Assessment of Landfill Gas Odour Controls in Place at Waste Management Canada Ottawa Landfill 2301 Carp Road Ottawa, Ontario

Report to

Ministry of the Environment

September 2008

333100

SNC♦LAVALIN INC.

SNC·LAVALIN

CLIENT: Ministry of the Environment

PROJECT: Assessment of Landfill Gas Odour Controls in Place at Waste Management Canada Ottawa Landfill

Prepared By: Lynn Davidson **Signature:** Lynn D

Date: 2008 - 09 - 05

Reviewed By: Darren Dickson **Signature:** Lynn D for Darren Dickson

Date: 2008 - 09 - 05

Approved By: Ted Taylor **Signature:** Ted Taylor

Date: 2008 - 09 - 05

ISSUE/REVISION INDEX

Issue Code	Revision					Revision Details
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RR	PA	LD	TT	TT	2008-08-15	First issue to client for review and comment. Appendix D separate submission.
	00	LD	DD	TT	2008-08-27	Incorporation of Client comments,
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Issue Codes: RC = Released for Construction, RD = Released for Design, RF = Released for Fabrication, RI = Released for Information, RP = Released for Purchase, RQ = Released for Quotation, RR = Released for Review and Comments.

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1.0 INTRODUCTION

SNC-Lavalin Inc. (SLI) was retained by the Ontario Ministry of the Environment (Ministry) under the "Vendor of Record for the Provision of expert advice, critical scientific review, site investigation, remediation, mitigation and decommissioning for wells, environmental geoscience, surface water science and engineering services", for the project titled "*Assessment of Landfill Gas Odour Controls in Place at Waste Management Canada Ottawa Landfill*" (dated May 13, 2008). The project requires the provision of an expert opinion regarding the measures taken and the technologies employed at the Waste Management of Canada Corporation Ottawa landfill site to control odours.

1.1 Scope of Work

The scope of the work included:

- An initial teleconference call with the Ministry to confirm project objectives, scope and other details;
- A review of Ministry-provided information;
- A site visit;
- A review of publicly available information concerning similar landfill issues, their approaches and odour mitigating solutions;
- A survey of representative Ontario landfill operators to determine current in-field application of industry standards;
- Contact with provincial and federal regulators to determine industry standards;
- Sourcing of best management practices and industry standards;
- Development of an expert opinion regarding the odour controls in place at the Ottawa WMF including an evaluation of the following topics:
    - development and operation of the Waste Management of Canada Corporation Ottawa landfill site in relation to odour generation and release,
    - adequacy of overall odour management plan and practices,
    - landfill gas collection and destruction system and its effectiveness in controlling odour, and,
    - comparison with best management practices and industry standards for odour control elsewhere in the province of Ontario.

1.2 Report Structure

The report comprises 6 sections and is organized as follows:

- Section 1 provides the introduction to the work;
- Section 2 outlines the background to the work and includes general information on landfill operations and odour, the regulatory environment for landfilling operations in Ontario, and concludes with a synopsis of the issue being assessed;
- Section 3 provides a summary of Waste Management of Canada Corporation's operations and odour mitigation measures at their Ottawa landfill;
- Section 4 examines industry standards and best management practices (BMPs) as it relates to the control of odour from landfills;
- Section 5 provides the summary and conclusions of this assessment and includes an assessment of Waste Management of Canada Corporation's ability to perform within BMPs and industry standards; and
- References are provided in section 6.

1.3 Limitations

The following limitations regarding the data gathering process and the scope of the work should be noted:

- Best management practices for odour control from landfills are not explicitly noted in any provincial or federal publications although industry standards do exist.
- No site derived data or field measurements were obtained.
- The scope of work did not include empirical determination of odour emissions sources.
- Odour complaints were not investigated nor qualified in the scope of this work.

Please refer to Appendix A for the SNC Lavalin Inc. notice pertaining to studies.

2.0 BACKGROUND

Waste Management of Canada Corporation ("WMCC") operates the Ottawa Waste Management Facility ("Ottawa WMF") in the City of Ottawa. The Ottawa WMF is licensed to receive non-hazardous municipal solid waste province-wide, with the majority of the waste coming from the Ottawa area.

Prior to 2006, odour complaints received from the public were generally less than three per year. However, since 2006, the Ottawa WMF has been the source of many community complaints relating to odour. According to a Ministry database the annual number of complaints was approximately 500 in 2006 with this number increasing to more than 1,300 in 2007. Although WMCC has implemented a landfill gas collection and control system as well as various odour control measures, large numbers of odour complaints have continued to be received.

In May 2006, the Ministry requested WMCC institute a Voluntary Abatement Program (VAP) for odour control at the Ottawa WMF due to the marked increase in community odour complaints. WMCC agreed to implement the VAP and the work and actions were completed through 2006. In early 2007, the Ministry conducted community odour surveys and determined/concluded that despite the VAP measures instituted by WMCC, odours were still discharging to the natural environment. This conclusion resulted in the issuance of a Provincial Officer's Order in May 2007 with ten (10) conditions requiring the completion of a variety of reports to be submitted throughout 2007. WMCC completed all of the required conditions in the specified timeframe through 2007. In December 2007, a second Provincial Officer's Order was issued which contained four (4) additional conditions, again relating to reporting. On January 15, 2008, the Ministry issued a letter to WMCC indicating that the Company had complied with the submission and the informational posting requirements of the May 2007 Provincial Officer's Order.

Despite WMCC having incorporated improvements to the Ottawa WMF over time, odour complaints are noted to persist. The Ministry are currently investigating WMCC to determine if they have complied with relevant legislation and have been duly diligent in their operations of the Ottawa WMF.

The purpose of this Report is to provide the Ministry with an expert opinion regarding the measures taken and the technologies employed at the Ottawa WMF to control odours. This Report addresses the following questions posed by the Ministry:

- Did odour controls implemented by the Ottawa WMF meet industry standards or best management practices established for landfill operations?
- Does the Ottawa WMF Design and Operation plan comply with industry standards/best management practices for odour control?
- Has the Ottawa WMF demonstrated proactive management of landfill odours?
- Were areas of concern raised in the provided documentation sufficiently addressed in a timely manner?

2.1 Ministry Provided Documentation

A review of all the Ministry-provided resources (refer to Appendix B) and other information readily available was completed to determine if the odour control plan implemented for the Ottawa WMF was duly diligent. The following sections provide a brief summary of the documentation, organized by type of document.

2.1.1 Waste Management Canada Annual Monitoring Reports

Annual monitoring reports (AMRs) from 1998 to 2007, prepared by Water and Earth Science Associates (WESA) Group Inc, were provided for review. The format for all AMRs consistently covers all aspects related to operations, monitoring, quality assurance and quality control, and most important to our review, information pertaining to landfill gas monitoring, landfill operations, and odour complaints.

According to each of the AMRs reviewed, landfill gas related monitoring is conducted as follows:

- monthly monitoring of six on-site gas monitoring wells (numbered GM1 to GM6) using a hand-held Gastech monitor;
- continuous monitoring of landfill gas extraction and destruction equipment; and
- recent (initiated in 2007) regular monitoring of off-site odour.

Landfilling of waste has continued to follow the phased development plan described in the 1994 Design and Operations Report by Henderson Paddon Environmental Inc.

According to the 2007 AMR, odour complaints have been documented and addressed in accordance with the comprehensive site-wide C of A (Air) for the landfill which was issued on November 29, 2006.

Prior to 2006, odour complaints received from the public were generally less than three per year.

Based on revised projections of annual waste tonnage, daily cover usage and remaining airspace, WMCC estimates that as of June 2007 the site has sufficient capacity for approximately five years of operations.

2.1.2 Voluntary Abatement Program and Submissions

In May 2006, the Ministry requested a Voluntary Abatement Program (VAP) for odour control at the Ottawa WMF due to an increase in nuisance odour complaints in the area surrounding the landfill. A total of five actions were requested to be completed by WMCC to demonstrate their intent to remain in compliance with applicable Ministry legislation. A summary of the VAP and the associated correspondence between the MOE and WMCC is provided in Table 1.

Table 1. Summary of Voluntary Abatement Program Folder

Date	Document	Author	Description
May 11, 2006	Letter	**FROM:** MOE **TO:** WMCC	• Request WMCC produce a Voluntary Abatement Program (VAP) for odour. • Request based on recent rise of odour complaints. • Noted that the complaints multiplied after the landfill expansion proposal open house. • Noted WMCC intention to install a temporary flare. • Actions requested by MOE: 1. Retention of qualified contractors. 2. Evaluation of potential odour sources by qualified person. 3. Evaluation of approved Design and Operation (D&O) of existing LFG collection system and flare, leachate collection system and gas air sparging system. 4. Independent inspection of LFG collection/flare to identify deficiencies. 5. Recommendations for design and/or operation improvements.
June 8, 2006	Letter with enclosures (VAP)	**FROM:** WMCC **TO:** MOE	WMCC provides summary of abatement already underway (outside of VAP): • WMCCs plan to construct gas to energy facility. • Modelling of landfill gas by 'WMCC model' and by third party consultant, calibrated with gas collection and flare system data. • Gas collection wells are added annually to the collection system.

