facilities do not have any impact on groundwater quality. There is no direct discharge from such facilities to groundwater. Although there is aerial deposition of pollutants onto surrounding soils they are negligible and do not result in a discernable increase in soil concentrations throughout the life of facilities. Therefore, there is no leaching of soil contaminants to underlying groundwater. The expansion of the Covanta WTE Facility is not anticipated to negatively chemically impact groundwater and thus it will not be a potential exposure pathway to impact human health. However, it is not known at this point how much additional groundwater would be required for extraction for the proposed expansion. This issue will need to be addressed during the permitting phase if the project was to move forward.

6.1.12.3 Change in Road Structure

It is not anticipated that construction activities or routine hauling of waste to the Covanta WTE Facility will change or alter road structure or integrity in the area. However, it is recommended that a road use plan be developed for construction that ensures the ongoing integrity of the roads in the vicinity of the facility.

6.1.12.4 Virus/Pathogen Exposure

The expansion of the Covanta WTE Facility would only involve shipping of Metro MSW. It is OEHM's understanding that Metro will not be seeking to ship medical waste to the expanded facility. The high furnace temperatures involved in waste treatment and APC measures eliminate any potential virus/pathogen release to the environment and it is not an environmental health concern.

6.2 Social and Economic Factors WTE

The HIA considers social and economic determinants that could influence one's overall health and well-being. These are factors that are not necessarily related to environmental conditions of operating a WTE facility. The baseline demographic and economic factors for Brooks were provided in Section 5.

Overall, demographic indicators show that Brooks does not appear to be especially vulnerable to negative health outcomes traditionally associated with poverty, low income, unemployment and low educational obtainment. That said there is a higher population of youth and those reporting to be of two or more races that necessitates their consideration in the HIA as potential vulnerable populations and equity considerations.

During the scoping exercise only Political Involvement was determined to be a Priority 1 for assessment. Employment, Working Conditions and Local Economic Growth were designed as Priority 2 determinants as were also assessed.

A number of other social and economic factors were identified as lesser priority given that they were unlikely to have a significant negative or positive effect on health.

6.2.1 Political Involvement

One indicator of a healthy community is a high degree of public participation in and control over the decisions affecting one's life, health, and well-being. Involvement in community organizations and the political process are ways that individuals exercise control over decisions that affect their lives (Kawachi et al., 1997).

Potential Impact on Health from Political Involvement

In the peer-reviewed literature on this subject, group membership and political participation are significantly associated with human health outcomes:

- An analysis of data from 40 diverse U.S. communities showed that people who were involved in electoral participation were 22% less likely to report poor/fair health (Kim et al., 2006).
- A study examining neighborhood environments in England and Scotland found that if political engagement was low, people had 52% higher odds of reporting poor health (Cummins et al., 2005).
- A higher level of civic engagement through ties to community groups was associated with increased recall of cardiovascular disease health-promoting messages in a longitudinal cohort from the Minnesota Heart Health Program (Viswanath, 2006).

Community and political engagement also increase people's self-efficacy, which is the perceived ability to affect change in one's life. In a report entitled 'Social Cohesion as an Aspect of the Quality of Societies' (Berger-Schmitt, 2000) identified "political activities and engagement" as an aspect of strengthening self-efficacy and the social capital of a society. A strong and integrated social capital was identified as a positive indicator of 'social cohesion'.

6.2.1.1 Current Condition

Metro Council is a nonpartisan elected body comprised of a president and six councilors. They are charged with developing long-range plans for the region that consists of 1.5 million people. Metro encompasses 24 cities in the Portland region and serves the urbanized areas of Clackamas, Multnomah, and Washington counties.

Metro plans and oversees the implementation of the solid waste management program for the region. After an aggressive recycling and diversion program the region currently produces more than one million tons of residual solid waste a year. Metro Council will decide how to best manage its MSW based on staff recommendations and input from the public.

In 2016, researchers at Portland State University conducted a study of voter turnout for Mayoral elections across the fifty largest US cities. Voter turnout in Portland (59.4%) was by far the highest participation rate across all cities. This suggests active voter participation in the Metro area.

However, election results in Marion County indicate that only 24.5% of eligible voters turned out for the May 2015 District Election. This suggests poor voter participation, and at this point it is not known the extent to which the citizens of Brooks (where the proposed expansion facility is located) have been notified or are aware of the proposed undertaking. It is unknown whether residents of Marion County or Brooks will be engaged to provide their input to the expansion of the Covanta WTE Facility.

6.2.1.2 Project Impact

The HIA is a supporting document that will be provided to Metro Council during its deliberation of whether or not to divert 200,000 tpy of MSW to an expanded Covanta WTE Facility. This process has garnered significant attention in the media and by number of community and interest groups. Given that the ultimate decision on how to manage the Metro MSW rests with the Metro Council it has been, and will continue to be, an open and transparent process.

In the early stages of this HIA Metro staff recognized that community involvement was a factor to its success. To that end a Stakeholder Engagement Workshop was held at the Metro office. A broad and diverse group of potentially interested and affected parties were invited to have input to the scope of the HIA (Section 4). This group was continually informed on the progress of the HIA and was invited to provide comment and feedback on the results prior to public release.

In addition, deliberations by Metro Council on this issue will be public and all community members will be afforded the opportunity to share their views on whether diversion of 200,000 tpy of waste to an expanded Covanta WTE Facility is in the public interest.

It is understood that any decision made by Metro Council to divert MSW to a facility in Marion County will include discussions with the elected officials of Marion County.

The assessment of Political Involvement on health in determining how to manage Metro MSW is provided in Table 30.

Table 30. Assessment of Political Involvement for WTE.

Magnitude: what is the severity of the effect on human health?	
Medium	The effect is detectable and poses a minor benefit to health
	Rationale: Given that the decision on how to manage Metro's waste rests with council and that public input is integral to the process it may have a positive impact on community health.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Reversible	The effect is reversible.
	Rationale: Long-term planning for management of solid waste requires decisions by the elected officials and then long-term contracts to be signed with WTE facility. However, any decision made by Metro Council could subsequently be changed or overturned by new vote.
Frequency: how often is the effect expected to occur?	
Medium	The effect may occur.
	Rationale: Metro Council will retain the right to decide on the approach to managing the residual solid waste.
Duration: what would be the duration of the effect, if it were to occur?	
Long-term	A long-term (chronic) effect, lasting from months to years.
	Rationale: The Metro Council decision will have long-term implications on how waste will be managed. It is expected that the expanded Covanta WTE Facility would require a contract between 20 to 30 years.
Overall Effect Characterization	
Minor (+)	Overall, the diversion of waste to the Covanta WTE Facility is the decision that will be reached by the elected Metro Council. The public and interest groups will have the ability to express their support or concerns for the proposal to council members.
Likelihood: What is the probability of the impact occurring?	
Probable	The impact will likely occur, the probability is greater than 50%.
	The Metro Council will be required to make a decision as to how manage Metro Region's residual waste.

Given that the decision on whether to divert 200,000 tpy of waste to an expanded Covanta WTE Facility will be made by Metro Council it could have a **'minor positive effect'** on health. However, this finding is in the context of Metro residents and did not include an evaluation of residents of Brooks or Marion County The likelihood of occurrence was deemed **'probable'** given that a decision will have to be made by Metro Council.

Overall there is a low level of uncertainty in this assessment given that it is known that Metro Council will be deciding on how to manage MSW. In addition, consultation with Marion County officials will be held.

However, at this time no formal notification of the potential undertaking has been given to the residents of Brooks. It is recommended that if the proposed expansion were to proceed that public notification and meetings of the potential expansion be held in the community of Brooks to ascertain what, if any, concerns they may have.

6.2.2 Employment

Employment is a complex indicator of health. Health status can increase with well-paid, secure employment with benefits. However, it can also have health challenges related to working conditions and metal health related to job stress and personal interactions in the workplace. Sohng (2015) explored these relationships within a health impact assessment framework (Figure 15).

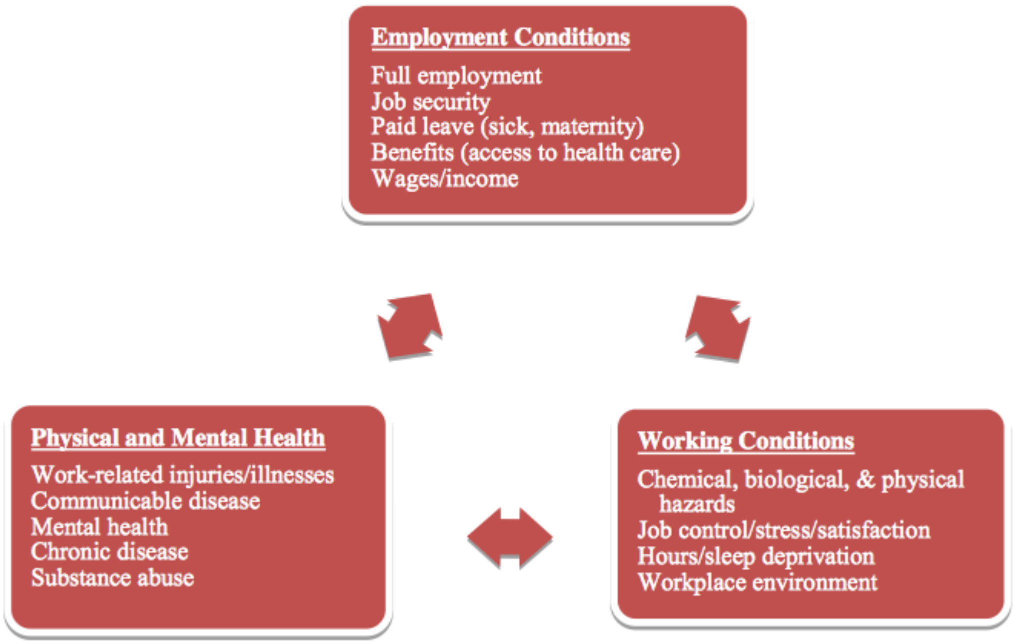


Figure 15. Relationship between working conditions, employment conditions and health (Sohng, 2015)

Working Conditions are covered in Section 6.2.3, while this assessment focuses on the economic factors of employment. This section is not a detailed employment study and should only be considered a high level relative comparison for the purposes of the HIA.

<u>Potential Impact on Health from Employment</u>

Employment in a secure, long-term, well-paid job with health benefits can lead to increase in social economic status and health care security. For those with families it has secondary benefits that extend to children, partners / spouses (Sohng, 2015).

<u>Vulnerable or Sensitive Populations</u>

Increased employment would benefit newly hired workers and their families.

6.2.2.1 Current Conditions

The Covanta WTE Facility currently employs 38 full-time skilled workers, excluding management staff. They are unionized jobs represented by Local 701 Operating Engineers. Covanta reported "*hourly employees at the facility have an average total annual compensation of approximately $90,000*".

6.2.2.2 Project Impact

Covanta has provided a preliminary estimate that the expansion would create an additional 10 direct permanent jobs, primarily in maintenance and operations support roles. It reported that the current annual compensation of such employees is approximately $90,000. This is a level that is almost $30,000 per year greater than the Marion County average. During construction Covanta estimates that there would be approximately 90 direct onsite construction jobs and 200 secondary jobs over a three-year period.

In addition, a haul contract for waste from Metro to the Covanta WTE Facility would be required. It is also suspected that there would be an increase in truck drivers required to be hired by Marion County for ash disposal.

Therefore, the HIA assessed the potential for increased employment for the expanded facility (Table 31).

Table 31. Assessment of Employment for WTE.

Magnitude: what is the severity of the effect on human health?	
Medium	The effect is detectable and poses a minor to moderate benefit to health
	Rationale: The addition of 10 permanent positions in Marion County will add to both individual prosperity and it is anticipated that it would also have a benefit to the community. In addition, there would be almost 300 construction jobs over a three-year period.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Irreversible	For positive effects, the improvement is permanent.
	Rationale: Covanta reported a high retention rate of staff. It is anticipated that the expansion of the facility would ensure continuous employment for at least a 20-year period.
Frequency: how often is the effect expected to occur?	
High	The effect occurs on a continuous basis.
	Rationale: There will be an addition of 10 permanent positions.
Duration: what would be the duration of the effect, if it were to occur?	
Long-term	A long-term (chronic) effect, lasting from months to years.
	Rationale: It is expected that the expanded Covanta WTE Facility would be operational for at least 20 years.
Overall Effect Characterization	
Major (+++)	Overall, the creation of 10 permanent positions, paying approximately $90,000 per year and health benefits would lead to direct health benefits to these employees and their families. They are likely to reside in Marion County.
Likelihood: What is the probability of the impact occurring?	
Probable	The impact will likely occur, the probability is greater than 50%.
	If the expansion was to occur the permanent positions and construction jobs would be required.

The expansion of the Covanta WTE Facility would create employment and could have a **'major positive effect'** on health in Marion County for newly hired employees and construction workers. The likelihood of occurrence was deemed **'probable'** given that if the expansion were to occur then additional full-time and construction jobs would be needed.

Overall there is a medium level of uncertainty in this assessment given that it was not a detailed employment and construction assessment and only based on preliminary estimates.

Covanta has indicated, "At the appropriate time, Covanta will commission a study that will further localize the economic impact of the Marion County facility expansion." This undertaking should include an assessment of employment and the direct benefit to workers and the local economy. In addition, Covanta should consider if there would be an opportunity for local employment of Brooks and surrounding community members. They will of course have to abide by the Oregon Fair Employment Practices Act that protects against discrimination.

6.2.3 Working Conditions

This section provides an overview of the safety record at the Covanta WTE Facility. Issues surrounding working conditions for truck drivers and other secondary employment were not considered in this HIA.

Potential Impact on Health of Working Conditions

Working conditions and especially those related to health and safety has a significant impact on expected health outcomes of employees.

Vulnerable or Sensitive Populations

The workers at the existing Covanta WTE Facility and those that would be employed after expansion are considered the vulnerable population for working conditions.

6.2.3.1 Current Conditions

In 2005, the Covanta WTE Facility began participating in the Occupational Safety and Health Administration's (OSHA) Safety and Health Achievement Recognition Program (SHARP). The purpose of the program is to recognize exemplary injury and illness prevention programs (US Department of Labor, 2017).

In addition, since 2008 the Covanta WTE Facility has participated in the Oregon Department of Consumer and Business Services, OSHA Voluntary Protection Program (VPP). The VPP program has been put in place to recognize workplaces with excellent safety and health management systems and promotes these employers as model workplaces. The VPP program does not replace legal requirements under Oregon OSHA; rather it requires participants to go above and beyond these requirements.

The Covanta WTE Facility reached VPP STAR status in 2008. This is the highest level of status that can be obtained under the program. STAR status is designated for exemplary worksites (Oregon OSHA):

- Implemented comprehensive, successful safety and health management systems; and,
- Achieved injury/illness rates below their industry's national average.

Covanta provided HDR with their VPP record from 2013-2015 (Figure 16). Its three-year average Total Case Injury Rate for Injuries and Illness (TCIR) was 2.73, which was 20% lower than the national average. Their three-year average Days Away from Work, Restricted Work Activity, and/or Job Transfer Rate (DART) of 0.92 was 50% lower than the national average (Figure 16).

Therefore, based on its safety record and the recognition of STAR status in the Oregon OSHA VPP program, working conditions form a physical health and safety standpoint appear to be excellent.

Although statistics were not provided, during discussions with Covanta (pers comm. M. Marler) during the site visit in November 2016, he indicated that the facility has a very low turnover rate of employees and has a preference to promote employees from within when possible. This is an indicator of satisfaction with working conditions and the work environment.

Table B-1
VPP Participant's Recordable Non-Fatal Injury and Illness Case Incidence Rates

1	2	3	4	5	6	7
Year	Total Number Employees	Total Work Hours	Total Number of Injuries & Illnesses	Total Case Incidence Rate for Injuries and Illnesses (TCIR)	Total Number of Injury & Illness Cases Involving Days Away from Work, Restricted Work Activity, and/or Job Transfer	Days Away from Work, Restricted Work Activity, and/or Job Transfer Rate (DART Rate)
2013	39	72,208	2	5.54	1	2.77
2014	37	73,476	0	0	0	0
2015	37	75563	1	2.65	0	0
3 Year Rate				2.73	0.33	0.92
Most recent published BLS rate for NAICS code __562213_______				3.4		1.8
Percent above or below National Average				80%		51%
Participant's 3-Year TCIR and DART rate				2.73		0.92

Figure 16. Marion County WTE facility VPP Record 2013-2015

6.2.3.2 Project Impact

Based on Covanta's participation in the Oregon OSHA VPP program it is assumed that the new employees will receive necessary health and safety training for the positions to be filled. It is also assumed that the employees would have good job satisfaction and remain employed for several years based on current trends at the facility. Table 32 provides an assessment of working conditions on health.

Table 32. Assessment of Working Conditions for WTE.

Magnitude: what is the severity of the effect on human health?	
Medium	The effect is detectable and poses a minor to moderate benefit to health
	Rationale: The attainment of STAR status in the Oregon OSHA VPP program and long-term retention of employees suggests good working conditions.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Irreversible	For positive effects, the improvement is permanent.
	Rationale: It is assumed that Covanta will continue their efforts in the VPP program.
Frequency: how often is the effect expected to occur?	
High	The effect occurs on a continuous basis.
	Rationale: It is assumed that Covanta will continue their efforts in the VPP program.
Duration: what would be the duration of the effect, if it were to occur?	
Long-term	A long-term (chronic) effect, lasting from months to years.
	Rationale: It is assumed that Covanta will continue its efforts in the VPP program, continued employee retention efforts and promotion of employees from within where possible.
Overall Effect Characterization	
Major (+++)	Overall, the Marion County WTE facility appears to be a safe and good place to work. It is assumed that new employees would continue to be treated to the same working conditions as existing employees.
Likelihood: What is the probability of the impact occurring?	
Probable	The impact will likely occur, the probability is greater than 50%.
	If the expansion were to occur the permanent positions and construction jobs would be required.

The expansion of the Marion County WTE facility would allow new employees to join a facility that has a proven health and safety track record and appears to be a good work environment and could have a **'major positive effect'** on health. The likelihood of occurrence was deemed **'probable'** given that if the expansion was to occur then it was assumed that the facility would continue to promote the health, safety and welfare of its employees.

Overall there is a medium level of uncertainty in this assessment given that it was not a detailed assessment of workplace conditions and no actual survey of employees was conducted.

No additional mitigation or enhancement measures are proposed.

6.2.4 Local and Regional Economic Growth

Covanta reported to HDR that the Marion County currently receives between $2,000,000 and $4,000,000 in direct contributions annually from the Covanta WTE Facility. Direct contributions include revenue sharing, property and payroll taxes, and community contributions.

Covanta estimates that the project would generate $440 million in economic activity during construction – the majority of which will be spent in the United States. Should the proposed expansion moves forward, Covanta has committed to complete a more detailed economic impact study as part of its project development process.

It would be premature and inappropriate at this stage to speculate on how procurement between Metro and Covanta would be negotiated. It is also not known how such an agreement would include Marion County.

Therefore, at a high level it is assumed that if the existing Covanta WTE Facility was to be expanded to double the annual throughput of MSW that there would be an overall economic benefit to Marion County, without assigning a dollar figure. It is also not known what, if any, direct or indirect economic benefit the residents of Brooks would realize. Furthermore, it is well beyond the scope of this HIA to speculate on how diversion of 200,000 tpy of Metro MSW to WTE would economically impact, if at all, Metro residents.

Therefore, OEHM could not use the assessment matrix at this point in evaluating the potential impact that regional or local economic growth could have on health. It is recommended that a formal economic evaluation report be conducted at the appropriate time in the process to better understand the potential benefits.

6.2.5 Discussion on Additional Social and Economic Determinants

Given that this is a Rapid HIA, not all social and economic determinants of health could be assessed in detail. However, this is consistent with even detailed quantitative HIAs where the focus is to be on those determinants that could have the highest potential for negative or positive influences on health and public interest. In terms of scoping the following were assigned a lower priority based on their potential for only minor negative impacts on health:

- Public Safety/Perception of Public Safety, Property Values, and Childhood Development (stimulating/enriching environment)

Each of these determinants of health is not anticipated to affect the health of populations living around WTE facilities. A brief qualitative discussion of each is provided below.

6.2.5.1 Public safety / Perception of Public Safety

The issues surrounding public safety were largely dealt with in the environmental factors that can influence health. In some instances when a new WTE facility is being sited there can be concern expressed from local residents about their safety. It is possible that given that the existing facility has been in Brooks for 30 years that such concerns may not exist. That said this could be determined during future public consultation in Brooks.

6.2.5.2 Property Values

New build WTE facility may raise concerns by some residents that their property values could be affected. In 2014, Phillips et al. investigated the effect of three WTE facilities on property values in the United Kingdom. They reported:

> *"In all cases analysed no significant negative effect was observed on property prices at any distance within 5 km from a modern operational incinerator. This indicated that the perceived negative effect of the thermal processing of waste on local property values is negligible."*

The current homeownership rate in Brooks is 81% of residences. If residents of Brooks do express such a concern then it could be further investigated by a property value and sale review.

6.2.5.3 Childhood development (stimulating/enriching environment)

The expansion of the Covanta WTE Facility would not directly positively influence the health of children or childhood development from a social determinant aspect. However, in the event that part of the County's revenue is provided to the local school district it could result in enhancement of school funding and educational opportunities.

6.2.6 Access to Services

Only two Access to Services factors were scoped as a low priority in the HIA. This is because they were unlikely to have a significant impact on health. They were access to childcare/daycare and access to education. It is not believed that the proposed expansion of the Covanta WTE Facility would impact or enhance access to those services. Therefore, there would be a neutral impact on these social determinants of health.

6.3 Biological and Additional Equity Factors

Age was identified as a biological factor to be considered in the HIA. However, there is no direct impact of the proposed project on age. Rather, age was considered as a factor in the vulnerable or sensitive population assessment in each of the determinants of health that were assessed.

Socio-economic status (SES) was again considered as a potential vulnerable population in each of the other determinants of health.

Ethnicity and Race were also scoped into the assessment during the Stakeholder Workshop. Ethnicity and race were not determined to lead to a particular sensitivity or vulnerability in the Environmental Factors. Hiring practices for construction or full-time employment at the expanded WTE facility would be subject to the Oregon Fair Employment Practice Act that protects against discrimination. A Stakeholder Workshop participant encouraged Metro staff to consider how contracts or ancillary services, such as the truck waste hauling contracts, could benefit communities of color. These discussions are beyond the scope of the HIA but stakeholder groups are encouraged to work with Metro staff if the proposed expansion was to move forward to share their ideas and thoughts about participation of racial minorities, both within Metro and Marion County.

6.4 Mitigation and Enhancement Recommendations

Table 33 provides a summary of potential mitigation measures and enhancement recommendations that could be considered if the expansion of the Covanta WTE was to proceed. Additional measures would be likely during the permit phase of the project through discussion with the responsible state agencies.

Table 33. Summary of Mitigation and Enhancement Recommendations

Air Quality
In the event Metro elects to commit the 200,000 tons per year of MSW resulting in the facility expansion, it is recommended that the BACT analysis and a dispersion modeling demonstration of compliance with the NAAQS and PSD increment consumption limits for all criteria air pollutants for which PSD is triggered be conducted. This would serve to confirm the assumptions in this assessment and is anticipated to be required as part of the regulatory process. Additional studies Metro may wish to consider include: a. Baseline Ambient Air Quality Monitoring in Brooks. There was no site-specific ambient air quality monitoring data available in the vicinity of the existing Covanta WTE Facility. To ascertain the actual existing ambient concentration of chemicals in the airshed a detailed pre-construction baseline air monitoring program could be undertaken for a one year period. Consideration should be given to collecting a broad suite of chemicals beyond those that are merely envisioned for regulated stack emissions standards. A monitoring plan should be developed that would conform with EPA and DEQ requirements. Such a program would likely require 18 months to design, implement and report. b. Detailed Air Quality Dispersion Modeling – Metro could consider requiring a more detailed air quality dispersion modelling than may be required under the routine permitting requirements. This would involve inclusion of a broader list of chemicals of concern (50 plus) than only those that have stack emission permitted levels. The modeling plan should be developed in accordance to EPA and DEQ requirement and would likely involve the use of the more sophisticated CALPUFF dispersion model. Stack emissions data would include proposed regulatory emissions limits and use of chemical stack test data for the additional chemicals from a similar designed facility. It could include specific requirements for modeling Start-up and Shut-down conditions, where chemical release could be higher than during normal operating conditions. The modeling domain would include the point of maximum modeled ground level concentrations and isopleths (predicted concentrations) of chemicals further from the facility. The resulting ground level concentrations would be compared to existing ambient air quality objectives and deposition rates of chemicals to the soil would also be provided as input to the human health risk assessment. c. Human Health Risk Assessment (HHRA) – in some jurisdictions an expansion of a WTE facility has required the conduct of a detailed quantitative multiple pathway (including biomagnification into food and water) HHRA to be undertaken. This would involve input from the baseline ambient air quality program and the detailed air quality dispersion modeling of the broader list of chemicals selected for analysis. Such an undertaking would use the most up-to-date toxicity reference values for both inhalation and oral exposure. For example, any new information published from Clean Air Oregon initiative would be considered. It will evaluate the risk to the local population of the baseline ambient air quality, the expanded Covanta WTE Facility emissions alone, and then a cumulative effects analysis on how expansion of the facility would impact health in combination with existing conditions. Exposures would result in risk quantification benchmarked on hazard quotients (non-cancer chemicals) and incremental lifetime cancer risk (ILCR) (e.g. probability of 1 additional cancer case in a population of 100,000 or 1,000,000 people). The results could be used to ascertain if regulatory stack emissions are sufficient to protect health or if more stringent standards should be used to regulate the proposed expanded facility. It would include Start-up and Shut-down conditions. A focus on health equity for sensitive sub-populations, the elderly, children, those with pre-existing conditions would be undertaken. This assessment would provide additional details on the expanded list of chemicals that would be released from the facility to ensure that they would not impact the people of Brooks.

d. Best Practices for Monitoring - although the AQ/HHRA reports would have to demonstrate no appreciable risk to people from exposure to chemical emissions from the expanded facility, a review of international best practices on facility monitoring can be completed. This would involve review of engineering practices for stack monitoring/sampling, and the need for ground-level monitoring of air, water, and soil. This could guide the monitoring program for an expanded Covanta WTE Facility.
Greenhouse Gas (GHG) Emissions
It is recommended that further discussions between the interested parties be undertaken in the future in an attempt to reach consensus on the best approach for determining GHG impacts.
WTE Ash
Over the past decade there has been considerable investment and investigation into additional beneficial reuses of WTE ash. The two main areas of research and demonstration projects appear to be used as aggregate and in the production of cement. Covanta is encouraged to pursue ongoing research in these areas of beneficial reuse of ash in Oregon.
Energy Production
In addition to electricity production, the steam produced in the process can be used as a co-generated source of district heating. Covanta should be encouraged to explore options to expand district heating to either nearby business or the town of Brooks.
Accidents and Malfunctions
It is recommended that if the Marion County WTE facility is to be expanded that an emergency response plan be developed, or revised if one already exists, that details fire action plans and potential for other industrial releases.
Political Involvement
Public notification and public meetings should be held in the community of Brooks to ascertain what, if any, concerns they may have.
Employment
Covanta has indicated that "At the appropriate time, Covanta will commission a study that will further localize the economic impact of the Marion County facility expansion". This undertaking should include an assessment of employment and the direct benefit to workers and the local economy.
Local and Regional Economic Growth
It is recommended that a formal socio-economic evaluation report be conducted at the appropriate time in the process to better understand the impact.
Health Equity and Social Environmental Justice
Health equity and social environmental justice were considered at a high level in this HIA. A more focused study could be completed if the proposed expansion of a WTE facility was to be undertaken. This would benefit from broader stakeholder survey (e.g., community of Brooks) and incorporate inputs from the formal socio-economic evaluation.

6.5 Summary of WTE HIA Findings

Ten environmental and three social and economic health determinants were determined to be of priority in the scoping exercise and were evaluated using a health assessment matrix framework (Table 34). Although discussion was provided on the potential for Regional/Local Economic Growth it was determined that not enough information was available to provide a detailed assessment on the potential health impact. Additionally, four environmental and three social economic determinants of health were discussed qualitatively.

Table 34. Summary of Assessment of Determinants of Health for WTE.