Table 1. Summary of Voluntary Abatement Program Folder

Date	Document	Author	Description
			• Plans for Installation of 2nd flare. • Odour control system/misting increased from 2000 to 4200 feet along Carp Road, will submit C of A for odour control. • Work Schedules in Appendix F. Response to actions requested by the MOE (through the VAP): 1. Retained consultants as qualified persons - RWDI. 2. Evaluation of odour sources by Andre Simard and Associates (ASA) is underway using US EPA method for methane concentrations (partial results in Appendix A). ASA is also completing a second surface emission survey to include the air sparging system. A LFG characterization study was completed by RWDI (Appendix B). 3. Evaluation of the approved D & O of the landfill gas system by ASA is underway (to be submitted July 14, 2006). Comcor will conduct evaluation of monitoring and maintenance requirements for the landfill gas collection and flare system and optimization of the collection efficiency. Landfill gas generation curve data (Appendix C), the proposed plan for landfill gas wells locations (Appendix D) and the plan for interim and final capping (Appendix E) are provided. 4. Not addressed in submission. 5. Recommendations include: a. Installation of the last portion of the LFG header to surround entire site to improve vacuum on well field. b. Installation of a min 15 new LFG wells on eastern portion of landfill (June 30, 2006). c. Approval and installation of second enclosed flare (July 21/2006 or upon approval). d. Approval and temporary candlestick flare (completed). e. Three new landfill gas blowers (June 12, 2006). f. Gas to energy facility (expected construction start – end of 2006). g. Expansion of odour control system and operation during winter months with MOE approval. (application due June 30, 2006).
June 20, 2006	Letter	**FROM:** Nielson Systems Inc. **TO:** WMCC	Letter describing the landfill gas flare equipment inspection. Includes a summary of all works completed on the flare from November 2004 to November 2005. (Satisfies Activity 4 of the VAP).

Table 1. Summary of Voluntary Abatement Program Folder

Date	Document	Author	Description
June 26, 2006	Letter	**FROM:** MOE **TO:** WMCC	Acceptance of the VAP submission. Deadline for submission of the air sparging system (Activity 2) and LFG well field optimization and collection efficiency report (Activity 3) is August 4, 2006.
July 21, 2006	Letter with attachments	**FROM:** WMCC **TO:** MOE	Submission of reports: *Assessment of the LFG Collection System Performance,* April 2006 (ASA) *Assessment of the LFG Collection System Performance - Complementary Study,* July 2006 (ASA) • Lists action taken for Evaluation of Existing LFG Collection and Flaring System by Henderson Paddon and Associates (HPA) and ASA. • Refined design of flare submitted to the MOE for total capacity of 2200 scfm (2nd flare) and 1200 scfm (original flare) to exceed current and predicted LFG collection rates. • 15 new extraction wells and a new header were constructed. • Implementing improvements from Conclusions and Recommendations of attached reports. • Included Schedule showing that all requested activities of the VAP had been completed.
July 11, 2006	Assessment of the LFG Collection system performance – Complementary Report	**BY:** ASA	Summary of Conclusion/Recommendations: • Only permanent flare was operating resulting in lower collected energy and lower vacuum and increased methane in collection wells. Noted a probable air leak in the interconnecting piping of the temporary skid (also may affect energy collected) and should be repaired. • No emissions of methane above 500 ppmv above air sparging system except 5 points on site. • Flaring station still has some capacity based on performance. • Major pressure drops in the main header indicating obstruction or water between wellfield and permanent flare. Should be investigated. • Energetic or methane flows should be calculated.

Table 1. Summary of Voluntary Abatement Program Folder

Date	Document	Author	Description
Jan 26, 2007	Letter with attachments	**FROM:** WMCC **TO:** MOE	Follow up to inspection report[1] from December 12, 2006: *Assessment of LFG Vertical Migration West, December 2006*, ASA Submission of Surface Emission Report as requested by the MOE and summary of resulting action taken by WMCC: 1. Surfaces on south slope, SW corner and NW corner greater than 250 ppmv were covered with 0.3 m clay. 2. Began dewatering (5 days/week) of landfill gas wells. 3. 8 new LFG wells along site access road with solar powered dewatering pumps in 6 wells. (continued next page) 4. Modified on-site misting system to operate in winter conditions. 5. 6 new horizontal LFG wells along south slope were CH_4>500 ppmv (proposed Feb 15, 2007). 6. 5 new LFG wells on NW slope along 137 m contour line (proposed Feb 28, 2007). 7. Assessment of LFG vertical migration by ASA (proposed May 28, 2007 by ASA).
Mar 12, 2007	Letter	**FROM:** WMCC **TO:** MOE	Subsequent to meeting with the MOE on March 7, 2007. • MOE does not think that the VAP has met its objectives based on odour survey conducted Jan 22, 2007 to Feb 23, 2007. • Notes that survey was conducted during installation of LFG wells which result in odours and that during the survey period, the VAP had not met its objectives. • Notes that VAP has doubled LFG collection capacity and tripled gas flaring capacity.

2.1.3 Provincial Officer's Orders and Submissions

The Ministry conducted community odour surveys in January and February of 2007, and determined that despite all of the VAP measures put in place, the Ottawa WMF was still discharging odours into the natural environment that was causing or was likely to cause an adverse effect, contrary to section 14 of the EPA. This conclusion resulted in the Ministry issuing the first Provincial Officer's Order. A summary of the Provincial Officer's orders and subsequent compliance by WMCC is summarized in Table 2.

[1] Inspection report was not provided to SNC Lavalin Inc.

Table 2. Summary of Ministry Orders and Subsequent Responses

Date	Document	Author	Description
May 11, 2007	Order No. 5830-6Z2PPW	**FROM:** MOE **TO:** WMCC	10 Conditions ordered: 1. Submit Summary Action Report (by June 1, 2007). 2. Retain Qualified Person for activities 3 to 7 (by May 17, 2007). 3. Odour Sources Survey Report: evaluation of all potential sources of odour with description and ranking of sources and recommendations for Section 14 compliance (by June 29, 2007). 4. Emissions Survey Report: description of emission results as per U.S. EPA method for operational standards and description of actions taken with regard to the landfill gas collection and flaring system (by the last day of June, August, October and December). 5. Ambient Air Monitoring Report: results from ambient air quality monitoring, testing and reporting set out in the Ambient Air Quality Work Plan by RWDI (Feb 16, 2007) in Appendix I of Order (by August 31, 2007). 6. Continuous Monitoring Report: assess options and potential effectiveness of continuous air quality monitoring equipment capable of monitoring odour at points of impingement (POIs) (by August 31, 2007). 7. Landfill Cover Report: evaluation of current landfill cover with recommendations (by June 29, 2007). 8. Operations Manual: manual with plans, specifications and a description of the operations and maintenance procedures for the landfill gas system collection and air injection systems (by June 1, 2007). 9. Monthly Progress Reports (by 15th of every month). 10. Contingency Work Plan: description and evaluation of potential contingency measures which could be implemented after September 30, 2007 to eliminate ongoing odour discharges from the site.
May 22, 2007	Letter	**FROM:** MOE **TO:** WMCC	List of contractors/qualified persons (Condition 2)
May 25, 2007	Director's order #5830-6Z2PPW-1	**FROM:** MOE **TO:** WMCC	In response to WMCC letter[2] May 17, 2007 requesting review of the provincial order. Director does not believe VAP resulted in the elimination of odours. Director confirms order in its entirety.