Health Determinant	Health Impact	Probability	Significance	Uncertainty
Environmental Factors				
Air Quality	Neutral (=)	Probable	Not Significant (=)	Low
Greenhouse Gas	Neutral (=)	Possible	Not Significant (=)	High
WTE Ash	Neutral (=)	Probable	Not Significant (=)	Low
Energy Production	Moderate (++)	Probable	Significant (++)	Low
Accident and Malfunction	Major (---)	Unlikely	Significant (--)	High
Soil	Neutral (=)	Probable	Not Significant (=)	Low
Traffic Volume and Safety	Minor (-)	Probable	Not Significant (=)	Low
Vehicle Emissions	Neutral (=)	Probable	Not Significant (=)	Low
Seismic Activity	Major (---)	Unlikely	Significant (--)	High
Surface Water	Neutral (=)	Probable	Not Significant (=)	Low
Social and Economic Factors				
Political	Minor (+)	Probable	Significant (+)	Low
Employment	Major (+++)	Probable	Significant (+++)	Medium
Working Conditions	Major (+++)	Probable	Significant (+++)	Medium
Local/Regional Economic Growth	Not scored			High

Each determinant was assigned a health impact and probability of occurrence, which combine to provide a determination of significance. In addition, the uncertainty of each determination was provided. All of these rankings need to be considered when making an overall conclusion on potential health impact. The following were the results of the significance findings of thirteen determinants of health assessed:

Positive — Energy Production (++), Political Involvement (+), Employment (+++) and Working Conditions (+++)

Neutral — Air Quality (=), Greenhouse Gases (=), WTE Ash (=), Soil (=), Traffic Volume and Safety (=), Vehicle Emissions (=), and Surface Water (=)

Negative — Accidents and Malfunctions (--), and Seismic Activity (--)

No weighting of the importance of one determinant of health over another was conducted as part of the HIA. However, the probability of occurrence was used to provide an overall significance of each health determinant.

For Accidents and Malfunctions and Seismic Activity, if they were to occur then there is a significant potential for health impact. However, the probability of these occurrences was deemed to be unlikely. Greenhouse gas production was seen to increase if MSW was to be disposed of at an expanded WTE facility. All of these potential negative health outcomes will be compared to those predicted for the Generic Landfill. These negative health consequences need to be weighed by decision makers as to their acceptability for the undertaking.

Similarly, the potential positive health impacts need to be considered in context and weighed against the potential negative impacts. Positive impacts of the potential undertaking included both Environmental and Social Economic Factors. The positive impacts of the project were seen at the local (Political Involvement, Employment and Working Conditions) and regional (Energy Production) level.

7 Assessment of Landfill Option

A Generic Landfill option located 150 miles from Portland was developed (Section 1.1) to evaluate the potential health impacts or benefits for this MSW disposal option. Given it is a Generic Landfill, local demographics and site-specific vulnerable or sensitive populations could not be developed. Therefore, throughout the assessment of the Generic Landfill professional judgment and experience were used to discuss generic vulnerable populations that could be living in proximity to the landfills.

In addition, there are sections and information that overlap with the assessment of the WTE option. In these instances reference to the pertinent section in the WTE assessment is made and not all of the information is repeated in this section of the report.

7.1 Environmental Factor Assessment

Environmental emissions and their potential impact on health are a significant consideration in the disposal of waste in landfill. Similar to WTE, historic practice of landfill disposal of waste involved considerable release of contaminants to the environment. However, changes in state and federal regulations for permitting and design of modern landfills have resulted in significant pollution reduction to the environment. Likewise, there has been a significant amount of monitoring and reporting of releases from such facilities in recent years, which is codified in their operating permit requirements.

However, landfills are not without potential environmental releases that could be of concern to health outcomes. This section provides an assessment of how environmental factors could potentially influence health. The intention of this HIA was not to conduct site-specific detailed chemical emissions and modeling for potential health impacts to surrounding communities. Rather assessment is done using available information and scientific knowledge of operating landfills reported in the literature. This should not be construed as replacing the need for detailed permitting activities through the DEQ that seek to ensure the protection of health.

During the scoping exercise four Priority 1 determinants were identified for assessment:

> Air Quality, Greenhouse Gas Emissions, and Accidents and Malfunctions

In addition, Electricity Production is included in the assessment.

Second priority was to be afforded to:

> Soil Quality, Traffic Volume and Safety, Vehicle Emissions, Ground Water Quality, and Seismic Events

A number of other environmental factors were identified as lessor priority given that they were unlikely to have a significant negative or positive effect on health. Their potential impact is discussed briefly in the text.

7.1.1 Air Quality

Local air quality surrounding landfills can be impacted landfill gas, emissions from landfill gas to energy (LFGTE) production and vehicle emissions used to manage the on-site waste. This assessment did not include vehicle emissions for the Generic Landfill.

No air quality modeling exercise was undertaken to analyze the potential ground level point of impingement levels that could be expected from the Generic Landfill. A review of permit requirements for the Generic Landfill is provided to understand how health may be impacted. Vehicle emissions associated with waste hauling are assessed in Section 7.1.6.

Potential Impact on Health of Airborne Emissions

Undue exposure to elevated concentrations of criteria air pollutants and hazardous air pollutants can result in a wide range of both short-term (acute) health impacts and long-term (chronic) health impacts. Although there are numerous chemicals that are emitted from landfills, regulatory authorities, including the USEPA and the DEQ, have prioritized a number of surrogate chemicals for monitoring. The levels set for emission of these chemicals and resulting ground level concentrations are benchmarked against air quality standards.

Vulnerable or Sensitive Population

Both children (<20 years) and the elderly (>65 years) are considered at-risk populations for exposure to airborne contaminants. Those with preexisting chronic conditions such as asthma, cardiovascular disease and COPD are also at-risk populations. The vulnerable population would be these individuals living in close proximity to the Generic Landfill.

7.1.1.1 Baseline Air Quality

The Air Quality Team conducted a search to determine if there was air monitoring stations located in the general vicinity of the Generic Landfill. However, similar to the WTE scenario the only reliable ambient air quality monitoring data available was from Portland. Therefore, the analysis of baseline air quality provided in Section 6.1.1.1 is applicable to the Generic Landfill option.

Overall, the concentration of the criteria air pollutants and HAPs are likely below ambient air quality standards in the around surrounding the Generic Landfill. It is recognized that this finding is limited by the fact that there are not air quality stations located in the immediate vicinity the Generic Landfill and instead the majority of data was taken from Portland air quality stations. However, the general area of the Generic Landfill is in an area that has been designed Attainment under NAAQs.

7.1.1.2 Generic Landfill Assessment

The Generic Landfill is located in an area that is designated as attainment for all National Ambient Air Quality Standards (NAAQS). Emissions from the landfill gas collection and control systems (GCCS) and LFGTE production are regulated by the rule required by 40 CFR Part 60, Subpart Cf that requires landfill emissions monitoring and reporting requirements and is overseen by Oregon DEQ.

They include monthly wellhead monitoring for gas concentrations (oxygen/nitrogen), gas temperature, and wellhead pressure. In addition, quarterly surface emissions monitoring for fugitive landfill gas emissions is required. If surface emissions exceed 500 parts per million (ppm) above background concentrations then remediation or re-monitoring efforts are required to maintain compliance.

Emissions for the Generic Landfill were estimated using the USEPA LandGEM model, and use the following assumptions:

- 200,000 tpy of MSW is placed in the landfill for each of twenty years.
- The landfill is equipped with a gas collection system that captures 75% of the generated gas.
- The captured gas is routed to state of the art reciprocating engines that meet applicable emission limits and destroy 98% of the organic portion of the landfill gas.
- The landfill is not on fire and has not received significant amounts of industrial solid waste high in benzene and toluene content.

The landfill gas emissions will vary over time as the waste degrades in the landfill. To conservatively represent landfill emissions, the year of highest landfill gas production (which occurs in the year following the last year of waste placement) was used.

These estimates are provided to put into perspective that 200,000 tpy of MSW in a landfill does result in atmospheric emissions (Table 35).

Table 35. Maximum Expected Emissions from Landfill of 200,000 tpy MSW

	Total Pollutant Generated	***Engine Emissions***		***Uncollected Emissions***	
	column 1	*column 2*	*column 3*	*column 4*	*column 5*
Pollutant	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
Methane	7,598	26.0	114	434	1899
Carbon Dioxide	20,847	3570	15635	1190	5212
1,1,1-Trichloroethane (methyl chloroform) - HAP	0.061	2.08E-04	9.10E-04	0.0035	0.0152
1,1,2,2-Tetrachloroethane - HAP/VOC	0.175	5.99E-04	2.62E-03	0.0100	0.0437
1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	0.225	7.71E-04	3.38E-03	0.0128	0.0563
1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.018	6.29E-05	2.76E-04	0.0010	0.0046
1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.038	1.32E-04	5.77E-04	0.0022	0.0096
1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.019	6.60E-05	2.89E-04	0.0011	0.0048
2-Propanol (isopropyl alcohol) - VOC	2.847	9.75E-03	4.27E-02	0.1625	0.7118
Acetone	0.385	1.32E-03	5.78E-03	0.0220	0.0963
Acrylonitrile - HAP/VOC	0.317	1.08E-03	4.75E-03	0.0181	0.0792
Benzene - No or Unknown Co-disposal - HAP/VOC	0.141	4.81E-04	2.11E-03	0.0080	0.0351
Bromodichloromethane - VOC	0.481	1.65E-03	7.22E-03	0.0275	0.1203
Butane - VOC	0.275	9.43E-04	4.13E-03	0.0157	0.0688
Carbon disulfide - HAP/VOC	0.042	1.43E-04	6.27E-04	0.0024	0.0105
Carbon tetrachloride - HAP/VOC	0.001	2.00E-06	8.74E-06	0.0000	0.0001
Carbonyl sulfide - HAP/VOC	0.028	9.55E-05	4.18E-04	0.0016	0.0070
Chlorobenzene - HAP/VOC	0.027	9.13E-05	4.00E-04	0.0015	0.0067
Chlorodifluoromethane	0.106	3.65E-04	1.60E-03	0.0061	0.0266
Chloroethane (ethyl chloride) - HAP/VOC	0.079	2.72E-04	1.19E-03	0.0045	0.0199
Chloroform - HAP/VOC	0.003	1.16E-05	5.09E-05	0.0002	0.0008
Chloromethane - VOC	0.057	1.97E-04	8.61E-04	0.0033	0.0143
Dichlorobenzene - (HAP for para isomer/VOC)	0.029	1.00E-04	4.39E-04	0.0017	0.0073
Dichlorodifluoromethane	1.833	6.28E-03	2.75E-02	0.1046	0.4582
Dichlorofluoromethane - VOC	0.254	8.68E-04	3.80E-03	0.0145	0.0634
Dichloromethane (methylene chloride) - HAP	1.127	3.86E-03	1.69E-02	0.0643	0.2816
Dimethyl sulfide (methyl sulfide) - VOC	0.459	1.57E-03	6.89E-03	0.0262	0.1148
Ethane	25.354	8.68E-02	3.80E-01	1.4471	6.3384
Ethanol - VOC	1.179	4.04E-03	1.77E-02	0.0673	0.2947
Ethyl mercaptan (ethanethiol) - VOC	0.135	4.64E-04	2.03E-03	0.0077	0.0338
Ethylbenzene - HAP/VOC	0.463	1.58E-03	6.94E-03	0.0264	0.1157
Ethylene dibromide - HAP/VOC	0.000	6.10E-07	2.67E-06	1.02E-05	4.45E-05
Fluorotrichloromethane - VOC	0.099	3.39E-04	1.48E-03	0.0056	0.0247
Hexane - HAP/VOC	0.539	1.85E-03	8.08E-03	0.0308	0.1347
Hydrogen sulfide	1.162	3.98E-03	1.74E-02	0.0663	0.2906
Mercury (total) - HAP	5.51E-05	9.44E-06	4.13E-05	3.15E-06	1.38E-05
Methyl ethyl ketone - HAP/VOC	0.485	1.66E-03	7.28E-03	0.0277	0.1213
Methyl isobutyl ketone - HAP/VOC	0.180	6.17E-04	2.70E-03	0.0103	0.0451
Methyl mercaptan - VOC	0.114	3.90E-04	1.71E-03	0.0065	0.0285
Pentane - VOC	0.226	7.72E-04	3.38E-03	0.0129	0.0564
Perchloroethylene (tetrachloroethylene) - HAP	0.581	1.99E-03	8.72E-03	0.0332	0.1453
Propane - VOC	0.459	1.57E-03	6.89E-03	0.0262	0.1149
t-1,2-Dichloroethene - VOC	0.257	8.81E-04	3.86E-03	0.0147	0.0643
Toluene - No or Unknown Co-disposal - HAP/VOC	3.404	1.17E-02	5.11E-02	0.1943	0.8510
Trichloroethylene (trichloroethene) - HAP/VOC	0.349	1.19E-03	5.23E-03	0.0199	0.0871
Vinyl chloride - HAP/VOC	0.432	1.48E-03	6.48E-03	0.0247	0.1081
Xylenes - HAP/VOC	1.207	4.13E-03	1.81E-02	0.0689	0.3017
$PM/PM_{10}/PM_{2.5}$ see note 1		1.50	6.58		
NO_x see note 2		9.85	43.1		
SO_2 see note 3		0.44	1.91		
Carbon Monoxide see note 4		24.6	108		
Hydrogen Chloride see note 5		0.22	0.98		

Pollutant Notes

1. $PM/PM_{10}/PM_{2.5}$ Calculation
Per Table 2.4.5 of AP-42 (1998), the emission factor for an engine is 48 lb/10^6 dscf methane.
2. NO_x Calculation
Based on 40 CFR Part 60, Subpart JJJJ limit of 2.0 g/HP-hr.
3. SO_2 Calculation
Per method described in section 2.4.4.2 of AP-42 (1998), using default reduced sulfur compounds concentration of 46.9 ppm.
4. CO Calculation
Based on 40 CFR Part 60, Subpart JJJJ limit of 5.0 g/HP-hr.
5. Hydrogen Chloride Calculation
Per method described in section 2.4.4.2 of AP-42 (1998), using default chlorine compounds concentration of 42.0 ppm.
6. CO_2e Calculation
Calculated using the global warming potentials from 40 CFR Part 98, Table A-1, reflecting the update effective January 1, 2014.
7. LFG Combustion CO_2 Calculation
Calculated using the default emission factor from 40 CFR Part 98, Table C-1, reflecting the update effective January 1, 2014.
8. LFG Combustion N_2O Calculation
Calculated using the default emission factor from 40 CFR Part 98, Table C-2, reflecting the update effective January 1, 2014.
9. General
Landfill assumed to not be on fire, so landfill emissions of carbon monoxide not included.
Landfill assumed to not co-dispose of industrial waste, so the "No or Unknown Co-disposal" values were used for benzene and toluene.

Column Notes (except as noted above)
Column 1 Values from LandGEM v302.
Columns 2 and 3 Collection efficiency assumed to be 75% and engine destruction efficiency of all compounds (except mercury) assumed to be 98%.
Columns 4 and 5 25% of the total landfill gas generated is assumed to be emitted as fugitive (i.e., not collected).

Although modern landfills do have airborne emissions of criteria air pollutants and HAPs they are under stringent emission limits and permitted guidelines. The Generic Landfill also includes consideration of a significant buffer of land between the landfill and local residents. It is beyond the scope of the Rapid HIA to evaluate whether the Generic Landfill emissions pose a site-specific health risk.

In 2013, RMIT University conducted an "Air Emissions from Non-Hazardous Waste Landfills – a literature review" for the Australian Victorian EPA (RMIT, 2013). The review examined the international scientific literature related to measured concentration of airborne chemicals in the vicinity of landfills and epidemiological studies on potential health conditions for residents living near non-hazardous landfills. The study concluded:

> *From the epidemiological studies, there are reports of an association between proximity to non-hazardous waste landfill and increased reports of headaches and nausea; however, these are generally from facilities with known odour issues. While there have been earlier reports of adverse outcomes from uncontrolled hazardous waste sites, there*

is no indication that controlled non-hazardous waste sites cause any health effects such as excess cancers or adverse birth outcomes.

There is no conclusive evidence from the epidemiological studies reviewed, that living close to a landfill for non-hazardous waste, causes adverse health effects in the general population.

In addition, HAP emissions from landfills also occur from on-site heavily equipment operations. At the time of preparation of the HIA these results were not yet available but will be incorporated into the final HIA.

Therefore, the assessment is predicated on the assumption that the stringent emissions criteria and monitoring requirements would ensure that airborne levels of potential landfill contaminants would be below both NAAQS and other health-based guidelines at the fence line of the Generic Landfill (Table 36).

Table 36. Assessment of Air Quality Effects for Generic Landfill.

Magnitude: what is the severity of the effect on human health?	
Low	The effect is minor and does not pose a hazard to health; health status will not change from baseline.
	Rationale: Although there will pollutant emissions from the Generic Landfill it would be required to be in compliance with permit emission levels and monitoring requirements.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Reversible	The effect is reversible given that no increase potential health impact is expected over baseline.
	Rationale: Although there will be chemical emissions to the Generic Landfill airshed, it is assumed that they would be at a quantity that is low enough to pose a negligible chronic risk to health. In addition, even if there are exceedances of standards, they would be expected to be short-term, and potentially only resulting in acute, reversible respiratory symptoms.
Frequency: how often is the effect expected to occur?	
High	The effect occurs on a continuous basis.
	Rationale: There would ongoing release of pollutants to the environment throughout landfill operation.
Duration: what would be the duration of the effect, if it were to occur?	
Short-term	A short-term (acute) effect, lasting from days to weeks.
	Rationale: Given that emissions will have to meet stringent permit levels and demonstrate compliance with NAAQS or other health-based standards.
Overall Effect Characterization	
Neutral (=)	The analysis results in a neutral or negligible effect on health. This assumes that emissions standards for the Generic Landfill are in alignment with federal and state permit requirements.
Likelihood: What is the probability of the impact occurring?	
Probable	The impact will likely occur. The probability of its occurrence is greater than 50%.
	This will be covered by the permit requirements of the facility expansion.

The assessment of Air Quality determined that disposal of 200,000 tpy of MSW to a Generic Landfill results in a **'neutral effect.'** Although disposal would result in an increase in landfill emissions, it would be expected to meet stringent regulatory limits. It would also likely represent less than 10% of the waste being disposed of on an annual basis at such a landfill and that the air quality requirements would encompass the entirety of the waste being managed.

The likelihood of occurrence was deemed '**probable**' given that the emissions from the landfill are a certainty. Overall there is a low level of uncertainty in this assessment given that there is considerable literature on air quality and health surrounding properly operated landfill facilities.

No additional mitigation measures or recommendations are provided.

7.1.2 Greenhouse Gas (GHG) Emissions

Greenhouse gas (GHG) emissions will result from any MSW management option. The amount or contribution of GHG from options is calculated on a metric ton per carbon dioxide equivalent (MTCO2e). The resulting MTCO2e for each management option of MSW would be dependent not only on the emissions from the option itself, but also on the emissions from haul vehicle transporting the waste to the destination associated with each option.

Potential Impact on Health of GHG Emissions

As described in Section 6.1.2.

Vulnerable or Sensitive Populations

Given that a Generic Landfill is being considered it is unknown what social vulnerability ranking the Oregon Health Authority would assign for the local community. Therefore, it was assumed that similar to the WTE option the local community would also be in the 'high' category for the composite social vulnerability index for climate change.

7.1.2.1 Current Conditions

As described in Section 6.1.2.1.

7.1.2.2 Generic Landfill Assessment

HDR completed a "Comparative Greenhouse Gas Analysis" for the current undertaking (1). It compared the GHG emissions between transporting 200,000 tpy of MSW from Portland to Generic Landfill 150 miles away to that of diverting the same quantity to the Covanta WTE Facility located in Brooks Oregon, 50 miles away. It also included the transportation of ash 36 miles to the Coffin Butte Landfill. Two approaches were used to compare the scenarios; the Waste Reduction Model (WARM) method and the Municipal Solid Waste Decision Support Tool MSW-DST method. The HDR report indicated for both modeling exercises that:

> *As WARM and MSW-DST generated conflicting answers to the question of which waste management scenario would result in fewer GHG emissions, HDR can make no definitive recommendation on which scenario would have the lesser impact on climate change. It is recommended that Metro consider the results of this GHG emissions modeling as indicative of the potential effects of each waste management scenario, with the understanding that these are broad estimates based on broad assumptions and there are limitations in the models used. Furthermore, as there is not yet consensus among the developers of the models, it should be noted that these results are not replicable across different models, even though each model may be well documented and widely used in a certain geographic or academic setting.*

Landfill carbon sequestration should be viewed as the appropriate approach for evaluating GHGs for the landfill scenario.

Using the WARM model the estimated GHG emissions per ton managed of MSW to the Generic Landfill option was -0.08 MTCO2e/ton or -15,874 MTCO2e a year for disposal of 200,000 tpy MSW. This means that the Generic Landfill option would actual result in a net decrease of GHG. However, the MSW-DST model including carbon sequestration predicts an increase of 68,281 MTCO2e a year of GHG emissions.

Given the discrepancy and uncertainty in the approaches it was determined that GHG emissions could be either positive or negative. It is under this premise that the potential health impacts were assessed (Table 37). However, a comparison between the Generic Landfill and WTE GHG emissions is provided in Section 8.

Table 37. Assessment of Greenhouse Gas (GHG) Effects for Generic Landfill.

Magnitude: what is the severity of the effect on human health?	
Low	The effect is minor and does not pose a hazard/benefit to health; health status will not change from baseline.
	Rationale: The GHG report provides conflicting results either positive or negative.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Not Applicable	
Frequency: how often is the effect expected to occur?	
Not Applicable	
Duration: what would be the duration of the effect, if it were to occur?	
Not Applicable	
Overall Effect Characterization	
Neutral (=)	The analysis provides inconclusive results for the Generic Landfill analysis.
Likelihood: What is the probability of the impact occurring?	
Possible	The positive impact will likely occur, the probability is less than 50%.
	The results of the comparative analysis indicate that regardless of the method used that there would be either a increase or decrease in GHG from the Generic Landfill option.

The assessment of GHG determined that disposal of 200,000 tpy of MSW to the Generic Landfill could result in a **'neutral effect'**. This is due to the fact that these GHG emissions are already accounted for in Metro's estimates of annual GHG production.

The likelihood of occurrence was deemed '**probable**' given the results of the GHG report indicate a either an increase or decrease in GHG emissions if waste were to be disposed of in the Generic Landfill. Overall there is a high level of uncertainty in this assessment given the conflicting results in the GHG analysis.

It is recommended that further discussions between the interested parties being undertaken in the future in an attempt to reach consensus on the best approach for determining GHG impacts.

7.1.3 Production of Energy

The landfill gas to energy (LFGTE) produced at the Generic Landfill would be considered a 'renewable energy' by Oregon. The energy is sold through a power purchase agreement (or similar contracting vehicle) to power homes and businesses. Although, it is recognized that the City of Portland and Multnomah County recently passed resolutions that appear to exclude LFGTE from being counted toward renewable energy in their energy portfolios.

Potential Impact on Health of Energy Production

LFGTE production has the benefit of supplying electricity to the grid that can partially offset the need for additional non-renewable sources of energy production. Given that Landfill air emissions have been accounted for in the Air Quality assessment, if emissions are at an acceptable level then energy production that could be recovered from landfill disposal could be considered either to have a neutral or positive impact on health through replacement of non-renewable derived energy.

Vulnerable or Sensitive Populations

No vulnerable or sensitive populations were identified for the production of energy from the Generic Landfill.

7.1.3.1 Generic Landfill Assessment

ODOE considers LFGTE to be a renewable energy. The Western Renewable Energy Generation Information System issues Renewable Energy Certificates (RECs) to the existing landfills in Oregon with such capabilities. The Generic Landfill electricity generation capacity was estimated from the existing landfills in Eastern Oregon on a MW per ton per year of MSW disposal. It was assumed that 200,000 tpy of landfill disposal of MSW would have the capacity to generate 1.3 MW of electricity or enough to supply power to the equivalent of 1,300 homes. It is also assumed that the electricity generated would be used to supply energy solely to Oregon customers.

This would be considered by the ODOE as contributing to an increase in renewable energy production in the state. Overall, the health impact assessment of electrical generation was assessed assuming that there is a potential benefit of this energy over that of the use of non-renewable sources of generation. An assessment of the potential of the additional production energy from the Generic Landfill is provided in Table 38.

Table 38. Assessment of Production of Energy Effects for Generic Landfill.

Magnitude: what is the severity of the effect on human health?	
Medium	The effect is detectable and poses a minor to moderate benefit to health; health status could change from baseline.
	Rationale: The increase in energy production could offset the need for some non-renewable based electricity generation.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Irreversible	For positive effects, the improvement is permanent.
	Rationale: Over the life of the project electricity would be generated for approximately 1,300 homes a year.
Frequency: how often is the effect expected to occur?	
Low	The effect may occur rarely.
	Rationale: Although it would be through the duration of the project it is recognized that it is only 1.3 MW of electricity.
Duration: what would be the duration of the effect, if it were to occur?	
Long-term	The effect occurs on a continuous basis.
	Rationale: It would be through the 20 year life of the project.
Overall Effect Characterization	
Minor (+)	The analysis results in a minor positive effect on health.
Likelihood: What is the probability of the impact occurring?	
Probable	The impact will likely occur, the probability is greater than 50%.
	Rationale: The disposal of waste in the Generic Landfill it will result in the generation of electricity.

The assessment of LFGTE production of energy determined that disposal of 200,000 tpy of MSW to the Generic Landfill could result in a **'minor positive effect'**. This is based on the increase of production of renewable energy over that of non-renewable sources of electricity generation.

The likelihood of occurrence was deemed '**probable**' given that energy would be produced as part of the expanded operations. Overall there is a low level of uncertainty in this assessment given that it would be expected to produce 1.3 MW of electricity.

No additional mitigation measures are recommended.

7.1.4 Accidents and Upsets

Landfills are not immune to potential accident or upset conditions. For the Generic Landfill the most significant of the accident events would be a landfill fire.

Potential Impact on Health as a Result of Accident or Malfunction

Major fire events maybe rare for landfills but if it were to occur there is a potential for physical injury or death in workers. In addition, uncontrolled burning of waste could lead to significant concentrations of chemicals in downwind air over communities and could potentially result in significant acute health impacts.

Vulnerable or Sensitive Populations

The Generic Landfill workers and nearby residents would be considered vulnerable populations given their proximity to the landfill if a major event was to occur.

7.1.4.1 Generic Landfill Assessment

Data on landfill fires and their probability of occurrence at individual landfills is not readily available. It is not known if any significant landfill fires have occurred in the landfills in Eastern Oregon.

From Moqbel (2009):

> *Each year in the United States, an average of 8,300 landfill fires occur, most of them in the spring and summer months, as reported by U.S. Fire Administration (2001). Also, Ettala et al (1996) reported an average of 380 annual fires in 633 operating sanitary landfills in Finland from 1990-1992. One-quarter of these fires were deep subsurface fires. Amongst fire types, spontaneous subsurface fires are considered the most threatening ones despite the fact that they are relatively infrequent. Their impact can extend beyond landfill boundaries and their damage can be devastating.*

From United States Fire Administration (2002):

> *Fires occurring at landfill sites across the United States are an ongoing, complex problem that has existed for decades. Landfill fires threaten the environment through toxic pollutants emit ted into the air, water, and soil. These fires also pose a risk to firefighters and civilians who are exposed to the hazardous chemical compounds they emit. The degree of risk depends in part on the contents buried in the landfill, the geography of the landfill, and the nature of the fire. There can be great difficulty in the detection and extinguishment of landfill fires, which is compounded because these fires often smolder for weeks under the surface of the landfill before being discovered.*

A search of the scientific peer-reviewed literature found little information on concentrations of contaminants in air and potential health risks to exposed populations. Weichenthal et al. (2015) reported on ambient air concentrations and potential health risk of a Canadian landfill fire. They determined:

> *A large landfill fire occurred in Iqaluit, Canada in spring/summer 2014. Air quality data were collected to characterize emissions as well as potential threats to public health. Criteria pollutants were monitored ($PM_{2.5}$, O_3, NO_2) along with dioxins/furans, polycyclic aromatic hydrocarbons, and volatile organic compounds. Median daily dioxin/furan concentrations were 66-times higher during active burning (0.2 pg/m^3 TEQ). Other pollutants changed less dramatically. Our findings suggest that airborne concentrations of potentially harmful substances may be elevated during landfill fires even when criteria air pollutants are largely unchanged.*

Overall, the health impact assessment was conducted on assumption that major landfill fire could occur at the Generic Landfill. It also took into consideration the proximity of local residents that could be downwind of the fire and could be exposed to elevated airborne chemicals (Table 39).