[2] Letter not provided to SNC Lavalin

Table 2. Summary of Ministry Orders and Subsequent Responses

Date	Document	Author	Description
June 1, 2007	Letter and attachments	**FROM:** WMCC **TO:** MOE	Submission of Summary Action Report (Condition 1). Notification of Completion of the Operations Manual (Condition 8).
June to August	Letters and attachments	**FROM:** WMCC **TO:** MOE	Various submissions fulfilling Conditions 2, 4, 5, 6, 7, and 9 of the VAP.
July 2007	Potential Contingency Measures for Odour Control	**BY:** Henderson Paddon & Associates	Condition #10 of VAP. (Modified Contingency Workplan submitted December 11, 2007, below).
December 11, 2007	Letter and attachments	**FROM: WM To: MOE**	Modified Contingency Plan with schedule of work for 2007 to 2010: 1. LFG Collection system: 18 new vertical wells for a total of 126 wells (by May 2008). 2. Clay Capping: uncapped slopes will be capped with contaminated soil and clay to final contours on North Slope (by Sep 2008). Capping of slopes and top to final contours (by Oct 2008). 3. Synthetic Beanie Cap: Designed (by March 2008) and MOE application (by April 2008). Beanie cap will consist of a layer of clay, horizontal LFG collector and a synthetic liner covered with a layer of vegetative cover (construction in 2009 and 2010). 4. Air Emissions Survey Reports: conduct 5 surveys/year from 2008 to 2010. 5. Leachate Seeps Management: weekly slope inspections and immediate repairs by draining leachate into waste and sealing cap with fresh clay. 6. Processed Biosolids Management: biosolids as a vegetative cover suspended due to short term odours. 7. Planned Construction/Maintenance Activities Reports: reports posted to the WMCC website.
December 19, 2007	Provincial Officer's order # 7160-79THQR	**FROM:** MOE **TO:** WMCC	Contains 4 conditions: 1. Odour Contingency Plan: carry out all activities and deadlines in the Odour Contingency Plan dated December 11, 2007. 2. Prepare quarterly reports on all odour contingency plan activities (1st report by April 15, 2008. 3. Post Provincial order on website (by January 15, 2008) 4. Post quarterly reports on WMCC website.

2.1.4 Certificates of Approval - Air

Table 3 below provides a summary of the Certificates of Approval for Air acquired by WMCC.

Table 3. Summary of Certificates of Approval for Air

Issue Date	Document	Description
Dec 29, 1999	C of A (Air) #8-4076-99-006	Approval for: 1. One enclosed flare for landfill gases with max flow rate of 0.57 standard cubic metres per second and max heat output of 41.7 gigajoules/hr exhausting through a stack extending 12.2 m above grade with diameter 2.1 m. (continued next page)
May 26, 2006	C of A (Air) #4339-6PPJ7Y	Approval for : 1. One temporary open candlestick type flare and associated flare blower system and other accessories, used to combust landfill gas at a volumetric flow rate of 0.64 cubic metre per second having a methane composition in the range of 30 to 50 percent by volume, equipped with a flame arrestor and a spark plug ignitor, exhausting into the atmosphere through the flare top, having an exit diameter of 0.2 metre and extending 8.5 metres above grade; 2. One diesel generator, having a rating of 106 kilowatts, to provide power for the temporary flare described above, exhausting to the atmosphere at a maximum volumetric flow rate of 0.13 actual cubic metre per second at an approximate temperature of 460 degrees Celsius, through a stack, having an exit diameter of 0.2 metre, extending 1.5 metres above grade. 3. C of A requires log of complaints and all appropriate measures to minimize odours from potential sources.
November 28, 2006	Amended C of A (Air) #0741-6S9NPE	Approval for: 1. One enclosed flare system, used to incinerate the landfill gases from a landfill gas collection system at a maximum volumetric gas flow rate of 0.57 standard cubic metre per second. The landfill flare has a maximum heat input of 41.7 gigajoules per hour, exhausting into the atmosphere through a stack, having an exit diameter of 2.1 metres, extending 12.2 metres above grade; 2. One enclosed flare system, used to incinerate the landfill gases from an expanded landfill gas collection system at a maximum volumetric gas flow rate of 1.04 standard cubic metres per second based on a methane content of 50 percent by volume. The landfill flare has a maximum heat output of 70.7 gigajoules per hour, exhausting into the atmosphere through a stack, having an exit diameter of 2.7 metres, extending 12.2 metres above grade; 3. One landfill gas-to-energy facility, consisting of initially five and up to a maximum of eight reciprocating engine-generator sets, all located inside a Building in the southeast side of the site, firing on landfill gas collected from the site, determined by actual landfill gas collection rate achievable at the site.

Table 3. Summary of Certificates of Approval for Air

Issue Date	Document	Description
		Each engine-generator set has a power rating of 800 kilowatts and a maximum landfill gas firing rate of 0.19 cubic metres per second, so that when eight (8) engine generator sets are operating simultaneously, the maximum landfill gas consumption rate is 1.52 standard cubic metres per second. Each engine-generator set exhausts into the atmosphere at a maximum volumetric flow rate of 2.85 actual cubic metres per second at an approximate temperature of 427 degrees Celsius, with its own stack, having an exit diameter of 0.41 metre, extending 5.5 metres above the roof and 13.4 metres above grade. As landfill gas generation and collection decreases, the engine-generator sets will be removed from the site as required; 4. One soil bioremediation Biopile process, to treat petroleum hydrocarbon impacted soil received at the site, consisting of: - two asphalt pads, on each of which petroleum hydrocarbon impacted soil is mixed with Biostimulation Compound and stockpiled, complete with pipes for aeration purpose and water irrigation system, and covered with a semi-permeable membrane, - one blower to draw air through perforated pipes through the impacted soil piles in order to maintain aerobic bacterial activity inside the biopiles, exhausting to the activated carbon filter described below, - one activated carbon filter, consisting of one activated carbon vessel, containing 900 kilograms of granular activated carbon, discharging into the atmosphere at a volumetric flow rate of 0.6 cubic metre per second, through a stack, having an exit diameter of 0.3 metre, extending 1.5 metres above grade; - one exhaust, to serve the gas stripper in the Blower Building used to remove methane and non-methane organic compounds from the wastewater before its discharge to sanitary sewer, discharging into the atmosphere at a volumetric flow rate of 0.42 cubic metres per second, through a stack, having an exit diameter of 0.1 metre, extending 1.2 metres above grade.
March 7, 2008	Amended C of A (Air) #7816-7C9JMR	Approval for: 1. One enclosed flare system, used to incinerate the landfill gases from a landfill gas collection system at a maximum volumetric gas flow rate of 0.57 standard cubic metres per second. The landfill flare has a maximum heat input of 41.7 gigajoules per hour, exhausting into the atmosphere through a stack, having an exit diameter of 2.1 metres, extending 12.2 metres above grade; 2. One enclosed flare system, used to incinerate the landfill gases from an expanded landfill gas collection system at a maximum volumetric gas flow rate of 1.04 standard cubic metres per second based on a methane content of 50 percent by volume. The landfill flare has a maximum heat output of 70.7 gigajoules per hour, exhausting into the atmosphere through a stack, having an exit diameter of 2.7 metres, extending 12.2 metres above grade;

Table 3. Summary of Certificates of Approval for Air

Issue Date	Document	Description
		3. One landfill gas-to-energy facility, consisting of initially five and up to a maximum of eight reciprocating engine-generator sets, all located inside a Building in the southeast side of the site, firing on landfill gas collected from the site, determined by actual landfill gas collection rate achievable at the site. Each engine-generator set has a power rating of 800 kilowatts and a maximum landfill gas firing rate of 0.19 cubic metres per second, so that when eight engine-generator sets are operating simultaneously, the maximum landfill gas consumption rate is 1.52 standard cubic metres per second. Each engine-generator set exhausts into the atmosphere at a maximum volumetric flow rate of 2.85 actual cubic metres per second at an approximate temperature of 427 degrees Celsius, with its own stack, having an exit diameter of 0.41 metre, extending 5.5 metres above the roof and 13.4 metres above grade. As landfill gas generation and collection decreases, the engine-generator sets will be removed from the site as required; 4. One soil bioremediation Biopile process, to treat petroleum hydrocarbon impacted soil received at the site, consisting of: - two asphalt pads, on each of which petroleum hydrocarbon impacted soil is mixed with Biostimulation Compound and stockpiled, complete with pipes for aeration purpose and water irrigation system, and covered with a semi-permeable membrane, - one blower to draw air through perforated pipes through the impacted soil piles in order to maintain aerobic bacterial activity inside the biopiles, exhausting to the activated carbon filter described below, - one activated carbon filter, consisting of one activated carbon vessel, containing 900 kilograms of granular activated carbon, discharging into the atmosphere at a volumetric flow rate of 0.6 cubic metre per second, through a stack, having an exit diameter of 0.3 metre, extending metres above grade; - one exhaust, to serve the gas stripper in the Blower Building used to remove methane and non-methane organic compounds from the wastewater before its discharge to sanitary sewer, discharging into the atmosphere at a volumetric flow rate of 0.42 cubic metres per second, through a stack, having an exit diameter of 0.1 metre, extending 1.2 metres above grade. - Includes condition for source testing, otherwise identical to previous C of A.

2.1.5 Certificate of Approval – Waste Disposal

In 1971 the site was initially issued Certificate of Approval Number 461002 (the approval) for sanitary landfilling with a re-issue on 17 August 1994. In 1994, Laidlaw Waste Systems Ltd. retained a consultant to complete a Design and Operations (D&O) Report for the site. The document was submitted (December 1994) to and approved by the Ministry and serves as the controlling document for current site operations. In November 1996, the approval was amended to include upgraded buffer zone requirements, name change, and to include appeal settlement discussions and to reflect operations at the site. An amendment to the approval was again issued November 2001 which required specific information be provided in the Annual Monitoring Report. A Development and Operations Update Report was submitted in April 2003 which expanded upon the original D&O Report to address the landfill gas collection and air injection system and odour control. An amended C of A was issued May 2003 which allowed for continued receipt of specified types of waste. In March 2004, the Ministry acknowledged another company name change from Canadian Waste Services Inc. to WMCC. In November 2006, an amendment was issued which recognized a change in total site area due to land acquisition for the contaminant attenuation zone, that such lands be registered for landfilling operations, and requirements relating to water supply wells. A December 2006 amendment corrected an error with respect to the Certificate of Requirement.

In July 2007, the approval was again amended to incorporate operational changes outlined in the updated D&O Report. Finally, as of March 2008, the approval was amended to include a number of requirements (primarily related to odour issues) reached as a result of the Environmental Review Tribunal settlement decision.

2.1.6 Other

Other related Ministry-provided documentation included various Operation and Maintenance Manuals, Contracts, Years 2006 and 2007 Complaint Databases, and site photos.

3.0 LANDFILL OPERATIONS AND WASTE MANAGEMENT CANADA OTTAWA

3.1 Landfill Gas Emissions and Odour

Landfill gas is generated during the natural process of bacterial decomposition of organic material contained in non-hazardous solid waste landfills. A number of factors influence the quantity of gas that a non-hazardous solid waste landfill generates and the components of that gas. These factors include, but are not limited to, the types and age of the waste buried in the landfill, the quantity and types of organic compounds in the waste, and the moisture content and temperature of the waste. Temperature and moisture levels are influenced by the surrounding climate.

By volume, landfill gas is typically comprised of about 50 percent methane and 50 percent carbon dioxide and water vapor. It also contains small amounts of nitrogen, oxygen, and hydrogen, less than 1 percent nonmethane organic compounds (NMOC), and trace amounts of inorganic compounds. Over three hundred trace compounds at trace concentrations have been identified in landfill gas samples. Unpleasant odours are usually associated with the sulphur-containing compounds, primarily mercaptans and sulphides (for example, hydrogen sulfide, or H_2S). Thermal treatment of NMOC and methane through flaring or combustion in an engine, turbine, boiler, or other device greatly reduces the emission of these compounds.

Landfill gas emissions can cause unpleasant odours as some compounds found in landfill gas are associated with strong, pungent aromas. Given proper weather conditions, these smells can be transmitted off-site to nearby homes and businesses. Unpleasant odours can lower the quality of life for individuals that live near landfills. When repeatedly experienced, these odours commonly lead to nuisance complaints. Odours in the community are generally the leading air pollution complaint made to regulators and government bodies.

3.2 Regulatory Environment: Ontario Landfills

3.2.1 Landfilling Activities

In Ontario, landfill sites and other waste management activities are subject to Part V of the Environmental Protection Act (EPA or Act) and the Regulations made under the Act. The basic legislative framework for waste management is defined in Part V and the regulatory requirements for the design and operation of waste disposal sites are included in Regulation 347 (General – Waste Management). For new or expanding landfill sites, these regulatory requirements are superseded by

Regulation 232/98 (Landfill Standards for new or expanding sites), which came into effect as of August 1, 1998.

Section 27 of the Act requires that a Certificate of Approval be obtained from the Ministry for the establishment, operation, alteration or enlargement of a landfill site. To obtain approval for a new or expanding landfill site, a detailed assessment of the site must be carried out. The assessment must identify any potential effects on the environment and show how these potential effects can be satisfactorily addressed. The basis for this assessment and the requirements for site design and operation are provided in Regulation 232/98 (Regulation 232). The Certificate of Approval process takes the landfill standards and refines them as necessary to reflect the particular setting and conditions at each landfill. The resulting Certificate of Approval will define the size of the site, the types of waste to be accepted, and any necessary conditions for design and operation. The Certificate will also describe how the site is to be closed and the measures to be taken following closure to ensure the site is properly maintained and monitored for the long term protection of the environment.

The comprehensive landfill standards contained in Regulation 232 apply to new or expanding landfill sites and include requirements for site design, operation, closure and financial assurance. The standards apply to sites larger than 40,000 cubic metres which accept non-hazardous waste and include requirements for:

A summary of the relevant sections of regulation 232 are noted below:

- Section 14.(1) assessment of the potential for the subsurface migration of landfill gas and design of control systems as necessary;
- Section 15.(1) mandatory air emissions control (i.e., landfill gas collection and flaring system) for sites larger than 3 million m3 (or 2.5 million tonnes) unless otherwise demonstrated that gas quantities for the site type do not require this (e.g. landfill receiving forest products). Such sites should have appropriate plans, specifications and descriptions for the design, operation, monitoring and maintenance procedures for the collectors, transmission lines and treatment and/or utilization of the landfill gas;
- Section 28 – requires the application of daily cover (soil, foundry sand, wood chips, compost or other MOE approved alternatives) over waste to control potential nuisance effects including odour;
- Section 29 – requires a minimum of 600 mm of final cover soil plus 150 mm of topsoil or other material to sustain vegetative growth;
- Section 7 requires a minimum buffer area that is at least 100 m wide or 30 m wide if supported with an assessment report;

- Site monitoring, record keeping (Section 20) and reporting (Section 21), and
- Section 17 - Financial assurance requirements for private sector landfills are to address closure and post closure care as well as sufficient funds for carrying out contingency plans for landfill gas and leachate impacts.

Under Regulation 232, landfill owners are required to submit a report on the design of gas control facilities to the Ministry for approval. The gas controls are then implemented as approved by the Director. However, if the owner of a particular landfill can show that the nature and quantity of landfill gas generated at the site is not significant, the existing regulation allows the Director to determine that gas controls are not required for that site.

The Regulation does not apply to closed landfills, to landfills associated with forest products operations, or to operating landfills that are not being expanded. A summary of each of the requirements under the landfill standards is located in Appendix C.

In addition to the requirements under Regulation 232, landfills may also be required to implement gas controls on a site specific basis, to address for example air quality issues such as odour. Landfill owners may also voluntarily implement gas controls, subject to approval of the Director.

3.2.2 Air Quality and Atmospheric Emissions

The EPA is directed towards the protection and conservation of the natural environment. Much of the text of the Act does not specifically address air quality or atmospheric emissions however there are aspects of environmental management that are included in the broad intent and general language of the Act. For example, Section 9 (1) states that no person shall construct, alter extend or replace anything or alter the production rate of any process that may discharge a contaminant into any part of the natural environment, except water, without a Certificate of Approval. Section 14 (1) of the Act requires that no person shall discharge a contaminant or cause or permit the discharge of a contaminant into the natural environment that causes or is likely to cause an adverse effect. Adverse effects can be caused by emissions to the atmosphere or the way(s) that emissions can affect air quality. The loss of enjoyment of normal use of property can include nuisance emissions such as odour.

Air quality and atmospheric emissions from sources (including landfills) are specifically addressed in Regulation 419 (Air Pollution – Local Air Quality) which is promulgated under the Act. The Regulation imposes air standard concentration limits for contaminants that are assessed using air dispersion models and/or ambient monitoring.

3.3 Ottawa WMF: Site Overview

3.3.1 General

The Ottawa WMF site is located at 2301 Carp Road and is bounded by Richardson Sideroad to the north, Highway 417 to the south, William Mooney Road to the west and Carp Road to the east. Please refer to Figure 1 for the site location.

The 142-hectare Ottawa landfill site was first licensed to receive solid waste in 1971, when the Ministry issued a provisional Certificate of Approval for sanitary landfilling, in what was then the Township of West Carleton. The landfill is approved to receive residential, institutional, commercial and industrial solid waste originating from within the Province of Ontario. The landfill may also receive some special waste including hydrocarbon-impacted soil material, sewage treatment plant grits and screenings and recycled products.