Table 39. Assessment of Accident and Malfunction Effects for Generic Landfill.

Magnitude: what is the severity of the effect on human health?	
High	The effect is severe and poses a major hazard to health; health status will change from baseline.
	Rationale: If a fire was to occur then it could pose a major hazard to the landfill workers or nearby residents.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Irreversible	The effect is not reversible (effect continues once exposure is removed) people are not likely to recover or adapt to the changes, even with additional support.
	Rationale: In the event of a major fire it is possible that the outcome could include injury of workers or nearby residents.
Frequency: how often is the effect expected to occur?	
Not Applicable	
Duration: what would be the duration of the effect, if it were to occur?	
Not Applicable	
Overall Effect Characterization	
Major (---)	In the event of a major fire at the Generic Landfill there is a potential to have a major negative effect on the health of the workers or nearby residents.
Likelihood: What is the probability of the impact occurring?	
Unlikely	The impact is anticipated to occur rarely, if ever. This classification is appropriate for those situations where impacts are not zero but they are limited to very rare occurrences, catastrophic events, or highly unlikely system failures.
	Rationale: Although major fires can occur at landfills they are fairly rare occurrences.

The assessment of Generic Landfill accidents and malfunctions determined that a major landfill fire could result in a **'major negative effect'**. Such an event could potentially lead injuries, death or public health risk to downwind residents.

The likelihood of occurrence was deemed '**unlikely**' given that such occurrences are fairly rare. Overall there is a high level of uncertainty in this assessment given that detailed occurrence rates are not available for these occurrences.

7.1.5 Soil Quality

A common public concern surrounding landfill operations is that blowing of trash or landfill day-cover could potentially lead to contaminants impacting local soil quality. United States landfills do not commonly have monitoring requirements for soil quality.

Potential Impact on Health from Exposure to Impacted Soil

Inadvertent ingestion of potentially impacted soil or uptake into garden produce would be considered secondary exposure pathways if soil had elevated concentrations of chemicals surrounding landfills.

Vulnerable or Sensitive Populations

In the event that local soil was impacted from landfill then local residents and agricultural lands in the area would be considered potentially vulnerable populations.

7.1.5.1 Generic Landfill Assessment

As described in Section 1.2.3.2 only non-hazardous is accepted at the Generic Landfill. Placement of material in the landfill is a controlled operation and the working face of the landfill is confined to as small an area as possible, typically less than one-half acre at a time. Waste is covered on a daily basis by day cover material. In addition, the Generic Landfill is bordered by a significant buffer zone between the waste cells and neighboring properties. Therefore, there would be little potential for off-site soil to be chemically impacted from landfill operations. Hence there would be no exposure pathway or potential public health risk to local residents.

An assessment of the potential of chemical impacted soil from disposal of MSW in the Generic Landfill is provided in Table 40. Overall, the health impact assessment was conducted on assumption that there would not be a significant measurable change in soil concentrations surrounding the landfill.

Table 40. Assessment of WTE Soil Quality Effects for the Generic Landfill.

Magnitude: what is the severity of the effect on human health?	
Low	The effect is minor and does not pose a hazard/benefit to health; health status will not change from baseline.
	Rationale: Windblown material or day cover from the landfill will not impact local soil.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Not Applicable	
Frequency: how often is the effect expected to occur?	
Not Applicable	
Duration: what would be the duration of the effect, if it were to occur?	
Not Applicable	
Overall Effect Characterization	
Neutral	Soil would not be measurably impacted by landfill operations. Therefore, there would be no health impact.
Likelihood: What is the probability of the impact occurring?	
Probable	The neutral impact will likely occur, the probability is greater than 50%.
	The disposal of MSW in the Generic Landfill will not impact the soil.

The assessment of the Generic Landfill operations determined that disposal of 200,000 tpy of MSW to landfill would result in a **'neutral'** effect on soil impact and human health. The likelihood that soil would not be impacted was deemed '**probable**' given that significant controls in landfill operation are in place. Overall there is a low level of uncertainty in this assessment.

No mitigation measures or enhancement opportunities were identified.

7.1.6 Traffic Volume and Safety

For the purposes of the HIA a haul distance from Metro region to the Generic Landfill was estimated at 150 miles one-way and 300 miles round trip along the I-84 corridor.

The Oregon Department of Transportation (DOT) releases annual reports on transportation volume on major highways and roadways in the state. The HIA considers both the potential for accidents to occur and vehicle emissions (Section 7.2.7) that occur from haul distances round trip, consistent with DOT statistics.

Potential Impact on Health from Hauling of MSW

The hauling of waste could potentially impact health through potential accidents along the haul route if significant increase in traffic is seen. Truck vehicular accidents could result in serious injury or fatalities.

Vulnerable or Sensitive Populations

Vulnerable populations would include those driving the interstate haul route.

7.1.6.1 Generic Landfill Assessment

Specially designed long-haul trucks each carrying a payload of approximately 34 tons maximum is used to transport waste to the Generic Landfill. For 200,000 tpy of MSW, this is the equivalent of 19 truck trips a day (six days a week) using the 34-ton maximum payload. For the purpose of the HIA the trucks were assumed travel to the Generic Landfill using the Interstate 84 (I-84). The average haul route distance is 150 miles, with a 300 mile round trip distance. This is the equivalent of 889,000 one-way and 1,778,000 round-trip vehicle miles traveled (VMT) to haul 200,000 tpy of MSW to the Generic Landfill.

The majority of the haul route is along the I-84 corridor. The Annual Average Daily Traffic (AADT) volume along the corridor between Portland and Arlington is 51,693 vehicles (Oregon DOT, 2016). This heavily trafficked route follows the Columbia River.

The 20 truck trips a day along I-84 for the equivalent of 200,000 tpy of MSW is negligible considering the overall volume of traffic. It was assumed that no residential areas or schools are located from the I-84 exit to the Generic Landfill and hence no susceptible or vulnerable populations for vehicle strike concerns. The Oregon DOT also publishes statistics on 12 Truck Safety Corridors in the state where higher than average truck crashes occur (Table 41).

Table 41. Truck Crashes by Year

	Corridor	2011	2012	2013
1	Siskiyou Summit -- I-5, MP2-9	9	9	7
2	Weaver to Roberts Mountain -- I-5, MP108-117	0	8	7
3	Salem -- I-5, MP252-260	6	5	9
4	Tualatin to Portland, Marquam Bridge -- I-5, MP289-300	15	17	24
5	West Linn to Clackamas -- I-205, MP8-14	9	15	16
6	Hood River to Mosier -- I-84, MP63-73	5	1	4
7	Emigrant Hill, aka Cabbage Hill -- I-84, MP219-228	4	11	7
8	Ladd Canyon -- I-84, MP270-278	4	3	6
9	Nelson Point to Weatherby -- I-84, MP331-340	3	2	5
10	North Bend to Coos Bay -- US101, MP233-243	2	3	2
11	Eugene -- I-5, MP168-208, and Lane County -- OR58, MP1-62	22	29	35
12	Deschutes County -- US20, Sisters to Bend and Bend to 10 miles east of Bend US97, Terrebonne to LaPine, Deschutes County	8	11	12

Corridor 6 is along the I-84 haul route. The corridor truck safety corridor accident rates were in the median range of the 12 areas. Although the corridor is considered a truck safety corridor accident rates were amongst the lowest of the 12 areas.

For 2015, the Oregon DOT estimated that there were 0.39 large truck crashes (commercial motor vehicle) at fault crashes per million vehicle miles traveled (VMT). Note this is the accident rate for Oregon interstates as a whole and does not specifically account for the corridors that would be traveled from the Metro region to the Generic Landfill. Given that that the total VMT for 1,778,000 VMT per year it would be less than 1 accident expected a year. The potential health impact for the Generic Landfill Traffic Volume and Safety is provided in Table 42.

Table 42. Assessment of Traffic Volume and Safety Effects for the Generic Landfill.

Magnitude: what is the severity of the effect on human health?	
Medium	The effect is detectable and poses a minor to moderate hazard to health; health status could change from baseline.
	Rationale: The overall increase of truck traffic on the I-84 corridor is negligible compared to existing traffic volumes. The increase of VMT would likely result in less than one accident per year.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Irreversible	The effect is not reversible.
	Rationale: In the unlikely event that a traffic accident was to occur it is possible it could be fatal.
Frequency: how often is the effect expected to occur?	
Low	The effect occurs rarely, if ever.
	Rationale: It is anticipated that accident frequency would be less than one per year.
Duration: what would be the duration of the effect, if it were to occur?	
Long-term	A long-term (chronic) effect, lasting from months to years.
	Rationale: The additional truck traffic would last for the 20-year life of the expansion of MSW to the Generic Landfill.
Overall Effect Characterization	
Minor (-)	Overall, the increase in truck traffic is likely to result in a probability of less than one accident per year, over a 20-year period.
Likelihood: What is the probability of the impact occurring?	
Unlikely	The impact is anticipated to occur rarely, if ever.
	Given that there would be an insignificant increase in traffic volume and that less than one accident per year would be expected it is unlikely to occur.

It was determined that the increase in truck traffic to dispose of 200,000 tpy MSW to the Generic Landfill could have a **'minor negative effect'** on health. This is because the increase in traffic volume would be insignificant and less than one accident a year would be anticipated based on DOT statistics. No susceptible or vulnerable populations were assumed between the I-84 interchange and the Generic Landfill. The likelihood of occurrence was deemed **'unlikely'** given the low potential for truck accidents. Overall there is a medium level of uncertainty in this assessment given that a more in-depth probabilistic assessment was not performed.

No further recommendations or mitigation measures are considered.

7.1.7 Haulage Vehicle Emissions

As discussed in Section 7.1.7 Traffic Volume and Safety there would be 1,778,000 round trip VMT per year between Metro Region to the Generic Landfill. This assessment considers the effect on vehicle emissions on health.

Potential Impact on Health from Hauling of MSW

If there is a potential significant increase in vehicle emissions it could have an impact on the health of residents located in close proximity to the interstate.

Vulnerable or Sensitive Populations

Those living along the interstate corridors, especially children and elderly, could be especially vulnerable to adverse changes in air quality.

7.1.8 Generic Landfill Assessment

Table 43 provides the emissions calculations inputs for truck hauling from Metro Region to the Generic Landfill. Emissions estimates and diesel consumption need to be expressed in annual number of truck ton (waste) – miles. It can be seen that 312,000 of gallons of diesel would be required on an annual basis for round trip travel.

Table 43. Emission Calculation Inputs for Truck Hauling for the Generic Landfill.

Parameter	***Calculation Inputs***
A. Distance (round trip) to Generic Landfill	300 miles
B. Annual number of truck freight ton-miles for 200,000 tpy	30,000,000
C. Annual gallons of diesel (based on round trip distance)	296,400

[1] Per a modal comparison study performed by TTI, in cooperation with NWF (http://www.nationalwaterwaysfoundation.org/study/FinalReportTTI.pdf), the emission factors used for PM/PM_{10}/$PM_{2.5}$, NO_x, CO, VOC, and CO_2 are based on the amount of freight hauled one way (i.e., the emission factors account for a full truck hauling one way and an empty truck returning).
[2] Per the TTI report, the diesel usage was calculated based on an average fuel efficiency of 6.0 mile/gal, and round trip travel.

The annual emission estimates for hazardous air pollutants for truck ton-miles are provided in Table 44. The potential increase volume of traffic on I-84 is negligible in comparison to the overall volume of traffic. Therefore, the increased truck traffic along the I-84 corridor would not result in impairment in air quality impact along the route. There would be no measurable change in ground level criteria air pollutants or HAP concentrations, even immediately adjacent to the interstate.

Table 44. Truck Hauling Emission Estimates for the Generic Landfill

Pollutant	Diesel			
	Emission Factor			
	Number	Units	Source	ton/yr
PM	0.06	g/ton-mile	A	1.98
PM_{10}	0.06	g/ton-mile	A	1.98
$PM_{2.5}$	0.06	g/ton-mile	A	1.98
NO_x	1.45	g/ton-mile	A	48.0
SO_2	0.001515	lb/MMBtu	B	0.03
CO	0.37	g/ton-mile	A	12.2
VOC	0.10	g/ton-mile	A	3.31
Greenhouse Gas				
CO_2	171.83	g/ton-mile	A	5,682
N_2O	6.0E-04	kg/mmBtu	C	0.027
CH_4	3.0E-03	kg/mmBtu	C	0.14
CO_2e	NA	NA	NA	5,694
Hazardous Air Pollutants				
Acetaldehyde	2.52E-05	lb/MMBtu	B	0.0005
Acrolein	7.88E-06	lb/MMBtu	B	0.0002
Benzene	7.76E-04	lb/MMBtu	B	0.0159
Formaldehyde	7.89E-05	lb/MMBtu	B	0.0016
Naphthalene	1.30E-04	lb/MMBtu	B	0.0027
POM	2.12E-04	lb/MMBtu	B	0.0043
Toluene	2.81E-04	lb/MMBtu	B	0.0057
Xylene	1.93E-04	lb/MMBtu	B	0.0039
TOTAL HAP				0.0348

NOTES:
A - Emission factor from Table ES-3 of the TTI report (see Inputs table).
B - Emission factors for large diesel engines obtained from Fifth Edition AP-42, Section 3.4 (10/96).
C - 40 CFR pt. 98 - Mandatory Greenhouse Gas Reporting, Tables A-1, C-1, and C-2
D - CO2e conversion factor CO2x1, N2)x298, CH4x25

Transportation of waste to the Generic Landfill for Vehicle Emissions is provided in Table 45. Given the insignificant increase and traffic volume along I-84 and that there would not be a measurable increase in ground level HAP concentrations it is not anticipated that there would be an impact on resident's health. The consumption of diesel fuel and relative HAP emissions will be discussed in the comparative analysis between WTE and Generic Landfill.

Table 45. Assessment of Haulage Vehicle Emissions Effects for the Generic Landfill.

Magnitude: what is the severity of the effect on human health?	
Low	The effect is minor and does not pose a hazard to health.
	Rationale: Although HAP emissions would increase along the I-84 corridor it is not anticipated that it would result in a measurable increase in ground level concentrations.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Not Applicable	
Frequency: how often is the effect expected to occur?	
Not Applicable	
Duration: what would be the duration of the effect, if it were to occur?	
Not Applicable	
	.
Overall Effect Characterization	
Neutral (=)	The increase in traffic volume will not have an impact on local air quality.
Likelihood: What is the probability of the impact occurring?	
Probable	The impact will likely occur, the probability is greater than 50%.
	There will be an increase in vehicle emissions along the I-84 corridor

The disposal of 200,000 tpy MSW to the Generic Landfill is likely to have a **'neutral effect'** on health for vehicle emissions. This was largely based on the fact that although emissions will increase they will be negligible in comparison to existing conditions. The likelihood of occurrence was deemed **'probable'** given that there would be an increase in vehicle emissions on I-84 over a 20-year period. Overall there is a low level of uncertainty in this assessment given that appropriate calculations were made for pollution estimates.

No mitigation measures or enhancement opportunities were identified.

7.1.9 Seismic Activity

A detailed investigation of seismic activity and how it could impact the Generic Landfill is beyond the expertise of the authors and the scope of the HIA. Therefore, the health assessment provided in this section should be viewed at best as a qualitative interpretation of information provided.

Potential Impact on Health from Hauling of MSW

The potential for the Generic Landfill to impact health would depend on the magnitude of the earthquake and the extent of damage to the landfill and associated energy production equipment.

Vulnerable or Sensitive Populations

Those living in the vicinity of the Generic Landfill would be considered to be potentially vulnerable to any earthquake impact on the Generic Landfill.

7.1.9.1 Current Conditions

Oregon is, in general, an area that is susceptible to earthquakes from three sources:

1. shallow crustal events within the North American Plate;
2. deep intra-plate events within the subducting Juan de Fuca Plate; and,
3. the off-shore Cascadian Subduction Zone.

The Generic Landfill was assumed to be in an area that has been designated by FEMA as being in D Seismic Design category. This categorization indicates that there could be very strong shaking that would result in slight damage in specially designed structures and considerable damage in ordinary substantial buildings with partial collapse.

The US Geological Survey (USGS) provides a tool that allows for Earthquake Probability Mapping. A simulation was run for the area 150 east of Portland to determine the probability of a magnitude 6 and above earthquake occurring over the next 20 years (Figure 17). It was determined that there was approximately a 5% probability that such an event would occur.

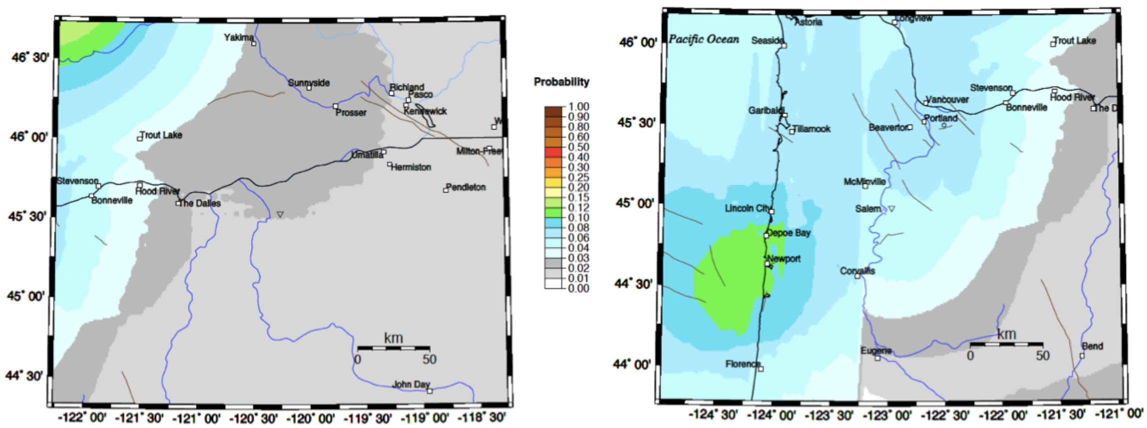


Figure 17. Earthquake Probability Map of a Magnitude 6.0 Occurring over next 20 year in the area of the Generic Landfill.

Through a similar simulation it was determined that there was a <1% probability of a magnitude 7 or above earthquake occurring over the next 20 years in the area of the Generic Landfill. These are merely predictions of probability and do not preclude the event from occurring during the life of the project. In February 2017, the City Club of Portland reported "*According to leading Cascadia experts, the likelihood of the next big earthquake occurring sometime in the next 50 years is 14 to 20 percent.*" However, the energy released at the fault would dissipate as it travels inland. The report also stated "*Chris Goldfinger, a professor of geology and geophysics at Oregon State University, is a leading expert on the Cascadia Subduction Zone. He told your committee that the felt experience in the city would be similar to a 5.0 or 6.0 earthquake*." (City Club, 2017). Given that the Generic Landfill is located 150 miles east of the Cascadia Subduction Zone it is likely the magnitude would be even less. This is consistent with predictions made above.

The following are the definitions for magnitude of earthquake:

6.1 to 6.9	May cause a lot of damage in very populated areas
7.0 to 7.9	Major earthquake. Serious damage

7.1.9.2 Generic Landfill Assessment

RCRA Subtitle D (258) provides "Seismic Design Guidance for Municipal Solid Waste Landfill Facilities" (USEPA, 1995). This document provides information on siting and facility design criteria with a focus on earthquake (or seismic) events. It is assumed that the Generic Landfill is designed in accordance to these standards.

Zania, et al. (2008), published a research paper on the Inertial Distress of Waste Landfills. In the paper's introduction it states:

> *Even though no remarkable failure has been recorded worldwide (as a consequence of a moderate or strong earthquake), many serious damages have been observed, raising thus the issue of seismic vulnerability of MSW landfills. Actually, the Northridge earthquake in 1994 has motivated a great interest of the scientific community to the seismic response of MSW landfills, since damages occurred in landfills in the greater California area, which were followed by extended investigations [2–4]. Similar investigations also took place after the 1995 Kobe earthquake [5]. Based on the available observational data of Northridge earthquake, Matasovic et al. [6] categorized the seismic damage on landfills to five levels from little or no damage to general instability with significant deformations.*

In the event of a magnitude 6 or 7 earthquake it is possible that damage to the Generic Landfill could arise in slope stability of the landfill, damage to the leachate containment system, damage to the landfill gas collection and control system, and the landfill gas to energy equipment. Although issues that could occur to the physical integrity of the landfill are well document, it is not known whether damage to the gas collection system or the energy equipment could result in potential structural issues or even fire. However, it is noted that under such conditions it is likely that there would also be significant damage and issues in the surrounding community of the Generic Landfill. Regardless, the focus of the HIA is on the Generic Landfill itself. The assessment of potential health impact of a seismic event causing damage to the Generic Landfill was predicated on a relatively low potential for occurrence of a magnitude 6 or greater earthquake occurring over the next 20 years (Table 46).

Table 46. Assessment of Seismic Activity Effects for WTE.

<table>
<tr><td colspan="2">Magnitude: what is the severity of the effect on human health?</td></tr>
<tr><td rowspan="2">High</td><td>The effect is severe and poses a major hazard to health; health status will change from baseline.</td></tr>
<tr><td>Rationale: If a magnitude 6 or greater earthquake was to manifest in the area of the Generic Landfill significant damage to the facility and associated energy components could occur.</td></tr>
<tr><td colspan="2">Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?</td></tr>
<tr><td rowspan="2">Irreversible</td><td>The effect is not reversible (effect continues once exposure is removed) people are not likely to recover or adapt to the changes, even with additional support.</td></tr>
<tr><td>Rationale: In the event of an earthquake it is possible that the outcome could include injury of workers or nearby residents. It could also damage leachate control systems and result in impact to groundwater.</td></tr>
<tr><td colspan="2">Frequency: how often is the effect expected to occur?</td></tr>
<tr><td rowspan="2">Not Applicable</td><td></td></tr>
<tr><td>Rationale:</td></tr>
<tr><td colspan="2">Duration: what would be the duration of the effect, if it were to occur?</td></tr>
<tr><td rowspan="2">Not Applicable</td><td></td></tr>
<tr><td>Rationale:</td></tr>
<tr><td colspan="2">Overall Effect Characterization</td></tr>
<tr><td>Major (---)</td><td>In the event of a major earthquake near the facility there is a potential to have a major negative effect on the health of the workers or nearby residents of the Generic Landfill.</td></tr>
<tr><td colspan="2">Likelihood: What is the probability of the impact occurring?</td></tr>
<tr><td rowspan="2">Unlikely</td><td>The impact is anticipated to occur rarely, if ever. This classification is appropriate for those situations where impacts are not zero but they are limited to very rare occurrences, catastrophic events, or highly unlikely system failures.</td></tr>
<tr><td>Rationale: Although the Generic Landfill is assumed to be located in a high risk area for earthquakes probability assessment indicates a less than 5% magnitude 6 earthquake and <1% magnitude 7 earthquake occurring.</td></tr>
</table>

The assessment of seismic activity determined that the Generic Landfill could result in a **'major negative'** effect. This is because such an event could potentially lead injuries or death.

The likelihood of occurrence was deemed '**unlikely**' given the low probability of a significant magnitude earthquake occurring over the next 20 years. Overall there is a high level of uncertainty in this assessment given that a detailed earthquake analysis by experts was not within the scope of this HIA.

7.1.10 Impacts to Groundwater

Historically, improper containment of landfill leachate led to chemical impacts to local groundwater around the United States. However, modern landfills are strictly regulated and have extensive requirements for containment design, leachate collection and monitoring of surrounding groundwater to prevent such occurrences.

Potential Impact on Health from Exposure to Impacted Groundwater

If landfill leachate was to impact local groundwater it could raise chemical concentrations in potable drinking water. Potential health impacts would vary based on the chemicals that impacted the well water.

Vulnerable or Sensitive Populations

Neighboring residents, living downgradient of the landfill, on well water would be considered vulnerable populations.

7.1.10.1 Generic Landfill Assessment

The Generic Landfill assumes water to be obtained from on-site extraction wells. Large landfills are expected to use between 2 to 4 million gallons of water per year. Most of the water use is for application to surface roads and circulation areas and the active landfill cell that is a function of the surface areas and not directly related to the quantity of waste received. Consequently, the increase or reduction of 200,000 tons of waste per year would have a negligible impact on the use of water at the site.

In addition, there will be precipitation water collected by the landfill. The Generic Landfill is located in within a relatively dry climate that experiences an average annual rainfall of 9.25 inches and 7 inches of snow.[12] Being located in a relatively dry climate can allow for generation of less leachate that needs to be managed at the Generic Landfill site.

The Generic Landfill is equipped with modern leachate collection and treatment systems. It consists of an underdrain layer of highly permeable gravel drainage material covering the entire landfill base. This layer contains perforated pipes at low points to collect and route leachate to a double composite lined evaporation pond. It also includes a recirculation process that pumps leachate from the pond back in to the landfill to accelerate waste decomposition and enhance landfill gas production.[13] The Generic Landfill is assumed to collect and re-circulate the leachate generated at the Landfill or contained within a pond for evaporation. As such, no leachate is required to be sent off-site to the local wastewater treatment plant for disposal. Therefore, no pre-treatment monitoring requirements are necessary.

[12] Source: http://www.usclimatedata.com/climate/arlington/oregon/united-states/usor0013
[13] http://wmnorthwest.com/landfill/columbiaridge.htm

The region has a unique underlying geology consisting of very thick layers of clay,[14] which reduces the potential for leachate to impact local groundwater. The Generic Landfill sites' geology and hydrogeology provide unique natural protections because the groundwater is several hundred feet deep and separated from the waste by naturally occurring low permeability soils. The low precipitation in the region also provides for additional protection.

Consistent with the Oregon requirements under OAR 340 Division 40, Groundwater Protection it is assumed that for the Generic Landfill that groundwater is monitored at numerous wells, both up-gradient and down-gradient of the waste disposal footprint. Additional details are provided in Section 1.2.3.5.

For the Generic Landfill, a groundwater monitoring program would be established. The groundwater monitoring program would include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide an accurate representation of groundwater quality at the background and downgradient wells installed in compliance with the appropriate regulations.

The Generic Landfill would prepare and submit a copy of an annual groundwater report to the jurisdictional health department and the Oregon DEQ each year. The groundwater annual report must include completed forms developed by the state department and the following information:

- A brief summary of statistical results and/or any statistical trends including any findings of any statistical increases for the year;
- A brief summary of groundwater flow rate and direction for the year, noting any trends or changes;
- A copy of all potentiometric surface maps developed for each quarter or approved semi-annual period; and
- A summary geochemical evaluation noting any changes or trends in the cation-anion balances, Trilinear diagrams and general water chemistry for each well.

The objective of the groundwater monitoring program is to ensure that chemical concentrations are not being impacted by landfill leachate. The permit requires that the landfill not impair or impact local groundwater.

Given that the Generic Landfill leachate is strictly controlled and monitored it would not impact local groundwater it would not be anticipated to pose a risk to human health. Overall, the health impact assessment was conducted on assumption that there would not be a significant measurable change in groundwater chemical concentrations surrounding the landfill (Table 47).

[14] Source: https://mrdata.usgs.gov/geology/state/fips-unit.php?code=f41021

Table 47. Assessment of Groundwater Impact for the Generic Landfill.

Magnitude: what is the severity of the effect on human health?	
Low	The effect is minor and does not pose a hazard to health; health status will not change from baseline.
	Rationale: Local groundwater quality will not be impacted by fugitive release of chemicals in leachate.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Not Applicable	
Frequency: how often is the effect expected to occur?	
Not Applicable	
Duration: what would be the duration of the effect, if it were to occur?	
Not Applicable	
Overall Effect Characterization	
Neutral	Groundwater would not be measurably impacted by leachate chemical release from the Generic Landfill. Therefore, there would be no health impact.
Likelihood: What is the probability of the impact occurring?	
Probable	The neutral impact will likely occur, the probability is greater than 50%.
	The disposal of MSW in the landfill will result in leachate that would not impair local groundwater.

The assessment of WTE determined that disposal of 200,000 tpy of MSW to the Generic Landfill would result in a **'neutral'** effect on groundwater and human health.

The likelihood of occurrence was deemed '**probable**' given that local groundwater would be monitored to ensure that leachate impacts do not occur. Overall there is a low level of uncertainty in this assessment given that it is supported by the requirement of state approval through permit application and monitoring.

No mitigation measures or enhancement opportunities were identified.

7.1.11 Discussion on Additional Environmental Considerations

Given that this is a Rapid HIA not all determinants of health could be assessed in detail. However, this is consistent with even detailed quantitative HIAs where the focus is on those determinants that could have the highest potential for negative/positive influences on health and public interest. In terms of scoping the following were assigned a low priority based on their potential for only minor negative impacts on health:

- Odor, surface water, vermin, insect and bird control

Each of these determinants of health is not anticipated to affect health of populations living around the Generic Landfill. A brief qualitative discussion of each is provided below.