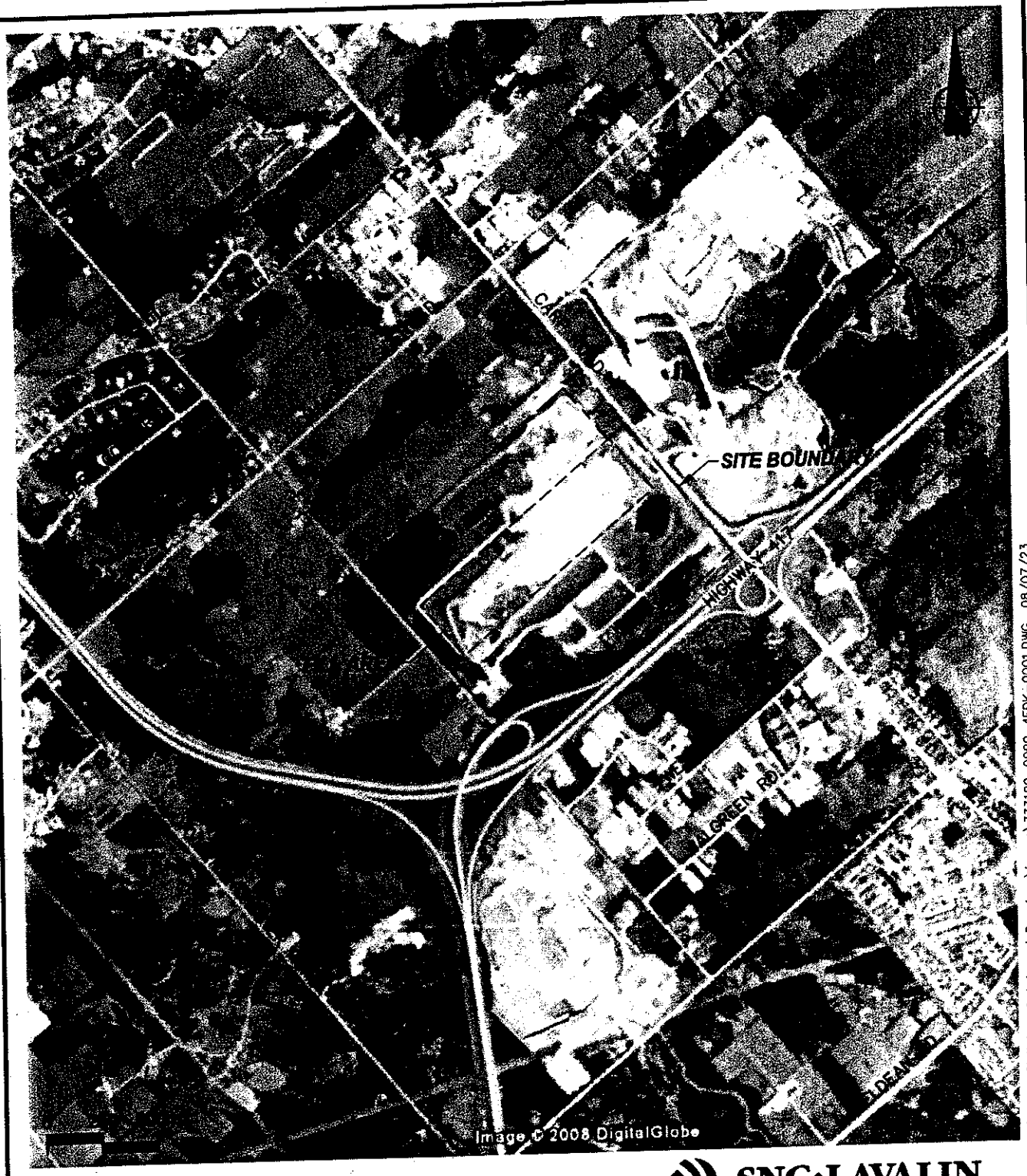
As documented in a previous section, the provisional Certificate of Approval Waste Disposal for has been re-issued as well as amended several times since first issuance. In the last ten years, three (3) Certificates of Approval for Air have been issued for the site. The documents approve the use and operation of a permanent flare, a temporary flare, and a second flare as well as other site sources of air emissions.

Within the larger site, 35 hectares make up the landfill site proper. The facility currently features the landfill mound, an administration office and scale, household waste drop-off building and area, landfill gas extraction and flare system including associated equipment and building, leachate collection system and gas stripping facility and building, surface water pond, two sediment pools, wooded areas, a grassy berm and sand pit. A landfill gas-to-energy facility is under construction in 2008.

According to the WM Ottawa Landfill 2007 Annual Report, based on the annual revised wastes tonnages to be received at the site, and the compaction densities achieved, Waste Management projects the landfill has approximately five (5) years of remaining capacity as of June 2007.

3.3.2 Odour Sources

As noted in section 3.1, landfill gas emissions can cause unpleasant odours. For any solid waste landfill, several operations (sources) can give rise to odours. These sources include:



SNC·LAVALIN

WASTE MANAGEMENT OF CANADA CORP.
ASSESSMENT OF LFG ODOUR CONTROLS IN PLACE
AT WASTE MANAGEMENT CANADA OTTAWA LANADFILL
JULY 2008

FIGURE 1

SITE LOCATION

SCALE APPROX. 1 : 25000

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- Various areas on the landfill mound (landfill gas and garbage);
- The leachate collection system;
- Use of contaminated soils and compost or other cover materials;
- Fuel combustion sources such as diesel generators, mobile equipment.

Each of the above sources produce different types of odour in that they may be comprised of different chemical compounds and have varying strength.

All odour sources associated with the Ottawa WMF were identified and assessed for their potential to produce odour in the RWDI study entitled "Odour Source Summary Ottawa Landfill Ottawa Ontario". Fourteen sources were identified specific to the Ottawa WMF site. Six of the sources were determined to be significant. All six fall under the general heading of landfill gas / garbage odours. Each of the potential odour sources assessed are noted in Table 4 below and the significant sources are highlighted.

Table 4. Sources of Odour: Ottawa WMF

Landfill gas / garbage odours
- **Working face of landfill**
- **Landfill active face area**
- **Landfill interim cover area**
- Landfill final cover area
- Public waste drop-off areas
- **Landfill gas well installation**
- **Trenching (leachate drainage)**
- **Cracks / fissures in landfill cap**

Leachate odours
- Leachate pumphouse
- Leachate cleanout manholes
- Leachate seepage

Contaminated soil odours
- Contaminated (petroleum and fuel) soil for daily cover

Compost odours
- Composted biosolids spreading

Fuel odours
- Diesel generator

The RWDI report entitled "Continuous Odour Monitoring Assessment Ottawa Landfill Ottawa Ontario" notes that at the Ottawa WMF, the major sources of odour "are associated with reduced sulphur compounds (TRS), most notably hydrogen sulphide (H_2S)." The report further notes that while it is true that not all odours from the landfill are related to H_2S, when odour descriptions are provided with complaints from the community, the odour is typically described as sulphurous or rotten egg smelling, which is typical of TRS. The report emphasizes that the landfill gas and leachate related odours are definitely strongly linked to H_2S concentrations.

In the study "Ambient Monitoring Report, Ottawa Landfill Ottawa Ontario" 59 VOCs and reduced sulphur compounds were concurrently measured in ambient air downwind and upwind of the landfill mound. The study concluded that none of the ambient measurements (of contaminants measured) were greater than the relevant point of impingement limits in Regulation 419/05. The Ottawa WMF was noted to demonstrate compliance with respect to Regulation 419/05 requirements for the parameters measured.

3.4 Design and Operations Report

The following paragraphs provide a brief summary of the relevant sections of the various design and operations reports prepared for this site as they relate to odour control. The current development, operational and maintenance practices on-site have developed with evolving technology as well as economic, regulatory and community pressures.

The original Design and Operations (D&O) Report for the Ottawa WMF was prepared in late 1989 for Laidlaw Waste Systems Ltd. by Conestoga Rovers & Associates (CRA). The report contents included site history, physical features summary, landfill design parameters, disposal rate and site capacity, site operations, environmental management, site closure, conclusions and recommendations.

The report was updated in 1994 by Henderson Paddon Environmental Inc. for Canadian Waste Services Inc. and outlined the work to be completed or to be implemented at the site. The 1994 D&O Report was approved by the Ministry and serves as the governing manual for the general operation of the site. This is reflected in the November 12, 1996 Notice to the C of A for the site.

In April 2003, a Development and Operations Update Report was again prepared by Henderson Paddon Environmental Inc. to primarily address the design and construction of a landfill gas collection and pumping system which began operation in 2001, waste biostabilization through leachate recirculation back into the waste mound and application of alternative daily cover materials.

An air injection system along the Carp Road boundary was also defined and the odour control system was discussed. General development and operational techniques addressed by the 1994 D&O and being followed at the site were not repeated in this report.

Further, an October 2004 (updated in May 2007) Operations and Maintenance Manual for the Landfill Gas Collection and Flaring System of the Ottawa Landfill was prepared by Henderson Paddon and Associates Ltd. This report describes the relevant equipment and process information associated with all components of the landfill gas control system, system start-up and shut down procedures, monitoring, maintenance, trouble shooting, contingency plans and odour control.

Sequential Development of Landfill

Landfilling has progressed following a phased approach (8 phases) outlined in the 1994 D&O Report in a west to east direction. The final (8^{th}) phase of site development is currently being carried out. The installation of the landfill gas collection system within the waste mound reflected this development plan in which with the gas recovery wells were installed in the higher final elevations reached first at the west end of the site. The site has adhered to the phased development approach which attempted to optimize the control of landfill gas, stormwater and leachate production while considering historic placement of waste at the site, practicality of the waste discharge from haulage vehicles and surrounding land uses. The vertical development of the site also provided for landfilling to occur in lower portions of the site during adverse weather conditions with higher areas to be closed out during summer or drier months. Overall the phased development of the site effectively facilitated the site operations, but resulted in significant areas of the landfill that could not receive final capping.

Operation Method

Landfilling has been carried out following an area method of operation, which allows waste to be tipped adjacent to the active disposal area and spreading waste in workable layers over the daily cell area and then compacting waste with heavy equipment. The report goes on to state that the size of the cells permits the placement of waste over a large "working face" up to 10 x 53 m and 2.5 m deep (sufficient space to facilitate 6 or 7 trucks simultaneously).

The site meeting of July 16, 2008 confirmed that the working face had reached such dimensions but has been greatly reduced over the past few years. It is also understood that special programs or waste deliveries have required extensions to the working face when appropriate.

A full complement of equipment has been maintained on site to carry out ongoing operations, maintenance and cover and system repairs as necessary. The heavy equipment includes, 2 landfill compactors, 2 dozers, 1 scraper, 1 backhoe, and 1 grader. Additional equipment is brought on-site as required for special or larger works.

Daily Cover

The 1994 D&O Report stipulated the placement of a 150 mm of daily cover soil over the compacted waste lift at the end of each day. The daily waste cell was also to be kept to a practical minimum in order to minimize cover material requirements. Alternative covers materials considered at the time of preparation of the 1994 D&O for the purpose of saving landfill capacity were ultimately tried and described in the 2003 D&O update. Only non-odorous materials were considered and only after receipt of approval from the MOE Regional Office or Environmental Assessment and Approvals Branch. Initially hydrocarbon contaminated soil (non-hazardous) and Posi-Shell (a synthetic cement like material) were used subsequently in conjunction with:

- Auto fluff (shredded waste from automobiles interiors);
- Wood chips;
- Shingles; and,
- Non-hazardous incinerator bottom ash.

Such alternative covers are only to be used when they control odour, vectors and vermin as well as the native silty sand originally used as daily cover.

Interim Cover

Interim cover has is to be placed over portions of the fill area, during landfill development to minimize the exposure of waste to erosion, to promote run-off and to reduce infiltration of precipitation. No reference is made as to the importance of an interim cover for the prevention of odour migration. An interim cover of 0.6 m depth is specified for areas exposed for greater than 6 months. It was evident from our site visit that vast areas of the landfill site have not been active within the past six months and therefore have received interim cover placement while awaiting subsequent filling activities or final cover placement. The thickness of cover could not be ascertained through visual observation.

Final Cap

The 1994 D&O report specifies the material and placement techniques for the final capping of the landfill. The report states that 'final capping of completed landfilled phases should be capped annually with on-site material (sandy silt soils) to promote run-off, minimize infiltration, minimize subsequent leachate generation, and prevent erosion. The cap should be laid in 0.2 m lifts spread and tamped by dozer or compactor, each lift, with the final 0.1 m lift scarified and fine graded to a uniform surface before placement of topsoil.' The thickness of the cap was increased in the 1994 D&O report from 600 mm to 900 mm of sandy silt overlain by 150 mm of topsoil and vegetated. Capping construction procedures were also detailed therein.

Historic placement of final cover material consisted mainly of utilizing the native sandy silt material with occasional placement of low permeability soil (i.e. clay) from off-site sources. In 2007 WMCC made a decision to enhance their capping program with the intent of improving odour control over the fill area. This program is to include additional placement of low permeability soil (e.g. in Area 2 and Area 3) and elsewhere where final cover has not been placed and installation of a synthetic "beanie" cap over the top (upper plateau) of the landfill. The beanie cap will consist of a clay layer, geomembrane liner and vegetative layer over a horizontal LFG collection layer and will be installed in 3 stages between 2009 and 2011.

Discussions with the site operator indicated that final cover has been placed as follows:

- East slope – Area #2 from 162 masl to 172 masl has received low-permeability soil;
- South slope – the entire slope to about 100 m east of the southwest corner, from the crest to within 30 m of the southern limit of waste;
- North slope – from the northwest corner to the contaminated soil storage pad, the entire face of the slope has received low-permeability soil, while native silty sand was placed east of the soil pad east to access road; and
- West slope – received native silty sand cap over entire slope some time ago.

Plans are in place to complete final capping of all slopes with low-permeability clay by the end of 2008.

In addition, surface emission surveys have been conducted over the past few years to identify potential zones of capping material that provide conduits for landfill gas venting.

A number of such zones have been identified and remediated through placement of additional compacted low permeability soil in the general area of concern.

Landfill Gas Control System

The landfill gas control system's design was summarized in the 2003 D&O update and again in more detail in the October 2004 (updated in May 2007) Operations and Maintenance Manual for the Landfill Gas Collection and Flaring System of the Ottawa Landfill. A detailed chronology of the installation of this system is provided later in Section 3.5. Both of these reports contain specific sections on odour control. In the initial report, this section only references the odour neutralization misting system installed along the eastern boundary of the site. The subsequent report significantly expands on odour control and references the active gas collection system, waste covering practices, the odour neutralization system and routine maintenance works. In addition to the systems identified previously, an air injection system was installed along the eastern boundary of the site to prevent subsurface migration of landfill gas off-site in the vicinity of Carp Road.

The landfill gas control system consists primarily of a vertical gas well field installed into completed sections of the waste mound with gas extraction provided by three blowers feeding two gas flares. Gas is delivered to the flares from the well field by a series of header and lateral gas collection piping that has been equipped with condensate drainage. The overall system also includes a full automated set of controls and alarms to effectively operate the system.

The well field currently (June 2008) consists of 136 vertical extraction wells and 6 horizontal collector wells with the first phase of installation having occurred in 2000. Ultimately it is envisaged that more than 10 additional wells will be installed upon completion of the system. The wells are generally uniformly spaced, with somewhat tighter spacing of wells along the north central region of the landfill slope. WMCC has generally applied a well spacing of 60 meters, although in some areas (e.g. north central slope and southwest slope) have tighter spaced wells. The gas extraction wells consist of 100 mm or 150 mm diameter Schedule 80 PVC pipe. The well head includes monitoring ports to monitor gas flow and pressure as well as leachate levels and a valve to control flow rates. The gas collection lateral and header pipes have been adequately sized to deliver reasonable flows and vacuums to the well field and have been sloped to provide condensate drainage and fitted with condensate traps. The main header pipe forms a looped configuration around the entire landfill. The gas collection system has not been connected to the leachate management system.

Three variable frequency drive blowers have been installed in a flare building. Each blower is rated at 1,200 cfm at 70" H_20 vacuum. Two high-temperature enclosed flares provided by John Zinc Ltd.

have been installed on-site. The first flare was designed for 1,200 cfm of landfill gas while the second was designed for destruction of an additional 2,200 cfm. Both flares are 12.2 m tall and have diameters have 2.7 and 2.1 m, respectively. These units have many integrated components and are widely used in the waste disposal industry for safe and high efficiency landfill gas destruction. The flares are designed to operate at temperatures of 900 to 950 degrees Celsius for a retention time of 0.75 seconds.

A programmable logic controller ensures that the system is fully automated with the system outputting to a Supervisory Control and Data Acquisition (SCADA) system that monitors, controls, and records the flare system from a central location in the blower building.

During the site visit, no odour release was noted from potential leaks along the header pipe in the vicinity of the blower/flare house indicating that the system is in good working condition and well maintained. Alarms and warning systems have been installed that immediately notify appropriate staff of various operational situations that may arise.

A routine maintenance schedule for all components of the gas control system (collection field, condensate management, electrical/mechanical and flares) has also been included in the May 2007 Operations and Maintenance Manual for the Landfill Gas Collection and Flaring System of the Ottawa Landfill that outlines specific tasks and the frequency of inspections and servicing required.