7.1.11.1 Odor

Landfills can be a source of odor complaints if not properly managed. 40 Code of CFR Part 258 Solid Waste Disposal Criteria addressed issues surrounding landfill odor. In addition, the Oregon DEQ under the Generic Landfill Title V permit would regulate this issue. Best operating practices for odor reduction include compacting and covering the waste daily to reduce odor. It would be expected that the Generic Landfill would abide by best practices to reduce odor and keep a complaint log if any odor complaints are received from the surrounding community. From the RMIT University (2013):

> *From the epidemiological studies, there are reports of an association between proximity to non-hazardous waste landfill and increased reports of headaches and nausea; however, these are generally from facilities with known odour issues.*

Therefore, caution would have to be taken to ensure odor suppression at the Generic Landfill to avoid public complaints and to ensure that headaches and nausea does not occur in surrounding community.

7.1.11.2 Surface Water Quality

Surface water and storm-water run-off in the Generic Landfill is captured in the leachate control system or the on-site stormwater ponds. No discharge of surface water would be permitted from the site.

7.1.11.3 Vermin, Insect, and Bird Control

The need for extensive vector control (control of rodents, birds, flies, and mosquitoes) at the Generic Landfill would be minimized through proper site operation, including on-going compaction and application of daily cover. The primary method for vector control is proper daily cover. If insects or rodents become a problem, insecticides and/or pesticides would be used to eliminate the vector problem. A licensed pest control professional would be utilized. If necessary, a program of bird deterrence using appropriate landfill bird control techniques would be developed. Any ponded water at the site would be controlled to avoid its becoming a nuisance and attracting vectors.

7.2 Social and Economic Factors

Although landfills provide an important municipal service, they have social and economic consequences. These can either potentially negatively or positive influence health. Only limited social and economic factors could be assessed in the HIA given that a Generic Landfill scenario was developed.

7.2.1 Political Involvement

The assessment of Political Involvement for the WTE option is equally true for when Metro Council deliberates on disposal of MSW to Generic Landfill. Therefore, only the findings in the context of the Generic Landfill are provided in this section.

Given that the decision on whether to dispose of 200,000 tpy of waste to a Generic Landfill will be made by Metro Council it could have a **'minor positive effect'** on health. No vulnerable populations were identified and it is noted that the Portland area appears to have a high rate of voter turnout and the undertaking has already garnered significant public interest. The likelihood of occurrence was deemed **'probable'** given that a decision will have to be made by Metro Council.

Overall there is a low level of uncertainty in this assessment given that it is known that Metro Council will be deciding on how to manage MSW. It would be beneficial for Metro to engage with the landfill host community prior to commencement of hauling of waste.

7.2.2 Employment

The Generic Landfill is assumed to accept approximately 200,000 tpy of MSW at a much larger overall facility. As such, the Generic Landfill already requires significant staffing to coordinate the operations and required monitoring.

Potential Impact on Health from Employment

Employment in a secure, long-term, well-paid job with health benefits can lead to increase in social economic status and health care security. For those with families it has secondary benefits that extend to children, partners / spouses (Sohng, 2015).

Vulnerable or Sensitive Populations

Increased employment would benefit newly hired workers and their families.

7.2.2.1 Current Conditions

The Generic Landfill was assumed to be a significant size landfill. As an example the Columbia Ridge Landfill reports employing 70 full time staff. For the purpose of the HIA it was assumed that the Generic Landfill would have a similar sized employment complement.

7.2.2.2 Project Impact

The placement of 200,000 tpy of waste would likely represent only 10% of the overall waste being received on an annual basis it is unlikely that diversion or addition of this material to the larger landfill would change staffing requirements by more than 1 or 2 operators. Therefore, the HIA assessed the potential for increased employment at the Generic Landfill (Table 48).

Table 48. Assessment of Employment for the Generic Landfill.

Magnitude: what is the severity of the effect on human health?	
Medium	The effect is detectable and poses a minor to moderate benefit to health
	Rationale: The addition of 2 permanent positions at the Generic Landfill will add to both individual prosperity and it is anticipated that it would also have a benefit to the community.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Irreversible	For positive effects, the improvement is permanent.
	Rationale: These positions would be permanent and be required for the duration of the landfill contract.
Frequency: how often is the effect expected to occur?	
Low	The effect occurs on a continuous basis.
	Rationale: It would only likely result in up to 2 permanent positions.
Duration: what would be the duration of the effect, if it were to occur?	
Long-term	A long-term (chronic) effect, lasting from months to years.
	Rationale: It is expected that the expanded Covanta WTE Facility would be operational for at least 20 years.
Overall Effect Characterization	
Major (+)	Overall, the creation of 2 permanent positions would lead to direct health benefits to these employees and their families. They are likely to reside in near the Generic Landfill.
Likelihood: What is the probability of the impact occurring?	
Probable	The impact will likely occur, the probability is greater than 50%.
	If 200,000 tpy of waste is disposed in the Generic Landfill it is probable that some increased in employment of operators at the landfill would be required.

The employment creation of 2 new positions could have a **'minor positive effect'** on health near the Generic Landfill for newly hired employees. The likelihood of occurrence was deemed **'probable'** given that the addition of 200,000 tpy of MSW to landfill were to occur then additional full-time jobs would be needed.

Overall there is a medium level of uncertainty in this assessment given that it was not a detailed employment assessment and only based on preliminary estimates.

7.2.3 Working Conditions

The Generic Landfill is assumed to have working conditions similar to other landfills in the United States. The Solid Waste Association of North America (SWANA) is a source for industry information in this regard.

Issues surrounding working conditions for truck drivers and other secondary employment were not considered in this HIA.

Potential Impact on Health of Working Conditions

Working conditions and especially those related to health and safety has a significant impact on expected health outcomes of employees.

Vulnerable or Sensitive Populations

The workers at the Generic Landfill and those that would be employed after expansion are considered the vulnerable population for working conditions.

7.2.3.1 Current Conditions

At least 98 fatalities directly related to MSW collection, processing and disposal occurred in the United States between July 1, 2015 and June 30, 2016, according to data collected by SWANA. Of the fatalities reported in that time period, 38 were solid waste employees on the job, a majority of which occurred during waste collection. However, 13 of the fatal worker incidents took place at a landfill or materials recovery facility (MRF). The average age of workers who died on the job was 41.7 years old, with 60 percent being over the age of 40. At post-collection facilities, being struck by a vehicle was also the most common cause of death.

In summary, a majority of fatalities occur during the collection operations. Based on the statistic of 13 fatal worker incidents in one year and correlating the 200,000 tons landfilled to the approximately 167 million tons landfilled in the United States,[15] it is clear that for the Generic Landfill, zero fatalities should be assumed. Other worker injury statistics were not readily available for the industry.

[15] https://archive.epa.gov/epawaste/nonhaz/municipal/web/html/ showing 254.1M tons generated and a recycling rate of 87.2M tons, yielding a total disposed of 166.9M tons

SWANA also provides a "*5 to Stay Alive: Safety Tips for Landfill Employees*"

> *Landfills can be a dangerous place for both workers and customers.*
>
> 1. *Proper PPE is a MUST!*
> 2. *Are you the right person for the task?*
> 3. *Maintain situational awareness.*
> 4. *Heavy equipment has the right of way.*
> 5. *No Scavenging.*
>
> *SWANA wants you to go home to your family every day, safely. So, of course, never use a cell phone or text while working at the landfill.*

Specific safety data was not available for the Generic Landfill. However, it was assumed that the landfill had a proper health and safety plan in place at the site and that workplace injury rates were low.

7.2.3.2 Project Impact

The two additional employees at the Generic Landfill were assumed to receive proper health and safety training and required protective equipment . Table 49 provides an assessment of working conditions on health.

Table 49. Assessment of Working Conditions for Generic Landfill.

Magnitude: what is the severity of the effect on human health?	
Medium	The effect is detectable and poses a minor to moderate benefit to health
	Rationale: It was assumed that employees would be subject good working conditions.
Reversibility (and/or Adaptability): is the effect reversible; how resilient is the community to this type of change; are they able to adapt?	
Irreversible	For positive effects, the improvement is permanent.
	Rationale: It is assumed Generic Landfill will continue good safety record.
Frequency: how often is the effect expected to occur?	
Medium	The effect may occurs occassionally.
	Rationale: It is assumed that Generic Landfill will continue health and safety efforts.
Duration: what would be the duration of the effect, if it were to occur?	
Long-term	A long-term (chronic) effect, lasting from months to years.
	Rationale: It is assumed that Generic Landfill will continue safety record over the duration.
Overall Effect Characterization	
Major (++)	Overall, the working conditions were assumed to be at a Generic Landfill with an excellent safety record.
Likelihood: What is the probability of the impact occurring?	
Probable	The impact will likely occur, the probability is greater than 50%.
	The health and safety record would continue through the duration of the landfill contract.

The employment creation of 2 new positions could have a **'moderate positive effect'** on health near the Generic Landfill if proper health and safety measures are employeed. The likelihood of occurrence was deemed **'probable'** given that it was assumed a proper health and safety program would be in place.

Overall there is a high level of uncertainty in this assessment given that it was not a detailed assessment of workplace conditions and no actual survey of employees was conducted for a Generic Landfill.

In the event that landfill is selected as a preferred option for managing 200,000 tpy of MSW then landfill-specific health and safety records could be requested.

7.2.4 Local Economic Contribution

The Generic Landfill would provide economic support to local business due to increased traffic and out of town personnel that support construction or maintenance activities. The Generic Landfill would also provide for an increase in tax revenues or a portion of tipping fees that would be going to the city and county that the facility resides in.

7.2.5 Property Values

Nuisances such as vectors, odors, airborne litter, dust and noise are frequently cited among the reasons why people do not want to reside in the proximity of a landfill. Various research has concluded that landfills likely have a negative adverse impact upon housing values depending upon the actual distance from the landfill. Given that the Generic Landfill is assumed to have significant buffer lands between the waste cells and the neighboring properties it is unlikely to affect property values.

7.2.6 Access to Services

No Access to Services factors were considered relevant for the Generic Landfill option.

7.3 Biological and Additional Equity Factors

Age was identified as a biological factor to be considered in the HIA. However, there is no direct impact of the proposed project on age. Rather, age was considered as a factor in the vulnerable or sensitive population assessment in each of the determinants of health assessed.

Socio-economic status (SES) was again considered as a potential vulnerable population in each of the other determinants of health.

Ethnicity and Race were also scoped into the assessment during the Stakeholder Workshop. Ethnicity and race were not determined to lead to a particular sensitivity or vulnerability in the Environmental Factors. A Stakeholder Workshop participant encouraged Metro staff to consider how contracts or ancillary services, such as the truck waste hauling contracts, could benefit communities of color. These discussions are beyond the scope of the HIA but stakeholder groups are encouraged to work with Metro staff if the proposed expansion was to move forward to share their ideas and thoughts about participation of racial minorities, both within Metro and Marion County.

7.4 Mitigation and Enhancement Recommendations

No mitigation or potential enhancement recommendations were made for the Generic Landfill option. However, during upcoming contracting of landfill disposal Metro could consider requiring receiving landfills to provide confirmation of environmental monitoring results and compliance track record with state permitting agencies.

7.5 Summary of Generic Landfill HIA Findings

Nine environmental and three social and economic health determinants were determined to be of priority in the scoping exercise and were evaluated using a health assessment matrix framework (Table 50) for the Generic Landfill. Although discussion was provided on Regional/Local Economic Growth it was determined that not enough information was available to provide a detailed assessment on the potential health impact. Additionally, four environmental and one social economic determinant of health was discussed qualitatively.

Table 50. Summary of Assessment of Determinants of Health for Generic Landfill.

Health Determinant	Health Impact	Probability	Significance	Uncertainty
Environmental Factors				
Air Quality	Neutral (=)	Probable	Not Significant (=)	Low
Greenhouse Gas	Neutral (=)	Probable	Not Significant (=)	High
Energy Production	Minor (+)	Probable	Significant (+)	Low
Accident and Malfunction	Major (---)	Unlikely	Significant (--)	High
Soil	Neutral (=)	Probable	Not Significant (=)	Low
Traffic Volume and Safety	Minor (-)	Probable	Not Significant (=)	Low
Vehicle Emissions	Neutral (=)	Probable	Not Significant (=)	Low
Seismic Activity	Major (---)	Unlikely	Significant (--)	High
Groundwater	Neutral (=)	Probable	Not Significant (=)	Low
Social and Economic Factors				
Political	Minor (+)	Probable	Significant (+)	Low
Employment	Minor (+)	Probable	Significant (+)	Medium
Working Conditions	Moderate (++)	Probable	Significant (++)	High
Local/Regional Economic Growth	Not scored			High

Each determinant was assigned a health impact and probability of occurrence, which combine to provide a determination of significance. In addition, the uncertainty of each determination was provided. All of these rankings need to be considered when making an overall conclusion on potential health impact. The following were the results of the significance findings of the ten determinants of health assessed:

Positive — Energy Production (++), Political Involvement (+), Employment (+) and Working Conditions (++)

Neutral — Air Quality (=), Greenhouse Gas (=), Soil (=), Traffic Volume and Safety (=), Vehicle Emissions (=), and Groundwater (=)

Negative — Accidents and Malfunctions (--) and Seismic Activity (--)

No weighting of the importance of one determinant of health over another was conducted as part of the HIA. However, the probability of occurrence was used to provide an overall significance of each health determinant.

For Accidents and Malfunctions and Seismic Activity, if they were to occur then there is a significant potential for health impact. However, the probability of these occurrences was deemed to be unlikely. These potential negative health outcomes will be compared to those predicted for the expansion of the Covanta WTE Facility. These negative health consequences need to be weighed by decision makers as to their acceptability for the undertaking.

Similarly, the potential positive health impacts they need to be considered in context and weighed against the potential negative impacts. Positive impacts of the potential undertaking included both Environmental and Social Economic Factors. The positive impacts of the project were seen at the local (Political Involvement, Employment and Working Conditions) and regional (Energy Production) level.

8 Limitations and Uncertainties

Over the past decade HIA has emerged as an appropriate scientific method to assess and evaluate the potential negative and positive health effects related to project activities. However, there is no universally accepted specific guidance for conducting HIA. Therefore, similar to quantitative chemical health risk assessment and epidemiological investigations it is important to document the limitations and uncertainties associated with this undertaking.

To conduct the assessment, OEHM relied on the following:

- Health Impact Assessment: Oregon's Practitioner Toolkit – A handbook for conducting Rapid HIAs (2nd Edition), Oregon Health Authority, January 2015;
- Minimum Elements and Practice Standards for Health Impact Assessment. Version 3, September 2014. Bhatia R, Farhang L, Heller J, Lee M, Orenstein M, Richardson M and Wernham A.;
- Peer-reviewed published HIA methodology literature; and,
- Professional judgement and experience.

It was important to OEHM to ensure that details were provided for how each determinant was assessed and the rationale behind the outcomes of the assessment. Regardless of the HIA's limitations it allows for individuals, stakeholders and decision makers to review the available information and draw their own conclusions.

The following limitations were noted for the health assessment:

- This HIA was conducted at the early stage of exploring diversion of MSW from landfill to a WTE facility. Every attempt was made to incorporate available site-specific and project specific data. The uncertainty in the data and information used in each assessment was ranked as low, medium and high.
- The small population for each Brooks results in a high margin of error in both demographic and economic indicators available from the US Census. Therefore, caution should be used not to over interpret the reporting of this data.
- Health status and indicators are only available at the county level and specific baseline health status of the Brooks was beyond the scope of the HIA.
- Health status and indicators were not sourced for the Generic Landfill as no specific location was identified.
- The determination of vulnerable and sensitive populations was first developed by the Stakeholder Working Group and then refined by OEHM. However, there was no community consultation conducted as part of the HIA. Therefore, it is possible that not all vulnerable or sensitive populations were identified.
- The assessment included consideration of the current practice waste disposal of 200,000 tpy to a Generic Landfill. However, in general more detailed information was available for the proposed expansion of the Covanta WTE Facility. No specific data requests were made of any landfill operation during this undertaking.

Overall, the HIA attempts to provide an unbiased analysis of the potential for the Project to have negative, positive or no substantial effects on the health of the local community and the region. It is not meant to advocate for any particular position with respect to how Metro should manage its MSW. Rather, the intention is to provide decision makers (in this case the Metro Council) with health-based evidence that may help to inform their decision.

9 Comparative Analysis of WTE and Landfill Options

The objective of the HIA is to evaluate the potential health impacts and benefits of managing 200,000 tpy of Metro's MSW through either landfill or WTE. This assessment considers a Generic Landfill with landfill gas management and energy production located 150 miles from Portland. It also evaluates the option of transporting MSW to an expanded Covanta WTE Facility, 50 miles south of Portland and ash disposal at the Coffin Butte Landfill (36 miles).

Table 51 provides the outcomes of the assessment of each of the two options. Most of the determinants of health were the same for the two assessments, with the exception of:

- Environmental Factors:
  - Surface Water assessed for the Covanta WTE Facility
  - Groundwater assessed for the Generic Landfill

There was no difference between the findings of the assessment for the common environmental determinants of health, with the exception of GHG and Energy Production. This does not mean that there are no health differences between the two waste management options. However, overall the assessment reveals that modern, properly permitted waste management facilities are unlikely to have an environmental health impact on surrounding communities. The differences in the Employment and Working Conditions for WTE and Generic Landfill were assessed, although there is a high degree of uncertainty in the information about the Generic Landfill.

The assessment determined that there would not be a significant impact on Air Quality, Soil, Surface Water, Groundwater based on facilities stringent permit conditions and monitoring requirements for chemical release. The following provides comment and observation on the significant negative health outcomes for GHG, Accidents and Malfunctions, and Seismic Activity.

Greenhouse Gas Comparison

The *Comparative Greenhouse Gas Analysis* prepared by HDR (Appendix 1) provided two modeling approaches to assess GHG outputs from WTE and landfill. The two models were the Waste Reduction Model (WARM) method and the Municipal Solid Waste Decision Support Tool (MSW-DST) method. The HDR report indicated for both modeling exercises that:

> *As WARM and MSW-DST generated conflicting answers to the question of which waste management scenario would result in fewer GHG emissions, HDR can make no definitive recommendation on which scenario would have the lesser impact on climate change. It is recommended that Metro consider the results of this GHG emissions modeling as indicative of the potential effects of each waste management scenario, with the understanding that these are broad estimates based on broad assumptions and there are limitations in the models used. Furthermore, as there is not yet consensus among the developers of the models, it should be noted that these results are not replicable across different models, even though each model may be well documented and widely used in a certain geographic or academic setting. It is beyond the purview of this study to comment on which approach is most appropriate for considering GHG emissions from the waste management options being considered. As such, caution is recommended to decision makers not to place too much emphasis, one way or another, with respect to relying on the findings of GHG emissions, given the lack of consensus in scientific communities for estimating the GHG impacts of waste management options. In the future, additional insight may be provided by refining the parameters and sensitivity analyses of the models, or creating a customized LCA using measured, site-specific operating data from each of the facilities involved in the waste management alternatives.*

There is considerable debate by the scientific community as to how GHG from the two waste management options should be considered. HDR chose to use the WARM and MSW-DST models, because they are the two most widely accepted models in the US. There is also disagreement between the two modeling approaches as to the net GHG account for WTE facilities. This is due to inherent differences in model assumptions, inputs and calculations.

It is beyond the purview of the HIA to comment on which approach is most appropriate for considering GHG emissions from the waste management options being considered. Given the conflicting results the HIA determined that the impact would be neutral for both the Covanta WTE Facility and the Generic Landfill.

Table 51. Comparison of HIA Assessment of Proposed Expansion of the Covanta WTE Facility and Generic Landfill Options for Managing 200,000 tpy MSW.

Health Determinant	Covanta WTE Facility				Generic Landfill			
	Health Impact	Probability	Significance	Uncertainty	Health Impact	Probability	Significance	Uncertainty
Environmental Factors								
Air Quality	Neutral (=)	Probable	Not Significant (=)	Low	Neutral (=)	Probable	Not Significant (=)	Low
Greenhouse Gas	Neutral (=)	Possible	Not Significant (=)	High	Neutral (=)	Probable	Not Significant (=)	High
WTE Ash	Neutral (=)	Probable	Not Significant (=)	Low				
Energy Production	Moderate (++)	Probable	Significant (++)	Low	Minor (+)	Probable	Significant (+)	Low
Accident and Malfunction	Major (---)	Unlikely	Significant (--)	High	Major (---)	Unlikely	Significant (--)	High
Soil	Neutral (=)	Probable	Not Significant (=)	Low	Neutral (=)	Probable	Not Significant (=)	Low
Traffic Volume and Safety	Minor (-)	Probable	Not Significant (=)	Low	Minor (-)	Probable	Not Significant (=)	Low
Vehicle Emissions	Neutral (=)	Probable	Not Significant (=)	Low	Neutral (=)	Probable	Not Significant (=)	Low
Seismic Activity	Major (---)	Unlikely	Significant (--)	High	Major (---)	Unlikely	Significant (--)	High
Surface Water	Neutral (=)	Probable	Not Significant (=)	Low				
Groundwater					Neutral (=)	Probable	Not Significant (=)	Low
Social and Economic Factors								
Political	Minor (+)	Probable	Significant (+)	Low	Minor (+)	Probable	Significant (+)	Low
Employment	Major (+++)	Probable	Significant (+++)	Medium	Minor (+)	Probable	Significant (+)	Medium
Working Conditions	Major (+++)	Probable	Significant (+++)	Medium	Moderate (++)	Probable	Significant (++)	High
Local/Regional Economic Growth	Not scored			High	Not scored			High

Accidents and Malfunctions

There is no question that with any industrial activity or waste management options that accidents or malfunctions can occur. For both WTE and landfill the most significant of these events would be a large fire. Although these events are rare, they do occur. At either facility a major fire would pose a significant threat to workers and the surrounding communities. There are no comparator statistics that can predict which facility would more likely experience a major fire. These events are very dependent on local operations and management. Therefore, it is suggested that equal weight in the decision making process be afforded to either of these scenarios.

Seismic Activity

Oregon is located in a zone of potential significant seismic activity. If a significant seismic event were to occur either in the area of the Covanta WTE Facility or the Generic Landfill it could have significant negative health consequences. That said, such an event would also have serious ramifications on the entire area. Given the relative uncertainty in this assessment it was not possible to compare one option against another for potential magnitude of potential health impact.

Additional Comparisons

Traffic Volume and Safety and Vehicle Emissions

The two scenarios involve very different haul distances and vehicle miles traveled. The Generic Landfill is 300 miles round trip from Metro region, although it is able to receive tipping trucks with higher maximum payloads (34 tons per vehicle). The proposed expanded Covanta WTE Facility involves a 100 mile round trip from Metro region and a 72 mile round trip to the ash disposal facility, using vehicles that are assumed to have a payload of approximately 26 tons.

Table 52 provides the comparators between the two waste management options for hauling of 200,000 tpy of MSW.

Table 52. Comparison of Vehicle Miles Traveled and Emissions.

	Covanta WTE Facility + Ash		
Parameter	Covanta WTE Facility	Ash Disposal	Generic Landfill
Round Trip Distance (mi)	100	72	300
Vehicle Miles Traveled per year	892,000		1,778,000
Gallons of Diesel per Year	148,000		296,000
Total HAPs Emitted per year (t/y)	0.0175		0.0348

Assessment of the Traffic Volume and Safety determinant found that both options would not significantly impact health. However, the Generic Landfill option requires approximately an additional 886,000 VMT each year that would almost double the probability of a truck accident over that of the WTE option.

The Generic Landfill option would require nearly 2 times the number of gallons of diesel per year than the WTE option. There are no refineries in Oregon and the potential health impact of extraction and production of increased diesel fuel was not accounted for in the HIA.

The truck traffic associated with either scenario is insignificant compared to overall traffic volume and would not measurably contribute to roadside ambient HAP concentrations. However, the annual transportation generated HAP emissions for the Generic Landfill option would be higher than those of WTE.

Overall, the WTE option would result in a net health benefit for Traffic Volume and Safety and Vehicle Emissions over that of the distant Generic Landfill option.

Energy Production

The Oregon DOE considers both WTE and LFGTE to be sources of renewable energy. They are both given Renewable Energy Certificate (RECs) in Oregon. It is noted that for 200,000 tpy of disposal of MSW that WTE generates 13 MW of electricity compared to 1.3 MW of electricity for the Generic Landfill option.

Social and Economic Considerations

Given that a Generic Landfill was assessed there was little available data to provide meaningful assessment of social and economic assessment of determinants. For the Covanta WTE Facility, both Employment and Working Conditions have significant positive benefits to health and preliminary indications for the Generic Landfill also indicate benefit to health. Although Local/Regional Economic Growth was not scored Covanta estimated that construction costs would be on the order of $400,000,000 and that Marion County would receive several million dollars annual in payments from the facility. Covanta has indicated that they will conduct a full economic benefit analysis of the expansion in the future. It is expected that disposal of 200,000 tpy of MSW to Generic Landfill would include local and regional economic benefit in the form of payment of a portion the tipping fee to the local government.

9.1 Conclusion of HIA Comparison of WTE and Generic Landfill

Both the Generic Landfill and the expansion of the Covanta WTE Facility were assessed as employing best available control technologies and adherence to stringent federal and state permitting requirements. Each option has benefits and potential drawbacks. The HIA finds that either can be done in a manner that would not adversely affect public health.

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APPENDIX 1

COMPARATIVE GREENHOUSE GAS ASSESSMENT

Technical Memorandum

Date:	Thursday, July 06, 2017
Project:	Expansion of the Existing Covanta Waste to Energy Facility
To:	Metro
From:	HDR
Subject:	Comparative Greenhouse Gas Analysis

As part of HDR's effort to support Metro in evaluating the option to send a portion of its mixed solid waste (MSW) to a proposed expansion of the Covanta Waste-to-Energy (WTE) Facility, a comparative greenhouse gas (GHG) analysis has been performed to compare the WTE facility option with the current landfill disposal process. The results will be incorporated into the Health Impact Assessment, to be performed as a separate task. HDR has identified multiple tools currently in use by the waste management industry for evaluating GHG emissions, and has prepared this summary and select tool results. The GHG task was conducted using two tools. The first is the Waste Reduction Model (WARM), a modeling tool developed by the United States Environmental Protection Agency (EPA) that is widely used and accepted throughout the solid waste industry, although some in the industry have raised concerns that its modeling assumptions and constraints are not able to reflect site-specific conditions. The second is the Municipal Solid Waste Decision Support Tool (MSW-DST), a peer reviewed and commonly used modeling tool also developed by EPA.

Range of Modeling Options and Assumptions

GHG modeling tools classify emissions into biogenic and anthropogenic. Biogenic emissions are considered to be carbon that was originally removed from the atmosphere through natural processes, like photosynthesis, and would eventually return to the atmosphere through a natural degradation process. Anthropogenic emissions are emissions resulting from human activities and subject to human control that impact the naturally occurring carbon cycles and balance. For example, the emissions resulting from burning fossil fuels (i.e., petroleum-based materials such as the majority of plastics in the MSW) are considered to be anthropogenic because the emissions would not have been released without human intervention. Both WARM and MSW-DST exclude the impact of biogenic GHG emissions.

In the early 1990s, life-cycle assessment (LCA) tools for end-of-life (EOL) materials management began being developed independently by a range of developers in a range of locations. As summarized in Gentil, et al. ,[1] a PhD thesis published in 2004[2] and an associated

[1] Gentil, E.C., Damgaard, A., Hauschild, M., Finnveden, G., Eriksson, O., Thorneloe, S., Kaplan, P.O., Barlaz, M., Muller, O., Matsui, Y., Ii, R., Christensen, T.H. Models for Waste Life Cycle Assessment: Review of Technical Assumptions. Waste Management 30 (2010) 2636–2648.
[2] Winkler, J., 2004. Comparative Evaluation of Life Cycle Assessment Models for Solid Waste Management. PhD Thesis. TU Dresden, Dresden, Germany, p. 127.

article published in Waste Management in 2007[3] compared six such LCA models (ARES, EPIC/CSR, IWM2, MSW-DST, ORWARE, and UMBERTO) by using each of them to evaluate the same waste management scenario based on Dresden in Germany. When results from all of the tools were compared, some were contradictory and results varied up to 1400 percent. Other studies have found that even the relative order of results (i.e., the recommended hierarchy of materials management strategies based on environmental impacts) is not consistent among different models.

In November 2015, the National Risk Management Research Laboratory (NRMRL), a center within the United States Environmental Protection Agency (USEPA), published *A Comparative Analysis of Life-Cycle Assessment Tools for End-of-Life Materials Management Systems* as part of their strategic long-term research plan.[4] NRMRL identified 29 different LCA software tools, and from that list chose five tools to further evaluate how they assessed environmental and economic impacts of end-of-life materials management options. Three of the tools (WARM, MSW-DST, and SWOLF) were developed specifically for American materials management strategies. Although the other two (WRATE and EASETECH) were developed for European conditions, they offered a large enough number of customizable parameters that the NRMRL felt they could be used for scenarios outside of their intended geographic area. The five tools were found to have great variations in areas such as materials classification, management options included, variety of user-specified parameters, nature of environmental impacts assessed, and age of source data.

There are many variations between the models often used or cited for GHG analysis of waste management options. However, the consideration of carbon storage/sequestration in landfills is one of the key variables that differs between models, and is one of the most significant topics being debated by the scientific community. This discussion involves whether (and to what extent) landfill carbon sequestration should be considered a sink for the portion of landfilled biogenic carbon-containing waste (e.g., paper, wood, etc.) that will not degrade to biogenic carbon dioxide (CO_2) and methane. This biogenic carbon, which otherwise would have decomposed aerobically to produce biogenic CO_2, can potentially be considered as removed from the global carbon cycle and stored in the landfill as an anthropogenic sink. All of the modeling tools evaluated (including the two used) recognize that a portion of the biogenic carbon will not biodegrade (i.e., not produce GHG emissions) in a landfill. However, there are varying opinions on whether or not this non-degraded biogenic carbon should be considered permanently sequestered and counted as an anthropogenic carbon sink (i.e., negative emissions) for LCA purposes.

According to the NRMRL report, biogenic carbon storage is explicitly included as an anthropogenic credit in the landfill GHG estimates for WARM and SWOLF. In SWOLF, biogenic carbon storage can be excluded by adjusting the carbon storage factors to zero. WARM does not offer such flexibility. The NRMRL report also indicates that MSW-DST and EASETECH

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[3] Winkler, J., Bilitewski, B., 2007. Comparative evaluation of life cycle assessment models for solid waste management. Waste Management 27, 1021-1031.

[4] Remediation and Redevelopment Branch, Land Remediation and Pollution Control Division, National Risk Management Research Laboratory, Office of Research and Development. A Comparative Analysis of Life-Cycle Assessment Tools for End-of-Life Materials Management Systems. November 2015

allow users the flexibility to include or exclude landfill carbon storage. Carbon storage is completely excluded in WRATE.

At the direction of Metro, based on discussions with the Oregon DEQ, landfill carbon storage is included in the GHG analysis summarized in this memo. Results from the use of both the WARM and MSW-DST models are included. The impact of the inclusion of landfill carbon storage on the results from both models is evaluated in sensitivity analyses included in this memo.

HDR also requested Covanta review the analysis. Covanta expressed a number of concerns about modeling assumptions and factors used in WARM and, to a lesser extent, in MSW-DST.[5] The requested changes to the models included:

- Adjusting the WARM results so that the fossil CO_2 emission factor reflects the historic operation of the Covanta WTE facility.
- Adjusting the WARM results to reflect a different methane generation potential constant.
- Adjusting the WARM results to reflect a different carbon storage factor consistent with selected published values for MSW (range of 0.19 – 0.285 ton carbon stored per ton of biogenic carbon in MSW).
- Adjusting the operating length of the landfill gas collection system from 30 to 45 years in MSW-DST.
- Reallocating the non-recycled paper fractions of the Metro Design Basis Material Classification from the MSW-DST category “combustible compostable recyclables” into the MSW-DST category “paper – non recyclable” as an alternate way to align the Metro waste types with the modeled categories in MSW-DST.
- Adjusting the MSW-DST carbon storage results to be consistent with selected published values for MSW (range of 0.19 – 0.285 ton carbon stored per ton of biogenic carbon in MSW), and reporting the results of the comparative analysis both with and without carbon storage.
- Adjusting the methane emissions results from landfilling in both WARM and MSW-DST to account for evolving industry discussion regarding the 100-year methane global warming potential (“GWP”), which was recently increased to a potential range of 28 to 34 in the Working Group I contribution to the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report.[6] This increase has yet to be reflected in either WARM or MSW-DST, which use a GWP of 25 for methane.
- Adjusting the results of both WARM and MSW-DST so that the methane GWP reflects methane’s role as a short-lived climate pollutant (SLCP).

WARM does not allow the editing of any of the parameters suggested for adjustment by Covanta. Some, but not all, of Covanta’s recommendations for the MSW-DST were possible as

[5] Michael E. Van Brunt, P.E., Covanta. “Re: Draft Comparative Greenhouse Gas Analysis.” Letter to Rob Smoot, Metro Property and Environmental Services. June 28, 2017.
[6] See Table 8-7 of Myhre, G. et al. (2013) Anthropogenic and Natural Radiative Forcing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Available at <https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf>.

sensitivity analyses that could be performed by refining the inputs to the model. However, changes to the inherent modeling parameters of either model would require engaging with the model's developers as well as a wide range of stakeholders and industry experts. Given the limited time to complete this study in support of the HIA, and that detailed evaluations of GHG modeling tool inherent assumptions and parameters are beyond the scope of this study, none of the changes recommended by Covanta were implemented for inclusion in this document.

During their review, Covanta identified a potential error in the MSW-DST landfill carbon storage calculator report and they requested that the MSW-DST developer, RTI International (RTI), review the model. In a memorandum dated July 5, 2017 (revised), RTI confirmed the error and addressed the needed correction. Specifically, the memorandum states that the units reported in the MSW-DST landfill carbon storage calculator are currently labeled incorrectly. After investigating the issue, RTI concluded that the numerical results generated by the landfill carbon storage calculator add-on are correct. However, the units are incorrectly stated as tons of carbon equivalent (TCE). Instead, the results should be labeled as metric tons of carbon dioxide equivalent ($MTCO_2e$).[7] HDR updated the results of the initial GHG analysis according to RTI's recommendations.

General Scenario Assumptions

Waste Characterization

The composition of the 200,000 tons of MSW modeled for GHG emissions was the waste characterization described in a report previously commissioned by Metro[8] (HDR, 2015). This waste characterization is based on 2009 data and reflects the approximately 1,098,900 tons from Metro jurisdictions that were disposed in various landfills. The composition is shown in Attachment 1, along with the corresponding amounts and categories used for the WARM and MSW-DST models. Not all of the categories had exact matches in the two GHG modeling tools, so approximations were made to be as close as possible. WARM models 54 material types, while MSW-DST models 39 material types.[9] MSW-DST also did some inherent rounding of quantities, so that they were not able to exactly match WARM, but again, approximations were made to be as close as possible.

Metro has a goal to reduce the amount of food waste material being sent to landfills in the future. As a sensitivity analysis for WARM, an alternate waste characterization was developed that reduces the amount of food waste in Metro's MSW by half. The proportions of the other materials were adjusted accordingly to keep the total tons disposed at 200,000. Attachment 2 has a detailed table of the waste characterization for this reduced food waste sensitivity analysis.

[7] Keith Weitz, RTI. "MSW DST landfill carbon storage results labeling error." Memo to Susan Thorneloe, U.S. Environmental Protection Agency. July 5, 2017 (revised).
[8] HDR. Combined Qualitative Analysis and Greenhouse Gas Analysis of Selected Waste Scenarios. March 2015.
[9] NRMLR.

LANDFILL

Although private haulers permitted or franchised by their respective jurisdictions within the Metro region have the liberty to select where they will take their collected waste, all waste generated in the Metro region must be delivered to a "Designated Facility" or the hauler must have a "Non-System" license. The two Metro transfer stations, as well as other transfer stations, are primarily used by these companies for delivery of the waste materials, although some haulers do haul waste materials directly to a landfill.

Metro currently contracts with Waste Management, Inc. (WM) to dispose of waste at WM owned landfills. Currently, the majority of Metro's waste is disposed at WM's Columbia Ridge Landfill near Arlington, Oregon, approximately 150 miles from Portland.

The contract between Metro and WM is scheduled to expire on December 31, 2019. There are two other large modern landfills located in eastern Oregon and Washington that could be considered in a new contract. Republic Services, Inc. owns and operates the Roosevelt Regional Landfill, which is located in eastern Washington near the town of Roosevelt, approximately 140 miles from Portland. Waste Connections, Inc. owns and operates the Finley Buttes Landfill, which is located in eastern Oregon near the city of Boardman, and is approximately 168 miles from Portland. When evaluating the GHG emissions from the landfill scenario, a generic landfill scenario was created that assumed an average one way hauling distance of 150 miles. This hauling distance was eliminated for one of the sensitivity analyses performed using WARM in order to show the impact of haul distance on the GHG emissions estimate.

All three of these landfills are modern, regulatory compliant facilities and are equipped with state of the art landfill gas (LFG) recovery and energy production systems. All are accessible by truck, rail, and barge from Portland. Columbia Ridge Landfill and Roosevelt Regional Landfill have reportedly used leachate recirculation systems periodically each year during the past 10 years.[10,11] Finley Buttes Landfill reports that it does not use a leachate recirculation system.[12]

To model the GHG emissions from the generic landfill scenario, the existing climatic conditions of the region were assumed (i.e., each landfill receives less than 20 inches of rainfall annually). Because not all of the landfills use leachate recirculation routinely (and none reportedly inject liquids other than leachate for the purposes of operating as a bioreactor), the generic landfill scenario does not include bioreactor operation. The impact of bioreactor operation is evaluated in the WARM sensitivity analyses. Similarly, because LFG collection efficiency data was not readily available from all landfill options, the generic landfill scenario uses the typical LFG collection rates, as defaulted by the WARM and MSW-DST models. To determine the impact of LFG collection efficiency, WARM's highest possible LFG collection rate was evaluated in the sensitivity analyses.

[10] https://ghgdata.epa.gov/ghgp/service/html/2015?id=1007989&et=undefined
[11] https://ghgdata.epa.gov/ghgp/service/html/2015?id=1003676&et=undefined
[12] https://ghgdata.epa.gov/ghgp/service/html/2015?id=1004516&et=undefined

WASTE-TO-ENERGY

If Metro were to divert 200,000 tons of its MSW to the Covanta WTE Facility, it would require the material to be hauled approximately 36 miles from the South Transfer Station. However, not all material would come directly from the South Transfer Station; material may also be hauled from another transfer station or may be collected and taken directly to the WTE facility by local haulers. To model the GHG emissions for the WTE alternative, a scenario was created that assumed an average hauling distance of 50 miles. This hauling distance was eliminated for one of the sensitivity analyses performed using WARM to show the impact of haul distance on the GHG emissions estimate.

The ash that is produced at the Covanta WTE Facility is hauled 36 miles to the Coffin Butte Landfill. WARM does not allow customization of the hauling parameters for the ash from WTE facilities, although it does include GHG emissions resulting from the transportation of the ash, based on a report done in 1994 by Franklin Associates, Ltd.[13] MSW-DST allows for customizing the hauling required for the ash, and results reflect the distance of 36 miles.

Both WARM and MSW-DST assume WTE facility scenarios have a ferrous recovery system. WARM assumes that 88 percent of steel cans are recovered. MSW-DST has a default setting that assumes 90 percent of the ferrous metal combusted is recovered for recycling.

Neither WARM nor MSW-DST explicitly includes non-ferrous metal recovery by WTE. However, HDR chose to model 70 percent recovery and recycling of non-ferrous metals in both the WARM and MSW-DST models, as a conservative estimate for a new plant with a non-ferrous recovery system and an anticipated minimum guaranteed recovery rate. This decision was based on industry knowledge of practices at existing WTE facilities, although no data from Covanta was provided specifically for the recovery rate at the Covanta WTE Facility. The Unit 3 Expansion at the Covanta Honolulu Resource Recovery Venture facility had a non-ferrous recovery guarantee of 60 percent, and the test results in 2012 showed a capture rate of 82.9 percent.[14] The Covanta Durham York Renewable Energy Limited Partnership also had a non-ferrous guarantee of 60 percent, and demonstrated an actual capture rate of 85 percent in November 2015.[15]

MODELING TOOLS AND RESULTS

U.S. ENVIRONMENTAL PROTECTION AGENCY (USEPA): WASTE REDUCTION MODEL (WARM)

WARM was created by the USEPA as a streamlined life-cycle GHG accounting tool to help managers and policy makers understand and compare the emissions and offsets resulting from different materials management options (e.g., landfill disposal, composting, etc.) for materials

[13] USEPA, 2016. Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM). Available at <www.epa.gov/sites/production/files/2016-03/documents/warm_v14_background.pdf>.
[14] Covanta. Acceptance Test Report for Unit 3 Expansion, Covanta Honolulu Resource Recovery Venture. September 2012.
[15] Covanta. Acceptance Test Report, Metals Recovery Test for Covanta Durham York Renewable Energy Limited Partnership. November 2015.

commonly found in the waste stream. Only anthropogenic emissions are considered as GHG emissions in WARM.[16]

As indicated by EPA, the emission factors used by WARM represent the full life-cycle changes in GHG emissions associated with a management option as compared to a baseline option. Consequently, WARM correctly accounts for the full range of GHG emission changes resulting from alternative waste management options, but it does not explicitly model the timing of these GHG emission changes.[17] The emissions shown for each solid waste management alternative in WARM represent the estimate for net GHG emissions, which includes gross manufacturing emissions (as impacted by source reduction or by the use of recycled material versus the use of raw material), any increases in carbon stocks, any direct GHG emissions associated with the alternative, and any avoided fossil fuel utility emissions. WARM considers landfill carbon storage factors as part of its model of the carbon flows and emissions that occur for landfilled materials.[18]

The current version of WARM (Version 14, released in March 2016) allows categorization of the MSW stream into 54 different materials, products and mixed categories and EPA has written guidance for how to handle other material types not included in the 54 choices. The WARM model also accounts for the energy used by mobile equipment used at the landfill to compress the MSW and obtain and place cover materials. There are varying options available for the level of LFG collection and use, with averages ranging from 60.3 percent to 78.8 percent. The "typical collection" option was created to represent the average U.S. landfill, which EPA has judged to have 64.8 percent LFG collection efficiency.[19]

HDR used WARM to model the GHG emissions impact of shifting the proposed 200,000 tons of solid waste from final disposal in the landfill to processing at the Covanta WTE Facility. The key assumptions and detailed results are included in Attachment 2. As a sensitivity analysis, HDR then performed a separate calculation to determine how much of the GHG emissions in the WARM results were due to WARM's estimation of carbon sequestration in the landfill. Using the WARM values for carbon sequestration for each material type[20] and the quantities of each material input to the model, a total value for landfill carbon storage was extracted from the WARM model results.

Table 1 shows the final results from WARM, both with and without the credits for carbon storage in the landfill. Allowing WARM to consider carbon storage results in emissions of -0.08 $MTCO_2e$ per ton of waste managed at the landfill. The negative value indicates a credit, or reduction, in GHG emissions. When landfill carbon storage credits are removed from the WARM results, the landfilling result is 0.19 $MTCO_2e$ per ton of waste. The GHG emissions of the WTE facility calculated by WARM is 0.11 $MTCO_2e$ per ton of waste managed.

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[16] Ibid.
[17] USEPA, 2016.
[18] USEPA. "Landfill Carbon Storage in WARM." October 27, 2010. Available at <www.epa.gov/sites/production/files/2016-03/documents/landfill-carbon-storage-in-warm10-28-10.pdf>.
[19] USEPA Office of Resource Conservation and Recovery. *Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM).* March 2015.
[20] Ibid.

Table 1. WARM Results

Scenario	Annual Throughput (tons/year)	WARM Estimated GHG Emissions (MTCO2e)[1, 2, 3]	*Estimated GHG Emissions per Ton Managed (MTCO2e/ton)* [1,2,3]	WARM Estimated GHG Emissions from Carbon Sequestration (MTCO2e) [1,4]	Estimated GHG Emissions - Without Carbon Sequestration (MTCO2e) [1,2,3]	*Estimated GHG Emissions per Ton Managed - Without Carbon Sequestration (MTCO2e/ton)* [1,2,3]
Status Quo/Landfill	200,000	-15,874	*-0.08*	-54,528	38,654	*0.19*
Covanta WTE Facility	200,000	21,320	*0.11*	NA	21,320	*0.11*

1 - The emission values represent net emissions, accounting for both direct and indirect emissions and credits associated with a given solid waste management option. Negative emissions indicate that a management scenario represents a net CO_2 sink.

2 - The transportation emissions included represent round-trip distances from a transfer station to the anticipated solid waste management option location, plus emissions from mobile equipment used in the waste management practice (landfilling or combustion).

3 - The landfill scenario assumes a "typical" landfill gas capture efficiency and that the gas is recovered for energy (electrical production). The landfilling and WTE avoided electricity GHG emissions are based on WARM's regional marginal electricity grid mix emissions for Oregon.

4 - The potential carbon storage associated with landfilling is included as a credit by WARM, but is not included in many life cycle GHG evaluations conducted internationally. The credit amount calculated by WARM was determined and subtracted.

WARM Sensitivity Analyses

HDR performed a series of additional WARM evaluations as sensitivity analyses to the original model, the results of which are summarized in Tables 2 and 3. The purpose of these analyses was to illustrate the extent that certain model assumptions (landfill type, LFG collection efficiency, food waste diversion, hauling distances, and non-ferrous metal recovery) affected the model results. Overall, the parameters assumed for the landfill sensitivity analyses caused a higher degree of change in the results than those for the WTE sensitivity analyses. Most notably, modeling a bioreactor landfill with just typical LFG collection efficiency caused an increase in GHG emissions, even when accounting for carbon storage. Conversely, a LFG collection system operating at the highest level of collection available in the model ("California" version) reduced GHG emissions, and the greatest reduction in GHG emissions modeled corresponded to a landfill operating without a bioreactor but with the California version of LFG collection rates.

Table 2. WARM Sensitivity Analyses for Landfill Scenario

Landfill Scenario	Annual Throughput (tons/year)	WARM Estimated GHG Emissions (MTCO2e)	*Estimated GHG Emissions per Ton Managed (MTCO2e/ton)*	WARM Estimated GHG Emissions from Carbon Sequestration (MTCO2e)	Estimated GHG Emissions - Without Carbon Sequestration (MTCO2e)	*Estimated GHG Emissions per Ton Managed - Without Carbon Sequestration (MTCO2e/ton)*
Original (Dry)	200,000	-15,874	*-0.08*	-54,528	38,654	*0.19*
Bioreactor	200,000	8,096	*0.04*	-54,528	62,624	*0.31*
CA Reg LFG	200,000	-33,902	*-0.17*	-54,528	20,626	*0.10*
Bioreactor + CA Reg LFG	200,000	-8,485	*-0.04*	-54,528	46,043	*0.23*
50% Food Waste Diverted	200,000	-22,902	*-0.11*	-58,530	35,628	*0.18*
Original with No Hauling Distance	200,000	-20,800	*-0.10*	-54,528	33,728	*0.17*

Table 3. WARM Sensitivity Analyses for WTE Scenario

WTE Scenario	Annual Throughput (tons/year)	WARM Estimated GHG Emissions (MTCO2e)	*Estimated GHG Emissions per Ton Managed (MTCO2e/ton)*	WARM Estimated GHG Emissions from Carbon Sequestration (MTCO2e)	Estimated GHG Emissions - without Carbon Sequestration (MTCO2e)	*Estimated GHG Emissions per Ton Managed - without Carbon Sequestration (MTCO2e/ton)*
Original	200,000	21,320	*0.11*	0	21,320	*0.11*
No Non-Ferrous Recovery	200,000	26,040	*0.13*	0	26,040	*0.13*
50% Food Waste Diverted	200,000	24,950	*0.12*	0	24,950	*0.12*
Original with No Hauling Distance	200,000	19,292	*0.10*	0	19,292	*0.10*

RTI INTERNATIONAL (RTI): MUNICIPAL SOLID WASTE DECISION SUPPORT TOOL (MSW-DST)

MSW-DST was created by RTI, with co-funding by USEPA, as a comprehensive LCA tool to help solid waste planners evaluate the cost and environmental aspects of integrated solid waste management strategies, one aspect of which is a GHG emissions analysis.

MSW-DST calculates the emissions associated with all stages of waste management from waste collection, transfer, materials recovery, treatment, and final disposal for each waste management option. In addition, the model determines the potential benefits associated with energy production and materials recovery associated with a given waste management option. There are varying options available for the level of LFG collection and use.[21] The options chosen for this analysis, along with other key assumptions, are summarized in Attachment 3.

HDR used MSW-DST to model the GHG emissions of shifting the proposed 200,000 tons of solid waste from final disposal in a landfill to processing at the Covanta WTE Facility. In general, MSW-DST allows for more customization than WARM, allowing for more inputs such as distance traveled from the WTE facility to the ash disposal site. However, while WARM recognizes 54 material types, MSW-DST recognizes only 39 material types. As shown in Attachment 1, this created a slightly different distribution of tons across the material categories, though efforts were made to keep the comparisons as consistent as possible.

Table 4 shows the results obtained from MSW-DST, including the credit for carbon storage in the landfill (calculated separately by the model). Without carbon storage, emissions are 0.54 MTCO2e per ton of waste managed at the landfill; if carbon storage is included, emissions are reduced to 0.34 MTCO2e per ton of waste managed at the landfill. The GHG emissions per ton of waste managed at the WTE facility are modeled by MSW-DST to be negligible.

Table 4. MSW-DST Results

Scenario	**Annual Throughput (tons/year)**	**MSW-DST Estimated GHG Emissions with Carbon Sequestration (MTCO2e)** [1,2,3,4]	***Estimated GHG Emissions per Ton Managed (MTCO2e/ton)*** [1,2,3,4]	**MSW-DST Estimated GHG Emissions from Carbon Sequestration (MTCO2e)** [1,4]	**Estimated GHG Emissions – Without Carbon Sequestration (MTCO2e)** [1,2,3]	***Estimated GHG Emissions per Ton Managed – Without Carbon Sequestration (MTCO2e/ton)*** [1,2,3]
Status Quo/Landfill	200,000	68,281	*0.34*	-39,488	107,769	*0.54*
Covanta WTE Facility	200,000	-906	*-0.005*	NA	-906	*-0.005*

1 - The emission values represent net emissions, accounting for both direct and indirect emissions and credits associated with a given solid waste management option. Negative emissions indicate that a management scenario represents a net CO_2 sink.

2 - The transportation emissions included represent round-trip distances from a transfer station to the anticipated solid waste management option location, plus emissions from mobile equipment used in the waste management practice (landfilling or combustion).

3 - The landfilling scenario assumes a "typical" landfill gas capture efficiency and that the gas is recovered for energy (electrical production). The landfilling and WTE avoided electricity GHG emissions are based on MSW-DST's regional marginal electricity grid mix emissions for the Western Systems Coordinating Council, which includes the states of Washington, Oregon, Colorado, California, Nevada, Montana, Idaho, Wyoming, Utah, Arizona, and New Mexico.

4 - The potential carbon storage associated with landfilling is included as a separate calculation in MSW-DST, but is not included in the overall life cycle GHG value output of MSW-DST. The separately calculated credit amount was added to the MSW-DST output. As announced in a memorandum, dated July 5, 2017 (revised), from Keith Weitz of RTI, the current MSW_DST model presents the results generated by the landfill carbon storage calculator add-on incorrectly as tons of carbon equivalent (TCE). Instead, the units should be labeled as metric tons of carbon dioxide equivalent (MTCO2e). The results shown reflect this correction.

[21] RTI International Downloadable Resources, November 4, 2016. Available at <https://mswdst.rti.org/resources.htm>.

SUMMARY AND RECOMMENDATIONS

Differences in the modeling tools result in different values for the GHG emission impacts associated with sending 200,000 tons of Metro MSW to the Covanta WTE Facility instead of to landfill. WARM shows that landfilling has lower GHG emissions impacts than WTE, primarily due to the credit for carbon stored in the landfill. WARM estimates that landfilling the waste provides a slight reduction in GHG emissions (-0.08 $MTCO_2e$ per ton MSW managed), compared to a slight increase in GHG emissions caused by processing the waste at the WTE facility (0.11 $MTCO_2e$ per ton MSW). If carbon storage were not considered in the analysis, the results for WARM would be reversed, and WTE would show lower GHG emissions impacts than landfilling.

MSW-DST shows that WTE has lower GHG impacts than landfilling, even when accounting for the carbon stored in the landfill. MSW-DST estimates that landfilling the waste provides an increase in GHG emissions (0.34 MTCO2e per ton MSW managed), compared to a negligible decrease in GHG emissions caused by processing the waste at the WTE facility (-0.005 MTCO2e per ton MSW). If carbon storage were not considered in the analysis, the GHG emission results for landfilling would be even greater.

Through a series of sensitivity analyses performed in WARM, it is evident that the input parameters used in the model have the potential to significantly affect the results. As the contract for disposal of Metro waste nears its end, it is uncertain how these parameters will change with a new contract. In addition, it has been noted that several EOL LCA modeling tools are used around the world, each with variations in key assumptions and calculation methodologies. This variability reveals the divergence of scientific thought as it relates to LCA methodology. This is especially the case regarding the issue of whether or not carbon stored in the landfill is a carbon sink. The sensitivity analyses performed above demonstrate the reversal of conclusions when landfilled biogenic carbon is not considered as a sink.

As WARM and MSW-DST generated conflicting answers to the question of which waste management scenario would result in fewer GHG emissions, HDR can make no definitive recommendation on which scenario would have the lesser impact on climate change. It is recommended that Metro consider the results of this GHG emissions modeling as indicative of the potential effects of each waste management scenario, with the understanding that these are broad estimates based on broad assumptions and there are limitations in the models used. Furthermore, as there is not yet consensus among the developers of the models, it should be noted that these results are not replicable across different models, even though each model may be well documented and widely used in a certain geographic or academic setting. It is beyond the purview of this study to comment on which approach is most appropriate for considering GHG emissions from the waste management options being considered. As such, caution is recommended to decision makers not to place too much emphasis, one way or another, with respect to relying on the findings of GHG emissions, given the lack of consensus in scientific communities for estimating the GHG impacts of waste management options. In the future, additional insight may be provided by refining the parameters and sensitivity analyses of the models, or creating a customized LCA using measured, site-specific operating data from each of the facilities involved in the waste management alternatives.