3.5 Site History of Odour Control Measures

WMCC has implemented three main odour control systems at the Ottawa WMF and have committed to implementing a variety of measures in the future. The most extensive control system is the landfill gas collection system. The system extracts landfill gas from vertical wells within the landfill mound and directs it through a series of pipes of increasing size to a gas utilization facility consisting of 2 flares for gas combustion. In the future, the landfill gas will be directed to a gas-to-energy facility for use. The first stage of the permanent system was operational in the year 2001 and has continued to expand through to the present day.

An air injection system/gas barrier system was initially installed in 1998 and expanded in 2003 to prevent methane gas from migrating off-site. Air is injected into the ground through a series of vertical wells to form a barrier of air pressure thus preventing gas from migrating off the property. The system is currently operating.

The third approach to odour control at the Ottawa WMF is an odour neutralization system. Spray nozzles spaced in a ten foot wide interval along an eastern portion of the property line were initially installed. A solution of a proprietary product (piian odour neutralizer) and water is sprayed/atomized in the air via the nozzles with the intent of absorbing and biodegrading the odourous particles. The system was initially installed in 2000 and expanded in 2006 but was stopped in 2007 pending a re-evaluation of its effectiveness and other related issues. The system has remained non-operational to date.

In addition to the above described systems, the Ottawa WMF has implemented a variety of other options to assist in managing odour which includes conducting site and community based air emissions and odour monitoring, maintaining a site record of activities, recording local meteorological data and maintaining an open communication with adjacent neighbours.

A historical summary of site ownership, implementation of odour control measures and other related information are summarized below in chronological order. Figure 2 details the history of the site pertaining to odour control.

1987

Laidlaw Waste Systems Ltd. purchases the site from the original owner Newill Realty Limited.

1989

The first site Design and Operations (D&O) Report (1989), prepared by Water and Earth Science Associates for Laidlaw Waste Systems Ltd., provides no specific measures for odour control.

1994

The D&O Report (1994) prepared for Canadian Waste Services Inc. (CWSI) by Henderson Paddon Environmental Inc. does not include measures for control of odour. The August 1994 Waste Disposal Site approval also does not specifically note any odour control measures.

1996

Canadian Waste Services Inc. (CWSI) purchases the site from Laidlaw Waste Systems Ltd.

1998

An interim gas barrier system (air injection) was installed along Carp Road and began operating in July 1998. The purpose of the system is to prevent landfill gas (methane) from migrating off-site according to the 1997 – 1998 Annual Monitoring Report. In 1998 or sooner, a landfill gas extraction and flaring system design was completed. A temporary landfill gas extraction system was installed

on the western slope of the landfill so that pumping tests could be completed. Certificate of Approval Air No 8-4105-98-006 was provided by the Ministry to complete the tests.

1999

An application for a Certificate of Approval for Air is submitted in June 1999 for one enclosed flare for the incineration of landfill gas including the gas collection system. The Certificate of Approval for Air for the operation of a permanent enclosed flare system is approved in December 1999.

2000

The Year 2000 Annual Report references the installation of the first stage of a permanent landfill gas extraction system. The system includes 24 vertical wells, collection laterals and a header pipe to the flare location. The temporary landfill gas extraction system installed in 1998 is re-started and utilized April through October to reduce odours emanating from the western side of the landfill mound. Additionally, in August 2000, an Ecolo EP60 odour control system was installed on the east side of the landfill site. The system consisted of 600 feet of supply piping with 40 nozzles, spraying a low pressure neutralizing solution on a timed basis. The system was installed to control odours along the eastern boundary of the landfill footprint. The system operates through spring, summer and fall but is not winterized.

2001

In the year 2001, the installation and commissioning of the new landfill gas extraction system is completed with the installation of 24 new wells, a header, and the final connection to the flare system. The flare began operating April 2001 and the associated equipment building enclosure was completed December 2001.

2002

An analyzer is installed in 2002 in association with the flare system.

2003

The 2003 D&O Report Update is submitted to the Ministry and it discusses the landfill gas collection system, the air injection system as well as the odour misting system for odour control. In 2003, the odour control system is modified and expanded. The system is changed to high pressure, a new product is utilized and additional nozzles are added. The system continues to operate through three seasons. Ten new landfill gas extraction wells are installed, a second blower was added to the flare system. The landfill gas barrier system is expanded/extended north by 14 wells.

2004

In 2004, the landfill gas extraction system is expanded with the installation of seven new wells. Various lines on the top of the landfill are repaired and re-routed to account for settlement. Additionally, a number of gas wellheads are insulated. It is notable that in 2004, WMCC applied to the Ministry to change the name from CWSI.

2005

Eleven new vertical and six new horizontal landfill gas extraction wells are installed in 2005 and a header pipe extension is completed.

2006

In March 2006 an application for Certificate of Approval for Air is made to the Ministry for a temporary open candlestick flare for the combustion of landfill gas as well as diesel generator for flare power. The flare is in operation as of March 2006. In June 2006 the Certificate of Approval for Air is approved. A second application for Certificate of Approval for Air is made in July 2006 for two enclosed flares for incineration of landfill gas, landfill gas-to-energy facility, one soil bioremediation pile process, and the exhaust from gas stripper with activated carbon filter. The Certificate of Approval for Air 7816-7C9JMR is approved in November 2006.

The odour control system is expanded in the Spring of 2006 by an additional 260 nozzles to a total of 440 nozzles. A portion of the system is winterized.

A weather station datalogger is installed. In April and December, Surface Emission Surveys are completed to identify the location of new gas extraction wells.

A total of 33 new landfill gas extraction wells are installed in 2006 and a large header pipe. A condensate trap and separator are installed at the flare building.

A number of surveys and reports are completed through the summer and fall as a result of the Voluntary Abatement Plan for odour including:

- Evaluation of Odour Sources
- Evaluation of approved Design and Operation of the existing landfill gas collection system, flare, leachate collection system and gas air sparging system.
- Independent inspection of landfill gas collection and flare system and recommendations for improvements

2007

Thirty-one new landfill gas extraction wells are installed in 2007 and 7 horizontal wells are decommissioned. Seventeen dewatering pumps are added to improve flow. The candlestick flare is removed from the site in March. In April 2007, the first Provincial Officer's Order (Order) is received. The operation of the odour control system is suspended pending re-evaluation of its effectiveness and other related issues. As of September 2007, the site waste acceptance rate is reduced and household drop-off is stopped.

A number of surveys and reports are completed through the summer and fall as a result of the Order including:

- Odour Sources Survey Report
- Emission Survey Report
- Ambient Air Monitoring Report
- Continuous Monitoring Report
- Landfill Cover Report
- LFG Operations Manual
- Monthly Progress reports
- Contingency Work Plan

Soil capping of a variety of areas was completed.

A second Order was received in December 2007 requiring the implementation of activities detailed in the Contingency Plan and reporting of the activities. Certain information is also required to be reported on the WMCC website.

The Ministry amends the Waste Disposal Site Approval to incorporate operational changes (use of alternate cover materials) outlined in the updated D&O Report which was added to the certificate.

2008

To mid-year, twenty-nine new landfill gas extraction wells have been installed. As of the beginning of June, a total of 136 wells are located on-site and twenty-one wells have been re-drilled.

In March 2008, the Ministry issues an amendment to Certificate of Approval for Air 7816-7C9JMR which includes additional conditions for monitoring (relating to odour) and source testing as a result of the decision of the Environmental Review Tribunal.

Air emission surveys are completed at the regularly scheduled intervals noted in the Certificate of Approval for Air.

Amended Provisional Certificate of Approval for a Waste Disposal Site Number A461002 is issued March 7, 2008 which adds conditions related to operational odour controls and other odour related items.

The following actions are required to be adopted in the future by WMCC as a result of the Minutes of Settlement (September 2007) and because of the Amendment to the Provisional Certificate of Approval Waste Disposal Site A461002 (March 2008). These actions are outlined in the 29 June 2007 RWDI Odour Source Summary Report and noted below and categorized by operational area.

Working Face of Landfill

- Reduce size of working face to as small as practically possible.
- Place temporary cover on working face at the end of each day.

Landfill Active Face Area

- Active face area kept to a minimum size.
- Where exposed refuse is visible, apply additional cover material.

Landfill Interim Cover Area

- Convert interim area to final as soon as landfilling is completed.

Landfill Final Cover Area

- Expand landfill gas collection and flaring system to minimize the amount of odourous landfill gas that escapes through the surface of the mound.
- Regularly inspect landfill gas collection wells to ensure that no leaks are occurring in the piping, wellhead, or seal around the base of the well.

Public Waste Drop-Off Areas

- Personnel to verbally report bins or containers that are pungently odourous to site foreperson and should be emptied as soon as possible.
- Monitor and empty bins on a regular basis.