ATTACHMENT 1

Metro Design Basis Material Classification	Metro Waste Characterization		WARM v14 Material Classification	WARM v14		MSW-DST Material Classification	MSW-DST	
	Tons	%		Tons	%		Tons	%
TOTAL PAPER	**194,882.2**	**17.10%**	**TOTAL PAPER**	**34,208.8**	**17.10%**	**TOTAL PAPER**	**31,149.9**	**15.57%**
Cardboard	40,653.9	3.57%	Corrugated Containers	7,136.2	3.57%	Corrugated Cardboard	7,130.0	3.56%
Office paper	8,887.8	0.78%	Office Paper	1,560.1	0.78%	Office Paper	1,520.0	0.76%
Newspaper and magazines	17,166.2	1.51%	Newspaper	1,958.6	0.98%	Newspaper	1,970.0	0.98%
			Magazines/Third-class Mail	1,054.7	0.53%	Magazines	1,060.0	0.53%
Mixed paper	21,602.4	1.90%	Mixed Paper (general)	3,792.0	1.90%	Combustible compostable recyclables (commercial stream)	3,792.1	1.90%
Other compostable nonrecycl. paper	70,773.4	6.21%	Mixed Paper (general)	12,423.3	6.21%	Combustible compostable recyclables (commercial stream)	12,423.7	6.21%
Other non-compostable nonrecycl. paper	35,798.6	3.14%	Mixed Paper (general)	6,283.9	3.14%	Combustible compostable recyclables (commercial stream)	6,284.1	3.14%
TOTAL PLASTIC	**156,428.3**	**13.73%**	**TOTAL PLASTIC**	**27,458.8**	**13.73%**	**TOTAL PLASTIC**	**27,510.0**	**13.75%**
Plastic bottles	7,154.6	0.63%	PET	1,255.9	0.63%	PET	1,210.0	0.60%
Other rigid plastics	64,945.8	5.70%	Mixed Plastics	11,400.3	5.70%	Plastic nonrecyclable	11,442.6	5.72%
Plastic film - recyclable	21,245.8	1.86%	Mixed Plastics	3,729.4	1.86%	Plastic nonrecyclable	3,743.2	1.87%
Plastic film - non-recyclable	52,502.2	4.61%	LDPE	9,216.0	4.61%	Plastic nonrecyclable	9,250.2	4.62%
Mixed plastic / materials	10,579.9	0.93%	Mixed Plastics	1,857.2	0.93%	Plastic nonrecyclable	1,864.0	0.93%
OTHER ORGANICS	**532,025.0**	**46.69%**	**OTHER ORGANICS**	**93,389.4**	**46.69%**	**OTHER ORGANICS**	**101,050.1**	**50.51%**
Yard Debris	25,121.3	2.20%	Yard Trimmings	4,409.7	2.20%	40% grass, 30% leaves, 30% branches (based on DST default breakout)		
						Leaves	4,550	2.27%
						Grass	6,070	3.03%
						Branches	4,550	2.27%
Clean wood	47,779.6	4.19%	Dimensional Lumber	8,387.0	4.19%	Combustible compostable recyclables (commercial stream)	8,387.3	4.19%
Painted & treated lumber	16,805.3	1.47%	Wood Flooring	2,949.9	1.47%	Combustible compostable recyclables (commercial stream)	2,950.0	1.47%
Mixed wood / materials	56,184.5	4.93%	Dimensional Lumber	9,862.4	4.93%	Combustible compostable recyclables (commercial stream)	9,862.7	4.93%
Food waste	204,804.1	17.98%	Food Waste (non-meat)	35,950.5	17.98%	Food Waste	36,000.0	17.99%
Rubber	6,550.7	0.57%	Tires	1,149.9	0.57%	Miscellaneous Combustible	1,758.9	0.88%
Disposable diapers	38,226.0	3.36%	Mixed MSW	6,710.0	3.36%	Paper - non recyclable	6,680.0	3.34%
Carpet/pad	28,460.4	2.50%	Carpet	4,995.8	2.50%	Miscellaneous Combustible	7,641.8	3.82%
Textiles	46,923.5	4.12%	Carpet	8,236.7	4.12%	Miscellaneous Combustible	12,599.3	6.30%
Other misc. organics	61,169.6	5.37%	Mixed Organics	10,737.5	5.37%	(Included with Yard Debris)		
GLASS	**18,815.3**	**1.65%**	**GLASS**	**3,302.8**	**1.65%**	**GLASS**	**3,340.0**	**1.67%**
Deposit Beverage Glass	2,803.4	0.25%	Glass	492.1	0.25%	Glass - Clear	3,340.0	1.67%
Window and other glass	16,011.9	1.41%	Glass	2,810.7	1.41%	Glass - Clear		0.00%

Metro Design Basis Material Classification	Metro Waste Characterization		WARM v14	WARM v14		MSW-DST Material Classification	MSW-DST	
	Tons	%		Tons	%		Tons	%
METAL	**76,681.1**	**6.73%**	**METAL**	**13,460.3**	**6.73%**	**METAL**	**12,719.6**	**6.36%**
Aluminum	4,205.5	0.37%	Aluminum Cans	738.2	0.37%	Aluminum	759.0	0.38%
Ferrous metals	29,694.3	2.61%	Steel Cans	5,212.4	2.61%	Ferrous Cans	5,160.0	2.58%
Mixed Metals	26,028.3	2.28%	Mixed Metals	4,568.9	2.28%	Non-Combustible Non-compostable recyclables (commercial stream)	4,580.0	2.29%
Computers, brown goods, small apl.	16,753.0	1.47%	Personal Computers	2,940.8	1.47%	Miscellaneous	2,220.6	1.11%
OTHER INORGANICS	**133,664.3**	**11.73%**	**OTHER INORGANICS**	**23,462.9**	**11.73%**	**OTHER INORGANICS**	**17,717.4**	**8.86%**
Rock, concrete, brick	12,142.6	1.07%	Concrete	2,131.5	1.07%	Miscellaneous	1,609.5	0.80%
Soil, sand, dirt	16,581.6	1.46%	Concrete	2,910.7	1.46%	Miscellaneous	2,197.9	1.10%
Gypsum wallboard	36,358.3	3.19%	Drywall	6,382.2	3.19%	Miscellaneous	4,819.3	2.41%
Other misc. inorganics	68,581.8	6.02%	Asphalt Concrete	12,038.6	6.02%	Miscellaneous	9,090.6	4.54%
BULKY MATERIALS	**18,930.2**	**1.66%**	**10% Tires, 90% Mixed MSW**	**3,322.9**	**1.66%**	**Miscellaneous**	**2,509.2**	**1.25%**
MEDICAL WASTES	**5,422.5**	**0.48%**	**Mixed MSW**	**951.9**	**0.48%**	**Miscellaneous**	**718.8**	**0.36%**
HAZARDOUS MATERIALS	**2,519.6**	**0.22%**	**Mixed MSW**	**442.3**	**0.22%**	**Miscellaneous**	**334.0**	**0.17%**
Total Material Modeled	*1,139,368.6*	*100%*	***Total Material Modeled***	*200,000*	*100%*	***Total Material Modeled***	*200,079*	*100%*

ATTACHMENT 2

WARM ANALYSIS BACKGROUND

GENERIC LANDFILL AND COVANTA WTE FACILITY

The following key assumptions were used in the model:

- Waste is assumed to be landfilled at a landfill equipped with a landfill gas collection system, using WARM's assumptions for collection efficiency of a "typical operation" (0% in Years 0-1; 50% in Years 2-4; 75% in Years 5-14; 82.5% in Year 15 to 1 year before final cover; and 90% with final cover).
- Collected landfill gas is used to generate electricity in Oregon.
- The landfill receives less than 20 inches of precipitation per year.
- Average hauling distance of waste from transfer station to landfill is 150 miles.
- Average hauling distance of waste from transfer station to the Covanta WTE Facility is 50 miles.
- As WARM does not account for recovery of nonferrous metal after combustion, the WARM inputs for combustion assumed 70% of aluminum cans were recycled.

The table below shows the quantities used for each material category and the values used for calculating the portion of emissions reduction that WARM attributes to carbon sequestration from landfilling.

Metro Design Basis Material Classification	WARM v14 Material Classification	WARM v14		Amount of Carbon Stored (MTCO2e per Wet Short Ton)	Amount of Carbon Stored (Total MTCO2e)
		Tons	%		
TOTAL PAPER	**TOTAL PAPER**	**34,208.8**	**17.10%**	**TOTAL PAPER**	**20,876.7**
Cardboard	Corrugated Containers	7,136.2	3.57%	0.7	5,138.1
Office paper	Office Paper	1,560.1	0.78%	0.1	187.2
Newspaper and magazines	Newspaper	1,958.6	0.98%	1.2	2,330.8
	Magazines/Third-class Mail	1,054.7	0.53%	0.5	474.6
Mixed paper	Mixed Paper (general)	3,792.0	1.90%	0.7	2,621.0
Other compostable nonrecycl. paper	Mixed Paper (general)	12,423.3	6.21%	0.7	8,587.0
Other non-compostable nonrecycl. paper	Mixed Paper (general)	6,283.9	3.14%	0.7	4,343.5
TOTAL PLASTIC	**TOTAL PLASTIC**	**27,458.8**	**13.73%**	**TOTAL PLASTIC**	**0.0**
Plastic bottles	PET	1,255.9	0.63%	0.0	0.0
Other rigid plastics	Mixed Plastics	11,400.3	5.70%	0.0	0.0
Plastic film - recyclable	Mixed Plastics	3,729.4	1.86%	0.0	0.0
Plastic film - non-recyclable	LDPE	9,216.0	4.61%	0.0	0.0
Mixed plastic / materials	Mixed Plastics	1,857.2	0.93%	0.0	0.0
OTHER ORGANICS	**OTHER ORGANICS**	**93,389.4**	**46.69%**	**OTHER ORGANICS**	**29,414.2**
Yard Debris	Yard Trimmings	4,409.7	2.20%	0.5	2,381.2
Clean wood	Dimensional Lumber	8,387.0	4.19%	1.1	9,141.9
Painted & treated lumber	Wood Flooring	2,949.9	1.47%	1.1	3,215.4
Mixed wood / materials	Dimensional Lumber	9,862.4	4.93%	1.1	10,750.0
Food waste	Food Waste (non-meat)	35,950.5	17.98%	0.1	2,516.5
Rubber	Tires	1,149.9	0.57%	0.0	0.0
Disposable diapers	Mixed MSW	6,710.0	3.36%	0.2	1,409.1
Carpet/pad	Carpet	4,995.8	2.50%	0.0	0.0
Textiles	Carpet	8,236.7	4.12%	0.0	0.0
Other misc. organics	Mixed Organics	10,737.5	5.37%	0.0	0.0

Metro Design Basis Material Classification	WARM v14 Material Classification	WARM v14		Amount of Carbon Stored (MTCO2e per Wet Short Ton)	Amount of Carbon Stored (Total MTCO2e)
		Tons	%		
GLASS	**GLASS**	**3,302.8**	**1.65%**	**GLASS**	**0.0**
Deposit Beverage Glass	Glass	492.1	0.25%	0.0	0.0
Window and other glass	Glass	2,810.7	1.41%	0.0	0.0
METAL	**METAL**	**13,460.3**	**6.73%**	**METAL**	**0.0**
Aluminum	Aluminum Cans	738.2	0.37%	0.0	0.0
Ferrous metals	Steel Cans	5,212.4	2.61%	0.0	0.0
Mixed Metals	Mixed Metals	4,568.9	2.28%	0.0	0.0
Computers, brown goods, small apl.	Personal Computers	2,940.8	1.47%	0.0	0.0
OTHER INORGANICS	**OTHER INORGANICS**	**23,462.9**	**11.73%**	**OTHER INORGANICS**	**510.6**
Rock, concrete, brick	Concrete	2,131.5	1.07%	0.0	0.0
Soil, sand, dirt	Concrete	2,910.7	1.46%	0.0	0.0
Gypsum wallboard	Drywall	6,382.2	3.19%	0.1	510.6
Other misc. inorganics	Asphalt Concrete	12,038.6	6.02%	0.0	0.0
BULKY MATERIALS	**10% Tires, 90% Mixed MSW**	**3,322.9**	**1.66%**	0.2	**628.0**
MEDICAL WASTES	**Mixed MSW**	**951.9**	**0.48%**	0.2	**199.9**
HAZARDOUS MATERIALS	**Mixed MSW**	**442.3**	**0.22%**	0.2	**92.9**
Total Material Modeled		***200,000***	***100%***	***Total Carbon Stored***	***54,527.6***

WARM SENSITIVITY ANALYSES BACKGROUNDS

The following lists key assumptions used in each sensitivity analysis model.

BIOREACTOR LANDFILL

- Waste characterization is the same as used for the Generic Landfill model.
- Waste is assumed to be landfilled at a landfill equipped with a landfill gas collection system, using WARM's assumptions for collection efficiency of a "typical operation" (0% in Years 0-1; 50% in Years 2-4; 75% in Years 5-14; 82.5% in Year 15 to 1 year before final cover; and 90% with final cover).
- Collected landfill gas is used to generate electricity in Oregon.
- The landfill is operated as a bioreactor, where water is added until the moisture content reaches 40% moisture on a wet waste basis.
- Average hauling distance of waste from transfer station to landfill is 150 miles.

GENERIC LANDFILL WITH HIGHEST LANDFILL GAS RECOVERY OPTION

- Waste characterization is the same as used for the Generic Landfill model.
- Waste is assumed to be landfilled at a landfill equipped with a landfill gas collection system, using WARM's assumptions for "California" collection efficiency (0% in Year 0; 50% in Year 1; 80% in Years 2-7; 85% in Year 8 to 1 year before final cover; and 90% with final cover).
- Collected landfill gas is used to generate electricity in Oregon.
- The landfill receives less than 20 inches of precipitation per year.
- Average hauling distance of waste from transfer station to landfill is 150 miles.

BIOREACTOR LANDFILL WITH HIGHEST LANDFILL GAS RECOVERY OPTION

- Waste characterization is the same as used for the Generic Landfill model.
- Waste is assumed to be landfilled at a landfill equipped with a landfill gas collection system, using WARM's assumptions for "California" collection efficiency (0% in Year 0; 50% in Year 1; 80% in Years 2-7; 85% in Year 8 to 1 year before final cover; and 90% with final cover).
- Collected landfill gas is used to generate electricity in Oregon.
- The landfill is operated as a bioreactor, where water is added until the moisture content reaches 40% moisture on a wet waste basis.
- Average hauling distance of waste from transfer station to landfill is 150 miles.

WTE WITH NO NON-FERROUS METAL RECOVERY

- Waste characterization is the same as used for the Covanta WTE Facility model.
- Average hauling distance of waste from transfer station to the Covanta WTE Facility is 50 miles.
- WARM does not account for recovery of nonferrous metal after combustion.

FUTURE REDUCTIONS IN FOOD WASTE SENSITIVITY ANALYSIS (GENERIC LANDFILL AND WTE WITH NON-FERROUS RECOVERY)

- Waste is assumed to be landfilled at a landfill equipped with a landfill gas collection system, using WARM's assumptions for collection efficiency of a "typical operation" (0% in Years 0-1; 50% in Years 2-4; 75% in Years 5-14; 82.5% in Year 15 to 1 year before final cover; and 90% with final cover).
- Collected landfill gas is used to generate electricity in Oregon.
- The landfill receives less than 20 inches of precipitation per year.
- Average hauling distance of waste from transfer station to landfill is 150 miles.
- Average hauling distance of waste from transfer station to the Covanta WTE Facility is 50 miles.
- As WARM does not account for recovery of nonferrous metal after combustion, the WARM inputs for combustion assumed 70% of aluminum cans were recycled.

As part of sensitivity analyses, the amount of food waste assumed to be going to the landfill in the future will be approximately half of the amount that is going to the landfill now. Metro's 2009 waste characterization estimated that 204,804 tons (approximately 18%) of waste going to the landfill was food waste. This scenario assumes that amount is reduced to 102,402 tons, and the waste characterization is adjusted accordingly. The table below shows the values used for tons of each material category under this alternative scenario, and the corresponding values used for calculating the portion of emissions reduction that WARM attributes to carbon sequestration from landfilling.

Metro Design Basis Material Classification	WARM v14 Material Classification	WARM v14		Amount of Carbon Stored (MTCO2e per Wet Short Ton)	Amount of Carbon Stored (Total MTCO2e)
		Tons	%		
TOTAL PAPER	**TOTAL PAPER**	**34,276.1**	**17.14%**	**TOTAL PAPER**	**22,938.3**
Cardboard	Corrugated Containers	7,840.9	3.92%	0.7	5,645.5
Office paper	Office Paper	1,714.2	0.86%	0.1	205.7
Newspaper and magazines	Newspaper	2,152.1	1.08%	1.2	2,560.9
	Magazines/Third-class Mail	1,158.8	0.58%	0.5	521.5
Mixed paper	Mixed Paper (general)	4,166.5	2.08%	0.7	2,879.9
Other compostable nonrecycl. paper	Mixed Paper (general)	13,650.1	6.83%	0.7	9,434.9
Other non-compostable nonrecycl. paper	Mixed Paper (general)	6,904.5	3.45%	0.7	4,772.4
TOTAL PLASTIC	**TOTAL PLASTIC**	**30,170.4**	**15.09%**	**TOTAL PLASTIC**	**0.0**
Plastic bottles	PET	1,379.9	0.69%	0.0	0.0
Other rigid plastics	Mixed Plastics	12,526.1	6.26%	0.0	0.0
Plastic film - recyclable	Mixed Plastics	4,097.7	2.05%	0.0	0.0
Plastic film - non-recyclable	LDPE	10,126.1	5.06%	0.0	0.0
Mixed plastic / materials	Mixed Plastics	2,040.6	1.02%	0.0	0.0
OTHER ORGANICS	**OTHER ORGANICS**	**82,861.5**	**41.43%**	**OTHER ORGANICS**	**30,936.3**
Yard Debris	Yard Trimmings	4,845.2	2.42%	0.5	2,616.4
Clean wood	Dimensional Lumber	9,215.3	4.61%	1.1	10,044.6
Painted & treated lumber	Wood Flooring	3,241.2	1.62%	1.1	3,532.9
Mixed wood / materials	Dimensional Lumber	10,836.3	5.42%	1.1	11,811.6
Food waste	Food Waste (non-meat)	19,750.3	9.88%	0.1	1,382.5
Rubber	Tires	1,263.4	0.63%	0.0	0.0
Disposable diapers	Mixed MSW	7,372.7	3.69%	0.2	1,548.3
Carpet/pad	Carpet	5,489.2	2.74%	0.0	0.0
Textiles	Carpet	9,050.1	4.53%	0.0	0.0
Other misc. organics	Mixed Organics	11,797.8	5.90%	0.0	0.0
GLASS	**GLASS**	**3,628.9**	**1.81%**	**GLASS**	**0.0**
Deposit Beverage Glass	Glass	540.7	0.27%	0.0	0.0
Window and other glass	Glass	3,088.2	1.54%	0.0	0.0
METAL	**METAL**	**14,789.5**	**7.39%**	**METAL**	**0.0**
Aluminum	Aluminum Cans	811.1	0.41%	0.0	0.0
Ferrous metals	Steel Cans	5,727.1	2.86%	0.0	0.0
Mixed Metals	Mixed Metals	5,020.1	2.51%	0.0	0.0
Computers, brown goods, small apl.	Personal Computers	3,231.2	1.62%	0.0	0.0
OTHER INORGANICS	**OTHER INORGANICS**	**25,779.9**	**12.89%**	**OTHER INORGANICS**	**561.0**
Rock, concrete, brick	Concrete	2,341.9	1.17%	0.0	0.0
Soil, sand, dirt	Concrete	3,198.1	1.60%	0.0	0.0
Gypsum wallboard	Drywall	7,012.4	3.51%	0.1	561.0
Other misc. inorganics	Asphalt Concrete	13,227.4	6.61%	0.0	0.0
BULKY MATERIALS	**10% Tires, 90% Mixed MSW**	**3,651.1**	**1.83%**	0.2	**690.1**
MEDICAL WASTES	**Mixed MSW**	**1,045.8**	**0.52%**	0.2	**219.6**
HAZARDOUS MATERIALS	**Mixed MSW**	**486.0**	**0.24%**	0.2	**102.1**
Total Material Modeled		***200,000***	***100%***	***Total Carbon Stored***	***58,529.8***

ATTACHMENT 3

MSW-DST Analysis Background

The following key assumptions were used in the model:

- Regional Electricity Grid = Western Systems Coordinating Council (WSCC)
  - Washington, Oregon, Colorado, California, Nevada, Montana, Idaho, Wyoming, Utah, Arizona, New Mexico
- Distances to next unit process:
  - Distance to Landfill was set to 150 miles (speed remains at default value of 35 mph)
  - Distance to MSW Combustion Plant was set to 50 miles (speed remains at default value of 35 mph)
- Distance between nodes (One-way), Origin: Treatment at MSW Combustion Plant
  - Ash from the WTE plant is taken to the Coffin-Butte Landfill north of Corvallis where it is used as alternate daily cover in lieu of soil.[22] The transport distance is 36 miles.
- Landfill Gas Operation Times and Gas Management Options:
  - Methane decay rate (k): 0.02, to match the WARM assumption
  - Operation Time was changed from the default of 10 years to 20 years.
  - Methane collection efficiency was left as default, which is similar to but not exactly the same as the WARM assumptions for "Typical Operation" (0% in Years 0-1; 50% in Year 3; 60% in Year 4; 70% in Year 5; 75% in Years 6-13; 78% in Year 14; 80% in Year 15; 83% in Year 16; 85% in Year 17; 90% in Year 18 to 31, and 0% after year 31).
  - Gas Management Type was set to Energy Recovery for all years
  - Energy Recovery Method was left to the defaults of Energy Recovery Method of Internal Combustion Engine with 0.33 Efficiency for Energy conversion (slightly higher than WARM)
- WTE metals recovery
  - MSW-DST defaults to assuming 90% of the ferrous metal combusted is recovered for recycling, which is slightly higher than the 88% assumed by WARM.
  - MSW-DST does not directly include recovery of non-ferrous metal from combustion, however, a separate MSW-DST model for the recovery of non-ferrous metal was completed, and the results were incorporated into the GHG emissions totals. Recovery rate was assumed to be 70%, which was also used for the WARM analysis.

[22] http://www.co.marion.or.us/PW/ES/disposal/Pages/mcwef.aspx

APPENDIX 2

LITERATURE REVIEW OF WASTE TO ENERGY ISSUES

Metro Solid Waste Management Plan and Expansion Analysis

Literature Review of Waste-to-Energy Issues

Portland Metro

May 5, 2017

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Appendices

Appendix A: Literature Review of Potential Health Risk Issues Associated with New Waste-to-Energy Facilities (2014) Prepared for Metro Vancouver by Intrinsik Environmental Sciences Inc.

Appendix B: Review of Research into Health Effects of EfW Facilities (2012) Prepared for the Environmental Services Association by AEA Technology Plc. (now Ricardo-AEA Ltd.)

1 Introduction

Metro Portland (Metro) has oversight of policies, programs, and facilities in Clackamas, Multnomah and Washington counties (Tri-County area) and 24 cities in the region for the management of municipal solid waste (MSW). As part of a long-term strategic planning effort, Metro is exploring a variety of potential options to improve the recovery and beneficial use of the MSW non-recovered discards. Currently, Metro receives and transfers approximately 1.3 million tons per year (tpy) of MSW to landfills outside the region. Nearly 500,000 tpy of this MSW is taken to the Columbia Ridge landfill, located approximately 150 miles from Portland in eastern Oregon.

In April of 2015, Metro released a Request for Expressions of Interest (RFEOI) to solicit responses from vendors and technology providers to offer solid waste treatment options that beneficially use the MSW prior to disposal. Covanta Energy LLC (Covanta) offered the potential expansion of its existing Marion County Waste-to-Energy (WTE) Facility (Covanta WTE Facility) in Brooks, Oregon. The potential use of an existing facility was viewed as a unique response because it was the only WTE respondent that offered an existing, operating facility within close proximity (50 miles) to the Metro Region. The Covanta RFEOI response offers to expand the Covanta WTE Facility to be capable of diverting an additional 200,000 tpy of MSW beyond their existing permitted throughput. Metro is considering this option and has directed HDR Engineering Inc. (HDR) to assist in the further evaluation of Covanta's response to the RFEOI.

To evaluate the viability of the Covanta response, Metro directed HDR to undertake an assessment of the environmental, health, and economic benefits and costs of diverting 200,000 tpy of MSW to the Covanta WTE Facility. This report summarizes and provides relevant published literature on the potential impacts and benefits to human health and the environment, as well as the cost risks and benefits of a modern WTE (also known as Energy from Waste or EfW) facility. This report focuses primarily on describing policy considerations specific to the proposed Covanta WTE Facility expansion, while addressing the relevant health concerns of these types of facilities.

As part of the evaluation, HDR developed an archive of articles, publications, reports, and presentations related to the human health impacts, environmental impacts, and cost risks and benefits of WTE facilities.

2 Existing Facility Description and Background

The existing 180,000 tpy Covanta WTE Facility, located in Brooks, Oregon, began commercial operation in 1986. The facility serves the solid waste management needs of the more than 325,000 people of Marion County. It processes approximately 90% of Marion County's post-recycling waste. The other 10% of the county's waste consists of non-combustible material that is sent to landfill.

Approximately 130 refuse trucks arrive daily at the facility and proceed onto the weigh scales. Trucks then drive to the tipping floor (which is under negative pressure to reduce odor) where the MSW is dumped and then placed into the 34 foot deep pit. A large overhead crane mixes the garbage in the pit and then places it into the hoppers that feed the boilers.

The facility utilizes two 275 ton-per-day traditional mass burn units to process the waste and each unit is equipped with modern air pollution control equipment (Figure 1). For the WTE conversion process, the waste is combusted in a furnace creating a high temperature flue gas. Heat is recovered from the flue gas within the boiler sections of the units in the form of steam that is sent through a 13.1 MW steam turbine to create electricity that is sold to the local utility.

The flue gas exiting each boiler is sent through an air pollution control system that removes acid gases, heavy metals, dioxins and furans, and particulate matter. The particulate matter collected in the bag house filters are referred to as fly ash. The fly ash is placed on the same conveyor system that collects the bottom ash from the boiler. The result is an inert ash residue that is approximately 25-30% by mass, and 10% by volume, of the original waste material. Ferrous and non-ferrous metals are recovered from the ash residue. The ash is then transported and used as daily cover at the nearby Coffin-Butte Landfill located north of Corvallis.

Water usage and disposal can be significant in a WTE facility. The main water usage requirement is associated with the EfW power cycle (i.e., mainly boiler and cooling tower make-up water). Similarly, main contributors to the process wastewater discharge stream are boiler blowdown and cooling tower blowdown. In addition to the process water discharge, the Covanta WTE Facility has a storm water retention pond that is discharged under permit to a nearby stream.

In addition to MSW, the Covanta WTE Facility processes a small quantity of non-biological medical waste that comes from outside the county.

Covanta, who owns and operates the Covanta WTE Facility, is an experienced waste management company with more than 35 WTE facilities across North America. Covanta's latest sustainability report (2014) indicates that their WTE facilities in 2013 and 2014 maintained an average compliance performance of 99.9%, based on their continuous emissions monitoring equipment, and a compliance performance of 100% based on annual source testing. Specific data on compliance for the Covanta WTE Facility was provided to HDR and was found to be similar to that of the sustainability report (2014).

Additional details on the Covanta WTE Facility are found in a case study by Dr. Eileen Berenyi of Governmental Advisory Associates Incorporated (2010). The case study covers the history and description of the facility, an analysis of the Marion County demographic and economic profile, and a review of the economic, environmental, health, and political impacts of the facility.

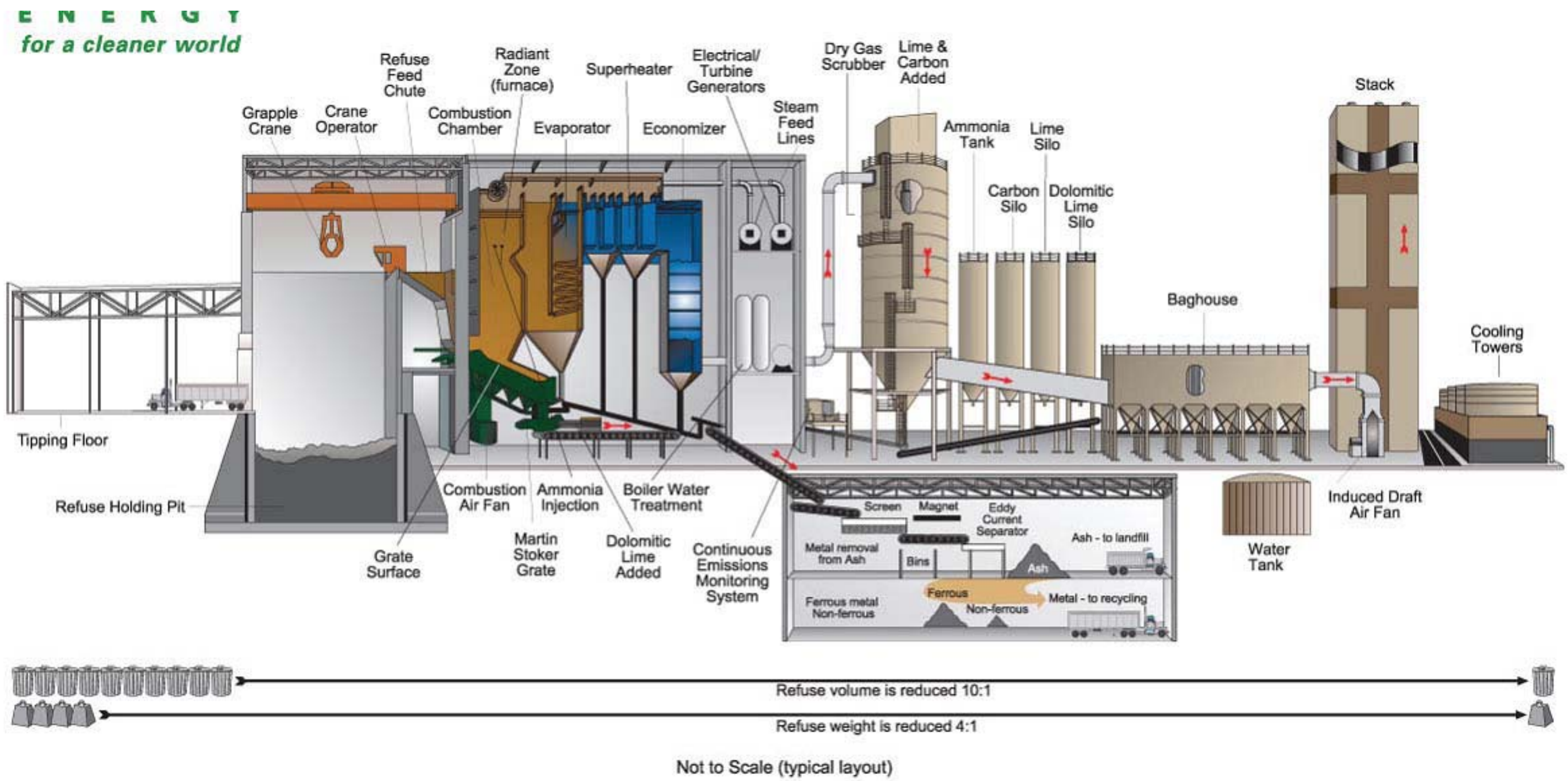

Figure 1. Schematic of a Typical Mass Burn WTE Facility

(http://www.co.marion.or.us/PW/ES/disposal/Pages/mcwef.aspx)

3 HDR Literature Review Strategy

HDR's literature search focused on scientific published articles, conference presentations and proceedings, and grey literature (publically available reports that may have not been peer-reviewed or published). Peer-reviewed articles were sourced from Science Direct and Google Scholar. Google search engine, the International Solid Waste Association (ISWA) and the Waste-to-Energy Research and Technology Council (WTERT) databases were also utilized to obtain publically available articles, publications, and reports. The literature search also includes papers and presentations that have been given at conferences that were attended by HDR. As per the scope of work, this was not a formal systematic review of the literature on each topic. Rather, representative papers, documents and reports were sought to provide Metro with an overview of the issues surrounding WTE facilities. The health literature review varied from that of the rest of the report and the strategy is provided in Section 5.

4 Environmental Impacts and Considerations

As with any solution to managing MSW, WTE facilities have potential to cause environmental impacts or may have benefits over alternative management options. This section provides issues for consideration.

In the event that Metro decides to move forward with the WTE option there will be a detailed permitting phase that will have to be undertaken by the proponent. This section is intended to highlight areas that should be considered.

4.1 Environmental Discharges from WTE Facilities

This section includes a discussion of typical discharges from WTE facilities, including emissions to the atmosphere, liquid effluent, and solid residues.

4.1.1 Control of Air Emissions

As noted above, the combustion of MSW creates a high temperature flue gas that contains various air pollutants that must be controlled before they are released to the atmosphere through the facility stack. Air pollutants associated with WTW include, but are not limited to, particulate matter (total particulate, PM_{10} and $PM_{2.5}$), acid gases [sulfur dioxide (SO_2) and hydrogen chloride (HCl)], nitrogen oxides (NO_x), heavy metals (cadmium, lead and mercury), polychlorinated dibenzodioxins/difurans (PCDD/F or collectively, "dioxins"), certain volatile organic compounds (VOC), and carbon monoxide (CO).

Air pollution control (APC) techniques applied at modern WTE facilities can be generally broken into two main types of controls; (1) combustion emissions control technologies, and (2) post-combustion emissions control technologies.

Combustion technologies generally minimize the formation of combustion-oriented pollutants CO, NO_x, VOC, and dioxins/furans. Time, temperature and turbulence are key parameters for the proper combustion of the waste, and are used to minimize CO emissions and maximize the destruction of VOCs. NO_x formation in the furnace is typically the result of either the production of thermal NO_x or fuel NO_x. Thermal NO_x results from the oxidation of atmospheric nitrogen (N_2), which occurs more readily at temperatures above 2,600°F. Fuel NO_x is formed from the oxidation of the nitrogen content in the fuel (MSW). Combustion control strategies, such as staged combustion and flue gas recirculation, are typically used in a modern WTE boiler to minimize NO_x production in the combustion zone.

There is a wide variety of primary APC systems available for WTE facilities and typically these are used in combination to minimize the potential emissions. The APC system technologies most commonly used in modern WTE facilities to control acid gas emissions are some form of scrubber system (dry, semi-dry or wet) followed by a particulate control device. The use of wet, semi-dry or dry scrubbers to control acid gases has been documented to achieve 87-94% removal of HCl. Particulates (including cadmium and lead) are typically controlled through the use of a fabric filter baghouse. Particulate removal efficiencies of up to 99.9% have been documented for baghouses.

The injection of activated carbon, prior to the baghouse, is used in modern WTE facilities to remove dioxins/furans and mercury from the flue gas stream.

The APC technologies at the existing Covanta WTE Facility include:

- A combustion control system to control the amount and distribution of overfire and underfire air, grate speeds, and feed ram speeds to control steam flow, oxygen, furnace temperature, and to minimize CO and NO_x formation and maximum VOC destruction.
- An SNCR system that injects aqueous ammonia into the upper furnace to reduce the emissions of NO_x.
- A semi-dry flue gas scrubber with a slurry lime injection for acid gas emission reduction, forming particulate matter reaction products that are subsequently removed by the baghouse. The scrubber also serves to reduce the flue gas temperature to prevent de novo synthesis of dioxins/furans.
- Activated carbon injection for the adsorption of mercury and dioxin/furan emissions.
- A fabric filter baghouse for the capture and removal of particulate matter (including cadmium, lead, the acid gas reaction products, and the activated carbon with the adsorbed mercury and dioxins/furans).

4.1.2 Odor

In addition to controlling air emissions, WTE facilities must also reduce the potential for odors from the handling and storage of putrescible wastes and control those odors that are produced. The most common method of odor control at WTE facilities is use of the air from the tipping floor and waste storage areas of the plant as combustion air in the boilers. This air is drawn through large louvers, typically located above the waste storage areas, and injected directly into the combustion zones. The high temperatures associated with the combustion process are sufficient to destroy any odors in the air. Some facilities also utilize rapid roll-up doors to prevent the escape of odors during truck and waste collection vehicle receiving hours.

4.1.3 Control of Liquid Wastes

In addition to air emissions, some WTE facilities also generate an effluent discharge. The amount and type of effluent discharge produced depends on the type of APC system used, as well as the type of steam cooling system and other design parameters. Effluent management is more often required for WTE facilities that include a wet scrubber as the primary acid gas removal method in the APC system. Facilities that use dry or semi-dry scrubbers to control acid gases are not likely to generate any liquid effluent other than storm water and/or sanitary wastewater, which are easily managed.

Water is used at WTE facilities for various purposes and effluent may result from any of the following sources:

- APC process wastewater – normally from wet flue gas treatment (dry and semi-dry systems do not typically produce any liquid effluent).

- Wastewater from the water/steam cycle resulting from the preparation of boiler feed water, boiler blowdown and drainage, and cooling tower blow down. In many cases this water is reused as quench water to cool bottom ash or in the APC treatment process as make-up water and does not result in an actual discharge from the facility.
- Sanitary wastewater (e.g., toilets and kitchen).
- Stormwater which originates from precipitation falling on surfaces such as roofs, service roads, and parking lots and is usually discharged directly to storm sewers, although it may also be stored in retention ponds on site and reused as quench water, for washdown, to cool bottom ash, or in the APC treatment process as make-up water.

WTE facilities that utilize dry or semi-dry APC systems are often designed with zero wastewater discharge. This is accomplished via the reuse of wastewater produced by a facility through the various methods described above. As mentioned previously in this report, semi-dry and dry APC systems are the most common type used in North America.

4.1.4 Control of Solid Wastes

The combustion process also produces an inert bottom ash residue that comes off the grate/stoker and fly ash that is recovered from the boilers and APC process. This combined ash residue is approximately 25-30% by mass, and 10% by volume, of the original waste material that was combusted. Ferrous and non-ferrous metals are typically recovered from the ash residue.

Bottom ash is the mineral material left after the combustion of the waste. Bottom ash is a heterogeneous mixture of slag, metals, ceramics, glass, unburned organic matter and other noncombustible inorganic materials, and consists mainly of silicates, oxides and carbonates. Typically, a modern WTE Facility generates bottom ash that is approximately 20 – 25% by weight or 5 to 10% by volume of the original waste combusted. At most modern WTE facilities, the bottom ash is mechanically collected, cooled and magnetically or electrically screened to recover recyclable metals. In North America, the remaining residue is typically disposed of at a landfill. In countries within Europe and Asia (specifically Japan) the bottom ash is commonly used as a construction aggregate substitute. There are some applications of the reuse of WTE ash in asphalt or as a road base in the United States as well.

The fly ash residues from a WTE Facility process result from the APC system and other parts of the process where flue gas passes (i.e., superheater, economizer). Fly ash residues are usually a mixture of lime, fly ash and carbon and are normally removed from the emission gases in a fabric filter baghouse or ESP. Fly ash may contain high levels of soluble salts, particularly chlorides, heavy metals such as cadmium, lead, copper and zinc, and trace levels of dioxins and furans, and make up approximately 2 – 5% by weight of the original waste combusted. In Europe, fly ash residues are managed separately from bottom ash as they are often classified as a hazardous waste. In Canada and Japan, the fly ash residue is handled separately but may be treated chemically or even thermally so that it is stabilized and rendered non-hazardous before it is disposed of in a landfill. Common practice in the U.S. is to combine the bottom ash and fly ash streams. WTE facility ash has been routinely demonstrated to be non-hazardous, including at the Marion facility. Ash is periodically tested for the toxicity characteristics using the U.S. EPA's Toxicity Characteristic Leaching Procedure (TCLP) and the EPA's *Guidance for the Sampling and Analysis of Municipal Waste Combustion Ash for the Toxicity Characteristic*.

4.2 Air Quality Emissions International Regulatory Levels

An expansion of the existing Covanta WTE Facility will require an air quality permit and will be subject to applicable federal and state regulations applicable at that time. The air emission limits that will ultimately be imposed on the expansion facility will be a combination of United States Environmental Protection Agency (USEPA) New Source Performance Standards (NSPS) requirements found in 40 CFR Part 60 and those associated with the State of Oregon Department of Environmental Quality (ODEQ) air quality construction permitting program.

A number of sources of potential emission limits were reviewed and are summarized in Table 1, including a mix of US and international sources. An expansion of the Marion County facility is expected to be classified as a new large unit (i.e., > 250 tpd design capacity) that is subject to 40 CFR Part 60, Subpart Eb. Table 1 summarizes the current emission limits contained in Subpart Eb, as well as the limits currently applicable to Marion County's existing two units that are subject to the requirements of 40 CFR Part 60, Subpart Cb and construction permit imposed limits. Both Subpart Eb and Subpart Cb are currently under review by USEPA and revisions are expected, but at this time no details are available to predict what those revised limits will be.

Based on the permitted emissions of the existing Covanta WTE Facility and the anticipated emissions of an expansion, an expansion is anticipated to trigger the Prevention of Significant Deterioration (PSD) preconstruction air permitting requirements for all of the pollutants regulated by Subpart Eb. Part of the requirements of the PSD program is a Best Available Control Technology (BACT) review that evaluates all technically and economically feasible control options for each PSD regulated pollutant. The control option that is technically feasible, economically feasible, and results in the highest level of control is chosen as BACT and will be a limit included in the air construction permit. BACT limits can be no less stringent than any otherwise applicable requirement (e.g., NSPS limits) and are determined on a case-by-case basis to account for the unique characteristics of a given project.

As part of a BACT analysis, control options (and associated permit limits) that have been demonstrated in practice must be evaluated. To that end, three additional sources of information are included in Table 1. The first is the construction permit (i.e., BACT) limits for the Palm Beach expansion that recently began operation and is the most recent large unit MWC facility to begin operation in the United States. Also included for informational purposes are emission limits from the European Union (EU) Incineration Directive and the emission limits for the Durham York Energy Centre (DYEC) located in Ontario, Canada that also recently began operation. Although the DYEC would be classified as a small unit MWC (subject to the requirements of 40 CFR Part 60, Subpart AAAA instead of Subpart Eb) in the US, its emission limits may be informative in the context of limits that will be reviewed as part of the BACT analysis for a Covanta WTE Facility expansion.

Care must be taken when reviewing the emission limits summarized in Table 1 to account for differences in compliance averaging times, determination methods, and the economic feasibility of achieving the limits. For instance, trying to impose the DYEC's CO limit (that is on a 24-hour averaging basis) onto a 4-hour block average (which is the typical basis for US limits) would result in a much more stringent limit than would be evident by just comparing the absolute values of the limits (i.e., 43 ppm compared to 100 ppm). Another example is the dioxin and furan limits of the EU Incineration Directive and the DYEC. Those limits are on a toxic equivalent (TEQ) basis, which multiplies the mass emissions of specific dioxin and furan congeners by a toxic equivalency factor (TEF) to result in a toxicity-weighted equivalent mass of the mixture. In contrast, dioxin and furan limits in the US are on a total mass basis. There is no direct conversion between dioxin and furan results on a total mass basis and those on a TEQ basis (although USEPA indicates that a limit of 13 ng/dscm total mass is equal to about 0.1 to 0.3 ng/dscm TEQ)[1]. Finally, the NOx limit imposed on the Palm Beach facility is based on a case-by-case determination that the use of selective catalytic reduction (SCR) is BACT. This may or may not be the case for a Marion County expansion because the economic feasibility of SCR must be accounted for in the BACT analysis.

The information summarized in Table 1 should be used as boundary conditions to anticipate where final emission limits could land. As stated previously, the limits can be no higher than those of Subpart Eb effective at the time the air permit is being developed. Further, it is reasonable to assume that the limits should be no lower than the most stringent of those listed.

Currently in the US, compliance with the emission limits for CO, SO_2, and NO_x are determined through the use of continuous emissions monitoring systems (CEMS). The remainder of the pollutants (i.e., PM, Cd, Pb, Hg, HCl, dioxin/furan, and VOC and ammonia (if applicable)), are tested at the stack annually to demonstrate compliance. Typically, stack testing is not required for any other pollutants (such as the additional metals regulated under the EU Incinerator Directive and the large number of compounds required to be tested at the DYEC even though no permit limit is imposed on them), but testing of additional compounds is at the discretion of ODEQ and cannot be predicted at this time.

[1] Federal Register, Volume 60, No. 243, December 19, 1995. Available at https://www.gpo.gov/fdsys/pkg/FR-1995-12-19/pdf/95-30257.pdf, see footnote b of Table 1).

Table 1. International Emission Standards for WTE Facilities.

Parameter	US EPA 40 CFR Part 60 Subpart Eb		Current Marion WTE Facility		Palm Beach Renewable Energy Facility		EU Incineration Directive		Durham-York Energy Centre		Anticipated Marion WTE Facility Expansion	
Carbon Monoxide (CO)	100	ppmdv 4-hr block arithmetic average	100	ppmdv 4-hr block arithmetic average	100	ppmdv 4-hr block arithmetic average	56	ppmdv daily avg. value	50	ppmdv 24-hr geometric mean	100	ppmdv 4-hr block arithmetic average
					80	ppmdv 30-day rolling average	112	ppmdv half-hourly avg. in any 24-hr period				
							168	ppmdv 10-min average				
Particulate Matter (PM)	20	mg/dscm	25	mg/dscm	12	mg/dscm	13	mg/dscm daily average	13	mg/dscm	12	mg/dscm
Cadmium (Cd)	10	µg/dscm	20	µg/dscm	10	µg/dscm			10	µg/dscm	10	µg/dscm
Lead (Pb)	140	µg/dscm	200	µg/dscm	125	µg/dscm			71	µg/dscm	125	µg/dscm
Mercury (Hg)	50	µg/dscm, or	50	µg/dscm, or	25	µg/dscm	64	µg/dscm	21	µg/dscm	25	µg/dscm
	85%	Removal	85%	Removal								
Sulfur Dioxide (SO_2)	30	ppmdv 24-hr geometric mean, or	29	ppmdv 24-hr geometric mean, or	24	ppmdv 24-hr geometric mean	25	ppmdv daily average	19	ppmdv 24-hr geometric mean	24	ppmdv 24-hr geometric mean
	80%	Removal	75%	Removal								
Hydrogen Chloride (HCl)	25	ppmdv, or	29	ppmdv, or	20	ppmdv	9	ppmdv daily average	9	ppmdv 24-hr geometric mean	20	ppmdv
	95%	Removal	95%	Removal								
Dioxin/Furan	13	ng/dscm (total mass)	15	ng/dscm (total mass)	10	ng/dscm (total mass)	0.13	ng/dscm (TEQ)	0.086	ng/dscm (I-TEQ)	10	ng/dscm (total mass)
Nitrogen Oxides (NOx)	150	ppmdv 24-hr daily arithmetic average	205	ppmdv 24-hr daily arithmetic average	50	ppmdv 24-hr daily arithmetic average	137	ppmdv daily average	92	ppmdv rolling 24-hr arithmetic average	45	ppmdv 12 month rolling average
					45	ppmdv 12 month rolling average						

Parameter	US EPA 40 CFR Part 60 Subpart Eb	Current Marion WTE Facility	Palm Beach Renewable Energy Facility		EU Incineration Directive		Durham-York Energy Centre		Anticipated Marion WTE Facility Expansion	
Volatile Organic Compounds (VOC)			7	ppmdv					7	ppmdv (as CH_4)
Ammonia Slip (NH3)			10	ppmdv					20	ppmdv
Total Organic Compounds (TOC)					12.9	mg/dscm daily average				
Hydrogen Fluoride (HF)					1.3	mg/dscm daily average			3.5	ppmdv
Cadmium + Thallium (Cd + Th)					0.064	mg/dscm daily average				
Sum of (As, Ni, Co, Pb, Cr, Cu, V, Mn, Sb)					0.643	mg/dscm daily average				
Organic Matter							71	mg/dscm		
PM_{10}									35	mg/dscm
$PM_{2.5}$									35	mg/dscm
H_2SO_4									5	ppmdv

NOTES:

1. All values are at 20°C, 1 atmosphere of pressure and corrected to 7% O_2.
2. The West Palm Beach dioxin/furan limit will be adjusted to 0.75 to 10 ng/dscm after completion of initial performance test.
3. A netting analysis will be performed to determine if additional control of NO_x emissions from Units 1 and 2 can be achieved such that the net increase in NO_x emissions for the facility can be limited to less than 40 tpy, In this case, a higher permit limit for NO_x will be possible.

4.3 Greenhouse Gas and Climate Change

Specific issues surrounding potential tradeoffs of greenhouse gas emissions from diverting 200,000 tpy of MSW from landfill to a WTE facility are provided by HDR under separate cover. However, this section provides reports and articles that were retrieved from the scientific literature on this issue.

Vogt, R., Derreza-Greeven, C., Giegrich, J., Dehoust, G., Mock, A., and Merz, C. 2015. The Climate Change Mitigation Potential of the Waste Sector. Prepared for The German Federal Environment Agency

This report was performed by members of the Institute for Energy and Environmental Research (IFEU) and Institute for Applied Technology (Oko-Institut) in Germany to present the greenhouse gas mitigation potential of municipal solid waste management. The study focuses on four regions: the United States of America, the balance of the Organization for Economic Co-operation and Development (OECD) countries, India, and Egypt. The study shows that methane emissions from landfills are the main contributor to the greenhouse gas burden in these four regions, including the USA. The study also revealed that of the four main waste management practices studied (Landfill, Recycling, Incineration, and Composting), landfilling is the only one that results in a net positive increase in GHG emissions. The study highlights the potential for significant greenhouse mitigation by the other three waste management practices.

Parkes, O., Lettieri, P., Bogle, DL. 2015. Life cycle assessment of integrated waste management systems for alternative legacy scenarios of the London Olympic Park Waste Management 40: 157–166

This research involved a life cycle assessment (LCA) of 10 integrated waste management systems (IWMSs) for the London Olympic Park. The objective was to evaluate direct and indirect emissions resulting from various treatment options of MSW. The authors used the GaBi v6.0 Product Sustainability software to conduct the modeling. Their results indicate that IWMSs with advanced thermal treatment and incineration with energy recovery (WTE) had lower Global Warming Potential (GWP) than IWMSs where landfilling is the primary waste treatment process. This was due landfills having higher direct emissions and lower avoided emissions. Direct emissions include those from transportation/hauling of materials. Avoided emissions include emissions related to the production of energy, mineral fertilizers, and virgin materials.

Tan, S., Hashim, H., Lim, J., Ho, W. Lee, C., and Yan, J. 2014. Energy and Emissions Benefits of Renewable Energy Derived from Municipal Solid Waste: Analysis of a Low Carbon Scenario in Malaysia Applied Energy 136:797-804

The objective of this article was to evaluate the energy recovery and carbon reduction potential of different EfW practices and how they compare to landfilling in Malaysia. The article stresses the challenges of both landfilling and EfW (GHG emissions landfills versus dioxin/furan and particulate emissions of EfW facilities). In the article's analysis many factors were incorporated, including the energy conversion potential and chemical composition (e.g. moisture content, etc.) of the waste. Multiple scenarios were evaluated, including EfW technologies versus landfills, with and without, landfill gas recovery systems. The results of this analysis indicated that the integration of both landfill gas recovery and EfW technology into Malaysia's waste management system showed the highest economical benefit, energy recovery potential, and GHG reduction.

AECOM. 2009. Management of Municipal Solid Waste in Metro Vancouver – A Comparative Analysis of Options for Management of Waste After Recycling

In 2009, AECOM prepared a consulting report for Metro Vancouver that conducted a comparative analysis of options of three MSW technologies – mechanical biological treatment prior to landfilling or to produce a refuse derived fuel; WTE and landfilling with landfill gas (LFG) utilization. One of the comparators was evaluation of GHG emissions of the three options. AECOM concluded:

> *"GHG emissions from waste management activities are 3% of the GHG emissions produced in Canada and 5% of those produced in BC. 95% of the GHG associated with waste management in BC originates from landfills. Treating waste with MBT and WTE can reduce the amount of GHG produced in landfills. Refer to Section 10 for detailed analysis of the GHG emissions balance for various waste management scenarios that have been analyzed in this study.*
>
> *In addition to reducing the GHG emissions from landfills, WTE also generates energy from the waste. Producing electricity and district heat or process steam from biogenic waste helps avoid the use of fossil fuels, providing additional savings to the overall GHG emissions balance. Capture and utilization of LFG can also produce electricity and heat, avoiding the use of fossil fuels."*

Kaplan et al. 2009. Is it better to burn or bury waste for clean electricity generation? Environmental Science & Technology Vol. 43, No. 6, 11711-1717

This is a joint effort by the National Risk Management Research Laboratory of the USEPA and the Department of Civil Engineering at North Carolina State University. The goal of the paper was to present a comprehensive set of life-cycle emission factors per unit of electricity generated during landfill-gas-to-energy (LFGTE) and WTE. The analysis was based on the composition and quantity of MSW sent to end of life facilities in the United States, and used LCA process models from the municipal solid waste decision support tool (MSW-DST). The paper concluded that GHG emissions from WTE range from 0.4 to 1.5 metric tons of carbon dioxide equivalent per megawatt hour ($MTCO_2e/MWh$), and GHG emissions from the most aggressive LFGTE scenario modeled were 2.3 MTCO2e/MWh.

The paper also examined the generation of NO_x and SO_x emissions from both management strategies. It concluded that WTE produces lower NO_x emissions than LFGTE. The management strategy with lower SO_x emissions depended on the specific configurations of WTE and LFGTE being compared. HCl emissions were found to be higher in WTE than LFGTE.

The paper briefly discusses the challenges with obtaining accurate estimates of emissions from landfills, particularly with the great diversity of size and operational methods across the country, compared to the more easily captured and measured emissions from WTE facilities.

Bogner et al. 2008. Mitigation of global greenhouse gas emissions from waste: conclusions and strategies from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report. Working Group III (Mitigation) Waste Manag Res February 2008 vol. 26 no. 1 11-32

This article summarizes the research conducted by the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report, Working Group III (Mitigation). They reviewed the GHG emissions from post-consumer waste and wastewater and determined that they contribute approximately 3% a year to total global emissions. They examined the mitigation technologies for GHG production at landfills and avoidance through alternatives like state-of-the-art incineration. They determined that "*Reduced waste generation and the exploitation of energy from waste (landfill gas, incineration, anaerobic digester biogas) produce an indirect reduction of GHG emissions through the conservation of raw materials, improved energy and resource efficiency, and fossil fuel avoidance*."

4.4 Environmental Monitoring WTE Facilities

It is common in Europe to conduct some level of environmental monitoring around WTE facilities. This is in addition to continuous and annual monitoring of stack emissions. It often includes collection of baseline information in soil, vegetation and ambient air quality. Over the years the results of the monitoring programs have often been incorporated in to human health risk assessments (HHRAs) for scientific publication. The results of these studies are provided in Section 5. This section provides overview of a comprehensive review conducted on environmental surveillance for the Durham York Energy Center (DYEC) and some more recent publications.

Stantec. 2010. Waste to Energy A Technical Review of Municipal Solid Waste Thermal Treatment Practices prepared for the British Columbia Ministry of the Environment

In 2010, Stantec consulting prepared a comprehensive overview report of issues and practices in the WTE industry. This report reviewed continuous emissions stack monitoring, stack testing and ambient monitoring approaches. This document should be referred to for a better understanding of the options available. They provided:

> *An overview of emission and ambient monitoring systems is provided. This includes continuous emissions monitoring, periodic (non-continuous) source testing and ambient air quality monitoring techniques. References to the applicable monitoring procedures are provided. A discussion on averaging periods for continuous and periodic stack testing methods is included in relation to determining compliance with emission criteria and permit limits.*

Jacques Whitford Limited. 2009. Review of International Best Practices of Environmental Surveillance for Energy-From-Waste Facilities prepared for the Region of Durham, Ontario Canada

The consulting firm Jacques Whitford conducted the one of the only systematic review of the literature on international best practices of environmental surveillance for WTE facilities. This was completed in support of the DYEC environmental permitting process. It included review of:

> *Baseline monitoring, ambient air quality monitoring, soil monitoring, vegetation sampling, agricultural product monitoring, and human biomonitoring studies.*

Although the report was completed in 2009, the trends in the scientific literature remain similar. Overall, the study found that emissions resulted in no appreciable changes in chemical concentrations detected by environmental and health surveillance around modern WTE facilities.

Ollson, C., Whitefield Aslund, C., Knopper, L., and Dan, T. 2015. Specific Risk Assessment of an Energy-from-Waste Thermal Treatment Facility in Durham Region, Ontario, Canada (2014): Part B Ecological Risk Assessment. Science of the Total Environment. Vol 466-467: 242-252

This scientific paper provides the results of the ecological risk assessment (ERA) that was completed as part of the DYEC WTE environmental permitting process. An extensive baseline sampling program of soil, sediment, surface water, vegetation and small mammals was conducted in support of the baseline ERA. Then multimedia models were used to predict potential deposition, uptake and exposure for all trophic levels of the surrounding ecosystem to the proposed facility. The authors concluded that the proposed 140,000 tpy WTE facility would not pose a chemical risk to the surrounding ecosystem. It is uncommon for WTE facilities to undertake an ERA in support of their environmental permitting process. However, it was required in Ontario given that the DYEC was the first greenfield WTE to be permitted in over 20 years in Canada. The results indicate that ERAs are unlikely necessary for future projects.

van Dijk C, van Doorn W, van Alfen B. 2015. Long term plant biomonitoring in the vicinity of waste incinerators in The Netherlands. Chemosphere. 2015 Mar;122:45-51

This is one of the few papers that exists on biomonitoring of crops and agricultural products in proximity to WTE facilities. The researchers reported on multiyear (2004 to 2013) biomonitoring programs that were established around three WTE in the Netherlands. The results indicate that WTE emissions did not affect the chemical quality of crops or cow milk. Chemical concentrations of metals, PAHs and dioxin/PCBs were similar to background levels and did not exceed standards for maximum allowable concentrations in foodstuffs.

Dwyer, H., and Themelis, N. 2015. Inventory of U.S. 2012 Dioxin Emissions to Atmosphere. Waste Management. Vol 46: 242–246

A peer-reviewed scientific publication by members of Columbia University in New York provides an update to the USA dioxin/furan emissions inventory for 2012. Emissions from all sources (controlled and opening burning) in the USA were gathered. Analysis of the data collected from 84% of the total MSW combusted showed that in 2012, PCDD/F emissions from WTE facilities represented only 0.54% of the controlled industrial dioxin/furan emission, and only 0.09% of all dioxin/furan sources. Of note, both controlled landfill gas flaring and open spontaneous landfill fires were also included as dioxin/furan sources. Dioxin/furan emissions from these two sources accounted for 0.45% and 37% of all dioxin/furan sources, respectively.

4.5 Summary of Environmental Impacts and Concerns

Overall, there are a number of issues that need to be considered in the design and operation of a modern WTE facility. The most significant of the environmental issues is ensuring adequate air emissions standards are in place to safeguard against unacceptable increases in ambient air quality.

All of the issues raised in this section should be given consideration during the environmental permitting phase of the project. Taken together, existing federal and state regulatory requirements comprehensively establish the basis of required analyses that are conducted during the environmental permitting phase of any WTE facility. These requirements are established, periodically reviewed and updated pursuant to the federal Clean Air Act (CAA) as amended. The CAA establishes an ambient ceiling for certain compounds based upon the identifiable effects the compounds may have on public health and welfare. The components of the required analysis will be incorporated into a Prevention of Significant Deterioration (PSD) Permit Application which includes:

1. Best Available Control Technology (BACT) Review, which results in an emissions limitation deemed achievable by a modern WTE facility, based upon the maximum degree of reduction that takes energy, environmental and economic impacts and other costs into account.
2. PSD Increment consumption, visibility and air quality related values (AQEV's) impact analyses at Federal class I areas (e.g. Mount Hood),
3. Assessment of air quality impacts resulting from pollutant emissions from the proposed WTE facility,
4. Assessment of the effects of emitted pollutants on soils and vegetation in the source's impact area, and
5. Assessment of impacts associated with indirect economic growth.

In addition, applicable state regulatory requirements will also be addressed in the permitting process, which will further define required analyses and emission limitations to be protective of human health and the environment.

5 Potential Health Issues Living in Proximity to WTE Facilities

As with any major infrastructure undertaking concerns have been raised about the potential for emissions from WTE facilities to potentially affect the health of neighboring property owners. A number of municipalities and government agencies have conducted reviews in recent years to better understand the published scientific literature and grey literature on this topic. Therefore, resources did not need to be spent in recreating these reviews for Metro Portland. The most comprehensive of these reviews was completed for Metro Vancouver in 2014 and is attached to this report.

Over the past several decades there have been hundreds of scientific papers published examining chemical emissions, the potential risk they pose to people and epidemiological studies examining populations living in proximity to WTE facilities. However, it is important when reviewing this literature to make a distinction between older and more modern WTE facilities. HDR considers that facilities built or upgraded post-2000 to be modern facilities. This is due to enactment of international regulations at this time that updated emission limits and regulations of air quality with respect to WTE facilities. In 2000 considerable changes to air emission limits were made in Europe and the United States.

European Union enacted Directive 2000/76/EC on the incineration of waste (the WI Directive) and it came into force on December 28, 2000. It set new emission limit values and monitoring requirements for nitrogen oxides (NO_x), sulphur dioxide (SO_2), hydrogen chloride (HCL), hydrogen fluoride (HF), particulate matter (PM), metals and dioxin and furans for WTE facilities. It required all new facilities built after December 2002 and existing facilities to be in compliance with the WI Directive by 2005.

In the United States, the Environmental Protection Agency (EPA) administers the Clean Air Act. In December, 2000 the EPA promulgated the new source performance standards (NSPS) and emissions guidelines (EG) to lower air pollution from WTE facilities. These include EG for nine air pollutants – PM, carbon monoxide (CO), dioxins and furans, SO_2, NO_x, HCL, lead, mercury and cadmium.

> *"The NSPS and EG were designed to substantially reduce emissions of a number of harmful air pollutants such as lead, cadmium, mercury, and dioxins/furans, which are known or suspected to cause adverse health and environmental effects. (USEPA, 2000)"*

Therefore, only scientific publications that examine modern (post-2000) WTE facilities are included in this review. Particular caution was exercised in review of the epidemiological literature given that although publication of manuscript may be post-2000 they often are evaluating historical population cohorts that had been living around older faculties.

This section provides an overview of sources of potential emissions, health risk assessments and epidemiological studies that have been completed after the publication of the 2014 Metro Vancouver report. This information will be used in the Health Impact Assessment (HIA), which is being prepared under separate cover for Metro Portland.

5.1 Environmental Health Exposure Considerations Surrounding WTE Facilities

As can be seen in Sections 2 and 3 of this report, issues surrounding air quality is the primary potential exposure pathway for residents and nearby landowners adjacent to WTE facilities. It is both through inhalation of air (direct) and subsequent deposition of persistent pollutants in the environment (indirect) that people maybe exposed to WTE emissions.

Although the EPA regulates nine contaminants from stack emissions there are of course hundreds of chemicals and metals emitted from such facilities. However, these nine chemicals are regulated as surrogates to ensure that the concentration of the remaining is below those of concern. That said it is common practice for new facilities to evaluate a longer list of contaminants of potential concern (COPCs) in an air modeling and health risk assessment exercise. For example, the Human Health Risk Assessment (HHRA) completed for the Durham York Energy Centre (DYEC) as part of the Environmental Assessment evaluated the potential risk from exposure to over 100 COPCs.

Although WTE facilities use process water, it is typically discharged to local sanitary system as grey water[2]. In addition, they typically have storm water retention ponds that may be discharged to local surface water bodies under permit. Direct or indirect contact with people and water from WTE facilities has not been a focus of public health risk assessments or epidemiological studies and not considered a significant exposure pathway.

Therefore, the primary focus of potential health related issues surrounding WTE facilities in through atmospheric emissions. Health concerns that have been previously raised for those living in proximity to such facilities include potential for increased cancer rates, respiratory related illness, infant mortality and developmental issues, and overall increase in body burden of toxic chemicals. In recent years there has been some concern raised by the public over the potential risk from emission of ultra fine particulate matter (PM<0.1) from WTE facilities. This issue will also be examined.

5.2 Recent Literature Reviews

Two recent literature reviews were retrieved during this undertaking. AEA Technology PLC (AEA) prepared the first in 2012 for the United Kingdom Environmental Services Association. Intrinsik Environmental Sciences prepared the second and more comprehensive review in 2014 for Metro Vancouver during their consideration of procuring WTE for managing part of their MSW. These reviews have been attached as Appendix A and B of this report and should be consulted further for a more in depth review of this topic.

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[2] http://covanta-csr.com/environmental-performance/ensuring-efficient-operation/

5.2.1 Review of Research into Health Effects of EfW Facilities (2012): Prepared for the Environmental Services Association by AEA Technology PLC. (now Ricardo-AEA Ltd.)

In January 2012, AEA Technology PLC (AEA) prepared a research review for the United Kingdom Environmental Services Association regarding the health effects of EfW facilities. The review focused primarily on the health issues and environmental emissions related to EfW facilities located in the United Kingdom. The strategy for the AEA report was to provide an in-depth review and analysis of published reports from government/environmental agencies, as well as scientific literature.

AEA provides the following conclusion on their review and analysis of available literature on the subject:

> *"On the basis of the discussion above, it is concluded that emissions from EfW facilities would not be expected to give rise to any significant effects on health. Emissions from EfW facilities as currently operated in the UK are substantially lower than those from facilities operating prior to the implementation of the Waste Incineration Directive [European Union Directive 2000/76/EC, in effect 28 December 2000]. Taking account of the uncertainty inherent in epidemiological studies of EfW facilities, it is concluded that EfW facilities as currently operated in the UK are most unlikely to have any significant or detectable effects on cancer incidence, the incidence of adverse birth outcomes, or the incidence of respiratory disease. (Page 12 of AEA report)"*

5.2.2 Literature Review of Potential Health Risk Issues Associated with New Waste-to-Energy Facilities (2014): Prepared for Metro Vancouver by Intrinsik Environmental Sciences Inc.

In May 2014, Intrinsik Environmental Sciences Inc. (IES) prepared a literature review for Metro Vancouver (British Columbia, Canada) focusing on the heath issues related to new EfW facilities. The report provided a collection of previous literature studies as well as an updated database of articles published after 2007. Dr. Ollson, part of the current HDR Team for Metro Portland, was a coauthor of this report.

The two previous literature reviews, which are attached to the IES report, were done for Halton Region and Durham Region in Ontario, Canada. The conclusions, which IES summarized from those literature reviews, were as follows.

For the Halton EfW Literature Review:

> *"Overall, the authors conclude that new EFW facilities using the best available technology and modern pollution controls were not expected to pose unacceptable risk to the public. However, they did comment that some health concerns were identified for older incineration facilities that did not employ modern pollution control technology. Finally, the authors suggest that any new facility be subject to a site specific risk assessment in order to identify any local issues and ensure that potential risks to public health are not unacceptable. Ultimately, Halton Region in Ontario did not decide to pursue a WTE facility at*

that time based on capacity of existing landfill space. (page 8 of IES 2014 report)"

For the Durham Region EfW Review:

"Upon reviewing the collective body of evidence, Dr. Smith concluded that "the current epidemiologic literature is inconclusive and does not demonstrate one way or another that modern incinerators have associated health effects on the people living around them". She also noted that this conclusion is consistent with the three review articles that were included in the evaluation and also not materially different than the Halton 4A report conclusions. Furthermore, since the body of evidence on incineration technology with modern pollution controls was limited, Dr. Smith suggested that evaluation of health risks for any proposed project must be based on predictive methods such as risk assessment, rather than relying solely on the available epidemiological literature which was largely inconclusive. (Page 10 of the IES 2014 report)"

Based on the findings from the previous literature reviews, the IES team limited the search to scientific publications between 2007 and 2013 to create an updated database. The IES team's literature review search strategy for the peer-reviewed articles was conducted by a medical librarian and included relevant health databases (e.g., PubMed) to retrieve relevant articles.

The PubMed database search found over 1,000 potentially relevant articles and studies, which were screened (by title and abstract) based on the inclusion/exclusion criteria developed specifically for the project, after which 21 new articles were retained for further review. Their review focused on three categories: risk assessment, human bio-monitoring, and epidemiology. The conclusions drawn after reviewing these articles was that no unacceptable health risks were associated with properly maintained and operated EfW facilities that were equipped with the adequate modern air pollution control equipment.

In addition to the peer-reviewed articles, the IES report gathered non-peer reviewed literature and government reports. This search was done to get a better understanding of the literature that is more readily available and more accessible to the general public. The subject matter of the literature obtained in this search focused on concerns and interests with EfW technology related to health effects and specific environmental pollutants.

From the conclusions of the Metro Vancouver report:

"An updated literature search (2007-present) was conducted to identify and discuss potential health risks surrounding modern WTE facilities. Both the peer-reviewed scientific literature and the publically-accessible grey literature were included in the review. In total, 21 scientific articles and numerous online publications were critically assessed. The overall findings of the updated literature review were compared to those from previous reviews published in 2007 focusing on health impacts of WTE facilities.

Out of the 21 peer-reviewed articles included for detailed review, 14 were risk assessments, 3 were human biomonitoring studies, and 4 were epidemiological studies. Although there were some limitations and uncertainties associated with *each of the studies, overall these articles best represented the available scientific knowledge on modern WTE facilities and potential health impacts. The results from these studies collectively indicate that there are no unacceptable health risks to residents living in the immediate vicinity of a modern, well-maintained and properly operated WTE facility equipped with the best available pollution control technologies.*

The results of the current scientific and grey literature reviews have highlighted potential issues of public concern and scientific interest surrounding modern WTE facilities. Some of these issues include specific pollutants such as PCDD/Fs, heavy metals and particulate matter, as well as potential health effects such as cancer, birth defects and overall health risk from pollution exposure."

What is clear from both of these reviews is that the weight of the scientific evidence suggests that modern WTE facilities can be designed, built and operated in a manner that suggests that they would not have an impact on public health. However, in particular the Metro Vancouver review points to the need for significant understanding of baseline air quality conditions, site-specific modeling of air emissions and subsequent human health risk assessment to be completed in order to ensure that any new proposed facility would not be predicted to impair chemical health of the local community.

5.3 Health Literature Review 2014 – 2016

An attempt was made to retrieve peer reviewed published scientific literature on potential health concerns and studies related to WTE facilities from 2014 – 2016. Although not as systematic as the Metro Vancouver (IES, 2014) literature review similar principles were followed and applied. The US National Libraries of Medicine of the National Institutes of Health PUBMED database was searched using terms related to WTE/EFW chemical exposure, health risk and epidemiology. Inclusion/exclusion criteria similar to that used in the Metro Vancouver review were then applied. Only articles available in English were included.

Eight new publications on potential health concern associated with living in proximity to WTE facilities were retrieved. The following section provides results of this search and retrieved articles. Each article and its findings are briefly summarized.

Ollson, C., Whitefield Aslund, C., Knopper, L., and Dan, T. 2014. Site Specific Risk Assessment of an Energy-from-Waste Thermal Treatment Facility in Durham Region, Ontario, Canada: Part A Human Health Risk Assessment. Sci Total Environ. Jan 1; 466-467:345-56.

This paper contained the results of the site-specific human health risk assessment (HHRA) conducted as part of the environmental permitting process for the Durham-York EfW facility in Clarington, Ontario, Canada. The HHRA focused on two options for facility construction and operation; 1) a base facility with 154,000 tons per year of municipal waste processing capacity, and 2) the full expansion facility of 440,000 tons per year of waste processing capacity. An extensive baseline sampling program (i.e., air quality, soil, produce, etc.) of the project site was performed to establish a baseline environmental condition data set. Air quality modeling of over 100 chemicals was then completed for the proposed facility and both direct (inhalation) and indirect (multimedia) exposure pathways were assessed for potential to pose risk to local residents, schools, business, and recreational spaces.

The human health risk assessment determined that for the emissions for the facility being built are unlikely to cause adverse health risks, both carcinogenic and non-carcinogenic, to local residents, farmers, or other receptors. However, for a limited number of chemicals the proposed expanded facility of 440,000 tpy of MSW a limited number of potential inhalation health risks were identified that would need to be further refined if the facility was to be expanded in the future.

It should be noted, that commercial operation of the DYEC began in late 2015 and a sampling program for ambient air, soil and water is on-going that will ground truth the HHRA assumptions.

Ashworth DC, Elliott P, Toledano MB. 2014. Waste incineration and adverse birth and neonatal outcomes: a systematic review. Environ Int. Aug; 69:120-32

The authors conducted a systematic review of the epidemiological literature that evaluated relations between WTE and the risk of adverse birth and neonatal outcomes. A total of 14 studies that reported on a range of outcomes (including congenital anomalies, birth weight, twinning, stillbirths, sex ratio and infant death), exposure assessment methods and study designs. Overall they concluded that the evidence-base was inconclusive and limited by problems related to exposure assessments and challenges associated with statistical power and variability in study design. In addition, it appears that some of the articles reviewed included epidemiological data on older WTE facilities. They did however suggest that further research was warranted. Therefore, site specific risk assessments undertaken for modern WTE facilities should include consideration of adverse birth and neonatal outcomes in their selection of toxicity reference values.

Candela S, Bonvicini L, Ranzi A, Baldacchini F, Broccoli S, Cordioli M, Carretta E, Luberto F, Angelini P, Evangelista A, Marzaroli P, Giorgi Rossi P, Forastiere F. 2014 Exposure to emissions from municipal solid waste incinerators and miscarriages: a multisite study of the MONITER Project. Environ Int. 2015 May; 78:51-60

The authors analyzed the occurrence of miscarriages in women 15 – 49 years old residing near seven WTE facilties in the Emilia-Romagna Region of Northern Italy from 2002 – 2006. The study considered air dispersion modeling of PM10 and ground level NOx measurements as indicators of WTE impacts. They analyzed 11,875 pregnancies with 1,375 miscarriages. They found a weak, but statistical, association with an odds ration of 1.29 between PM10 levels and risk of miscarriage. However, the study has a number of methodological challenges, including actual exposure levels of PM10. Ground level PM10 concentrations from WTE facilities have rarely been demonstrated to have a measurable increase, and very low at that, over background within a kilometer of facilities. Regardless, this health endpoint should be considered in any predictive HHRA.

Rovira, J., Vilavert, L., Nadal, M., Schuhmacher, M., and Domingo, J. 2015. Temporal Trends in the Levels of Metals, PCDD/Fs and PCBs in the Vicinity of a Municipal Solid Waste Incinerator. Preliminary Assessment of Human Health Risks. Waste Management. Vol 43: 168-175.

This publication was follow-up work to previous environmental sampling and health risk work conducted by Dr. Domingo's research group in 2008 near a WTE facility located in Mataró Catalonia, Spain. The concentration of PCDD/Fs, PCBs, and metals were collected and analyzed in soil and air samples in 2011 and 2013. Soil levels of metals did not show any temporal variations between the current and past collections. However, metal concentrations in air samples were lower than those reported in the 2008 research. No significant differences were detected in concentrations of air or soil concentrations of PCDD/Fs and PCBs in any of the sampling events. The HHRA determined that exposures to environmental concentrations of PCDD/Fs, metals and PCBs for those living in proximity to the WTE facility were below levels of potential concern.

Yamamoto K, Kudo M, Arito H, Ogawa Y, Takata T. 2015. A cross-sectional analysis of dioxins and health effects in municipal and private waste incinerator workers in Japan. Ind Health. 53(5):465-79.

The authors conducted a cross-sectional epidemiological study to examine the potential health effects of male workers (n=678) employed between 2000 to 2007 at 36 WTE facilities in Japan. Blood serum concentrations of PCDD/Fs and coplanar PCBs were analyzed and health issues surveyed through physician's interview and clinical data. There was a significant difference in serum concentrations of PCDFs between workers and the Japanese general population. However, there was no difference in total dioxin or PCDDs between the groups. Although some positive correlations were found between levels and health outcomes (e.g., diabetes), the authors concluded "*No essential differences in serum concentrations of total dioxins and in prevalence of diabetes between our subjects and the general population suggested that the incinerator workers were marginally exposed to dioxins in the workplace without any recognizable adverse health effects*"

Vilavert L, Nadal M, Schuhmacher M, Domingo JL. 2015.Two Decades of Environmental Surveillance in the Vicinity of a Waste Incinerator: Human Health Risks Associated with Metals and PCDD/Fs. Arch Environ Contam Toxicol. 2015

Over the past 20 years the research team has been periodically measuring concentrations of PCDD/Fs and metals in soil and vegetation surrounding a 160,000 tpy WTE facility in Tarragona in Catalonia, Spain. In addition, since 2007 both passive and active sampling of PCDD/F concentrations in air has been conducted. The most recent collection was conducted in 2013-2014 and indicates a decrease of PCDD/Fs in soil and vegetation since the background study in 1999. Levels of airborne PCDD/Fs remained nearly constant throughout time. There was some fluctuation in metal concentrations depending on the media sampled. The authors concluded "*Overall, the current exposure to PCDD/Fs and metals does not mean any additional health risks for the population living near the facility. In conclusion, the results of the present study show that the environmental impact of the Tarragona MSWI is not significant, in terms of PCDD/Fs and heavy metals, after >20 years of continuous operation.*"

Buonanno G, Morawska L. 2015. Ultrafine particle emission of waste incinerators and comparison to the exposure of urban citizens. Waste Manag. Mar;37:75-81

The authors conducted a review of the published literature with respect to ultrafine particulate matter (PM<0.1) emissions from WTE facilities. Their review identified only a limited number of publications that reported measuring of stack ultrafine particulate emissions. In general they determined that emission levels were low with a median value of 5.5×10(3) part cm(-3). It was reported that the lowest emissions were achieved through use of bag-house filter that has a number-based filtration efficiency higher than 99%. This results in emissions of ultrafine particles from WTE stacks lower than one single high-duty vehicle. The authors concluded that the contribution of ultrafine particulate from WTE facilities over general background would be negligible in terms of exposure dose.

Scungio, M., Buonanno, G., Stabile, L., and Ficco, G. 2016. Lung Cancer Risk Assessment at Receptor Site of a Waste-To-Energy Plant. Waste Management 56:207-215

The researchers used stack emission measurements of benzo(a)pyrene (B(a)P), cadmium, arsenic, nickel, PCDD/F and polycyclic aromatic from a 130,000 tpy refused derived fuel WTE facility to model ground level concentrations in Central-Southern Italy. A HHRA was then conducted to estimate a cumulative excess lifetime cancer risk (ELCR) from all contaminants to induce lung cancer. The results from the assessments showed that the ELCR for lung cancer for people living and working nearby the facility was below the World Health Organization (WHO) target of $1x10^{-5}$.

Kumar, P., Pirjola, L., Ketzel, M., Harrison, R.M. 2013. Nanoparticle emissions from 11 non-vehicle exhaust sources – a review. Atmospheric Environment 67, 252–277

This paper reviewed links with adverse impacts on public health and atmospheric nanoparticles (below 300 nm in diameter to represent most of the particle number concentration, PNC) from 11 major non-vehicle exhaust sources (NES). One of the NES categories was MSW incineration. Particles from nanosize up to 75 µm can make it through incineration, or be generated by incineration, and end up in flue gases from these facilities. Although concentrations vary, depending on various factors related to the MSW and the facility, the study’s authors estimate that 1 tonne of conventional waste can produce approximately 3.76x1015 nanoparticles, with a further addition of about 0.1 to 1 times from nanocomposites incineration. Flue gas treatment systems have been shown to remove nanoparticles with varying levels of efficiency, prompting the call for further study. However, the range of PNCs found after flue gas treatment systems are similar to urban air, where the PNCs are due primarily to road traffic. Although MSW incineration is determined to release PNCs likely to be considered small when compared to road traffic, the authors mention that MSW incinerators also release PM2.3, PM10, and ash, all of which may contain dioxins, heavy metals, and halogenated organic compounds.

5.4 Conclusions on Health Issues

Overall, the published scientific literature on potential health concerns living in proximity to WTE facilities indicates that modern facilities with appropriate air pollution control technology can be safely sited. That being said, it is imperative that any new build facility, as being contemplated by Metro Portland undergo a rigorous site-specific human health risk assessment of multiple chemical to ensure that public health is being protected.

6 WTE Sustainability Overview and Cost and Economic Benefit

There have been a limited number of publications on the potential cost-benefit and sustainability issues surrounding WTE facilities. This section is not intended to provide a detailed review of Metro's decision to pursue WTE for 20% of their residual MSW but an overview of studies that have been published.

6.1 Sustainability

Brunner, P. and Rechberger, H. 2014. Waste-to-Energy: Key Element for Sustainable Waste Management. Waste Manag 37:3-12.

The article focuses on the challenges and outlook for waste management with the objective of protecting human health and the environment while conserving resources. The article highlights the advantages of WTE technologies, with adequate air pollution control equipment, as a prime contributor to that objective. WTE technologies, while maintaining the purpose of the original incineration plants of hygienic treating and reducing the volume of waste, can also recover additional resources such as energy and metals.

Cucchiella, F., D'Adamo I., Gastaldi, M. 2014. Sustainable Management of Waste-to-Energy Facilities. Renewable and Sustainable Energy Reviews 33: 719–728

An article focusing on the issues regarding the current waste management practices in Italy. The current plan, which includes recycling, still sends more than 50% of the country's waste to the landfill. The article provides a proposed national waste management plan for energy recovery by evaluating all the aspects of the sustainability of EfW facilities. This proposal highlights the benefits of EfW technologies, such as: the mitigation of GHG emissions with respect to landfilling waste; the estimated cost benefit of EfW; and an estimate of job creation opportunities.

Finnveden, G., Johansson, J., Lind, P., and Moberg, A. 2005. Life Cycle Assessment of Energy from Solid Waste – Part 1: General Methodology and Results. Journal of Cleaner Production 13 (2005) 213–229

A life cycle assessment evaluating different strategies for solid waste management was done for Sweden. The assessment focused on the current solid waste management practices, including the following: landfilling; incineration; recycling; digesting; and composting. The results of the life cycle assessment supported Sweden's current waste hierarchy that emphasizes the "4R's" of reduce, reuse, and recycle then recovery by EfW before landfilling the residuals. However, the study predicts a scenario where there is a benefit to sending paper material to EfW facilities over recycling if there are proper fuel and energy market conditions.

6.2 Cost - Benefit

Themelis, N. and Mussche, C. 2014. Energy and Economic Value of Municipal Solid Waste and Non-Recycled Plastics Currently Landfilled in the Fifty States prepared for the American Chemistry Council.

This report was an update to the study created by members of the Earth Engineering Department of Columbia University. The objective of the study is to determine the amount of non-recycled plastics (NRP) in the MSW that is currently being sent to landfills in the United States in 2011. Based on this quantity of NRP that ends up in landfills, an estimate of the amount of energy that would have been produced if the NRP would have been processed in EfW facilities was calculated. Based on the data from 2011, the energy conversion of just the NRP that is being sent to landfills could supply enough electricity for almost 6 million homes, which is approximately 5% of the US demand. The report also provides an extensive summary and breakdown of the current waste management practices in each state in the United States.

Stantec. 2010. Waste to Energy A Technical Review of Municipal Solid Waste Thermal Treatment Practices prepared for the British Columbia Ministry of the Environment

In 2010, Stantec consulting prepared a comprehensive overview report of issues and practices in the WTE industry. One of the issues covered by Stantec was that of cost of WTE and energy benefit. They concluded: "*As part of the comparison of WTE technologies, the report includes a review of costs and energy efficiency for the various thermal treatment and APC technologies. The capital and operating cost for WTE facilities varies on a per tonne basis depending on the scale of the facility and specific design parameters. Generally, actual cost information is difficult to verify, and much of the available cost data is based on vendor information that has been provided outside of formal procurement processes. The sale of recovered energy in a WTE facility, in the form of electricity or as heat (steam), is typically critical to the financial viability of the facility, particularly when compared to other MSW management options."*

Solid Waste Association of North America. 2011. The Economic Development Benefits of Waste-to-Energy Systems.

The industry association SWANA undertook documenting what they believe to be the economic development benefits that WTE facilities provide to their communities in comparison to those who remote landfill.

They concluded:

> *Based on a review of the literature as well as the analysis of cost and performance data from two case studies, the following conclusions are offered with respect to the role that WTE facilities can play a role in local community economic development programs.*
>
> - *Over the life of the WTE facility, which is now confidently projected to be in the range of 40 to 50 years, a community can expect to pay significantly less for MSW disposal at a WTE facility than at a regional MSW landfill.*

- *Of primary importance is the fact that monies spent on WTE will be kept in the local community while 90 percent of the monies spent on disposal at regional MSW landfills will be transferred out of the local economy. These monies can represent hundreds of millions to billions of dollars over a 40-year timeframe.*
- *The construction of WTE facilities typically requires the employment of hundreds of construction workers while the operation of these facilities requires an average of 58 professional workers. These jobs cannot be outsourced.*

WTE facilities can provide significant quantities of base-load renewable electrical power. In this regard, they can play a critical role in the production and sale of base-load and peak renewable electrical power from a local renewable energy program that consists of WTE, solar, and wind generating facilities.

Solid Waste Association of North America. 2012. The Economic Benefits of Waste-to-Energy Systems: Jobs Creation and Community Development

Following from the 2011 report, the industry association SWANA undertook documenting what they believe to be the economic development benefits that WTE facilities provide to their communities in comparison to those who remote landfill.

They concluded:

Based on a review of the literature as well as the analysis of cost and performance data from a number of operating and planned facilities, the following conclusions are offered with respect to the role that WTE facilities can play with respect to the creation of jobs and the encouragement of community development.

- *Over the life of the WTE facility (which is now confidently projected to be in the range of 40 to 50 years), a community can expect to pay significantly less for MSW disposal at a WTE facility than at a regional MSW landfill.*
- *Of primary importance is the fact that monies spent on WTE will be kept in the local community while 90 percent of the monies spent on disposal at regional MSW landfills will be transferred out of the local economy. These monies can represent hundreds of millions to billions of dollars over a 40-year timeframe.*
- *The construction of WTE facilities typically requires the employment of hundreds of construction workers while the operation of these facilities requires an average of 59 professional workers. These jobs cannot be outsourced.*
- *Based on historical data, WTE facilities appear to encourage rather than discourage investments in community development projects in their vicinities. Community development projects representing hundreds of millions of dollars have been implemented in close proximity to WTE facilities. The fact that a number of these projects include large-scale residential developments and healthcare facilities contradicts the claims by certain environmental organizations that the air emissions from WTE facilities represent unacceptable public health risks.*

7 Conclusion

Waste to Energy, along with all manner of MSW management options, has its challenges. This literature review provided an overview of potential issues surrounding air quality, environmental quality, greenhouse gas benefits, health considerations, and sustainability and economic cost-benefit.

The issues raised in this review should be taken into consideration if Metro choses to move forward with procurement of 200,000 tpy management by an expanded Marion County WTE facility. This can be done during the contracting phase and detailing any additional requirements that are deemed appropriate during the environmental permitting phase.

8 References

AEA Technology PLC. 2012. Review of Research into Health Effects of EfW Facilities (2012): Prepared for the Environmental Services Association by AEA Technology PLC. (now Ricardo-AEA Ltd.)

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