Landfill Gas Well Installation

- Minimize number of landfill gas wells drilled or open at any given time.
- Immediately conduct well casing installation and backfilling as soon as drilling is completed.

- Once installed, tie new landfill gas wells into existing system.
- Shortly after installation, leak check seal surrounding new landfill gas wells.
- Avoid landfill gas well installation on days with low wind speeds and/or low barometric pressures.
- Delay landfill gas well installation when wind conditions are forecasted / exist as blowing towards nearby residential areas.

Trenching

- Minimize size of open trench at any one time.
- Cover trench area overnight.
- Avoid trenching activity on days with low wind speed and/or low barometric pressures.
- Delay trenching activities when wind conditions are forecasted / exist as blowing towards nearby residential areas.

Cracks / Fissures in Landfill Cap

- Conduct routine monitoring and inspection of the landfill cap to identify any fissures, cracks or erosion of the soil.
- Once identified, repair any fissures, cracks or erosion of the soil.
- Repair areas should be covered with clay, compacted, and then covered with topsoil.

Leachate

- Gases from the leachate stripper should be ducted to the flare for destruction.
- Seal and place all leachate collection manholes under pressure. Duct the collected leachate gas to the flare for destruction.
- Do not clean-out leachate collection manholes on days with low wind speed and/or low barometric pressures.
- Do not open or clean-out leachate collection manholes when the winds are blowing towards nearby residential areas or directly towards the nearest property line.
- Regularly monitor the landfill to identify areas of poor drainage / leachate seepage.
- Immediately correct leachate seepage through trenching or other means.

Contaminated Soil

- Contaminated soil stockpiles should be located as far as practical from the property line of the facility.
- Contaminated soil shipments should be monitored and any highly odourous loads should be covered as soon as possible.

Composted Biosolids Spreading

- Biosolids should be checked to ensure that the material has been well composted prior to spreading on the landfill.
- The amount of composted biosolids spread onto the landfill at any one time should be regulated.
- Composted biosolids spreading should be avoided on days with low wind speeds and/or low barometric pressures.
- When wind conditions blowing towards nearby residential areas exist or are forecast, the spreading activities should be delayed until more favourable wind conditions exist.

Diesel Generator

- At this time, no further mitigation is required to reduce odours from the diesel generator at the Ottawa Landfill.

3.6 Odour Complaints and Management

A review of the WMCC Ottawa WMF Annual Monitoring Reports was conducted to determine odour complaint statistics and community involvement initiatives. From 1998 through to 2005, the maximum number of complaints was six (in the year 2004) with the average number being three. Since 2006 however, when the Ottawa WMF announced an intended expansion, the community complaints relating to odour increased dramatically. According to a Ministry database, the annual number of complaints was just short of 500 in 2006 and in 2007 the number increased to just over 1300. WMCC have implemented a landfill gas collection and control system as well as various odour control measures, however, large numbers of odour complaints continue to be received.

In the 1994 D&O Report section 7 briefly discusses a Complaints Management process. The process states:

All complaints will be directed to the General Manager, who will take appropriate action to deal with the complaint which may include the following:

- **Take appropriate action to eliminate the source of the complaint.**
- **Communicate to the complaintant, the result of his findings in regard to the complain and what action, if any, he is proposing to take to eliminate the complaint if possible.**

At the site visit in July 2008, site management confirmed that the above process was in place and that all complaints are formally responded to within 48 hours. The Certificate of Approval for Air requires a formal response.

In the Site Operations section of each of the Ottawa WMF Annual Monitoring Reports, a summary of complaints received are provided as well as a summary of the company response as per the complaint management process.

The following provides a chronology of odour complaints received and community initiatives conducted by WMCC.

1998

- 1 odour complaint (biosolids use)
- Investigation and formal response provided by WMCC
- Community open house conducted and newsletter circulated

1999

- odour complaints (2 biosolids use, 2 liquid manure spreading by local farmer)
- Investigation and formal response provided by WMCC

2000

- 1 odour complaint (sweet smell)
- Investigation and formal response provided by WMCC

2001

- 5 odour complaints
- Investigation and formal response provided by WMCC
- Community open house conducted and newsletter circulated

2002

- 4 odour complaints
- Investigation and formal response provided by WMCC
- Community open house conducted and newsletter circulated

2003

- 3 odour complaints
- Investigation and formal response provided by WMCC

- Community newsletter circulated and sponsorship completed

2004

- 6 odour complaints
- Investigation and formal response provided by WMCC
- Community open house conducted, newsletter circulated and sponsorship completed

2005

- 2 odour complaints
- Investigation and formal response provided by WMCC
- Community open house conducted, newsletter circulated and sponsorship completed

2006

- Announced landfill expansion project January 2006.
- 176 odour complaints received to 29 November as well as an additional 353 odour complaints received via the Ministry.
- Investigation and formal response provided by WMCC.
- Extensive community consultation conducted through the environmental assessment process and sponsorship completed.
- As a result of a condition in the Comprehensive Site-Wide Certificate of Approval for Air, complaint notification and associated reporting to the Ministry was required and initiated.

2007

- 1339 odour complaints received via the Ministry.
- Odour complaints received directly and/or forwarded by other parties are documented and addressed in accordance with the condition in the Comprehensive Site-Wide Certificate of Approval for Air.
- Extensive community consultation conducted through the environmental assessment process and sponsorship is completed by WMCC.

2008

- As of mid-year, WMCC note that 544 complaints had been received.

4.0 INDUSTRY STANDARD AND BEST MANAGEMENT PRACTICES

4.1 Best Management Practices Defined

Best management practices (BMPs), in the context of this report, are defined to mean technologies and management practices that are best suited for implementation at a particular landfill site. It is notable that for most landfill sites, only a limited number of the BMPs will be feasible and able to be implemented. The design, construction, and operational practices for landfill gas collection and control systems and for odour control are presented below.

4.2 Landfill Gas Collection (LFG) and Control Systems

4.2.1 Design-Related Best Management Practices for Landfill Gas Collection Components

With respect to landfill gas collection components, the most common approach is to wait until landfill cells are complete and then proceed with the installation of vertical gas extraction wells using a standard design for well placement and spacing. This approach generally results in adequate landfill gas collection despite the fact that landfills are not homogeneous.

Horizontal Collectors or Surface Collectors

Horizontal collectors can be used an interim landfill gas control measure during the early stages of a waste cell or landfill (i.e. before final contours have been established) to control surface emissions. They are installed along the landfill surface in trenches within the waste and connected to the piping system at the outside slope of the landfill. The horizontal collector design usually comprises perforated pipe laid horizontally in a trench, surrounded by a permeable substrate and it is sloped to promote drainage of condensate and leachate to collection points and to accommodate settlement of the waste. The wellheads for the horizontal collectors are installed on the outside of the fill area to allow for monitoring. Burying the wellheads allows for sufficient protection to allow for gas collection while the cell or landfill is in active filling mode. However, 10 meters or more refuse placement above is desirable to limit air infiltration. This BMP allows for gas collection in the deepest portion of the waste if it is employed in the early stage of cell development. A variation of the horizontal well collection pattern is to use varying lengths of pipes spaced according to waste density in a particular area. The purpose is to place more collectors in areas where gas is more likely to escape from the landfill (i.e. side slopes).

Although not common, a continuous layer of permeable material located higher in the waste mass (surface collectors) has also shown to provide efficient landfill gas collection and can be used to in lieu of or in concert with a comprehensive horizontal collector system. Surface collectors can also be used to collect gas from a wet landfill where traditional horizontal and vertical wells fail due to water infiltration, or as an enhancement for surface emission control. The collectors are installed across the landfill surface above the refuse.

Tighter Spacing of Vertical Landfill Gas Wells

Vertical landfill gas wells are the primary method of landfill gas collection for landfills that collect gas. Spacing of the wells (typically between 50 and 80 m) depends on a variety of parameters including:

- thickness of the waste
- water content of the waste
- type of daily and intermediate landfill cover
- length and placement of perforated well pipe
- diameter of the well
- use of well bore seals
- distance from the top of the perforations to the landfill surface, and
- vacuum available.

Various tools, models and experience are used to estimate the expected radius of influence (ROI) for each well and the ROI is used to determine the number and spacing of wells needed to provide adequate coverage in a landfill or cell. The design generally uses a degree of overlap of the ROI for neighbouring wells to provide vacuum throughout the waste.

One variation that can be implemented to improve landfill gas collection is to use a variable well spacing. Wells near the perimeter or edge of a landfill are more prone to air short-circuiting into the landfill and therefore are less likely to operate at high vacuum. These wells would be installed at relatively closer spacing and operate at a relative lower vacuum then interior wells. Wells on the interior of a landfill may also be prone to air short circuiting however it is possible to operate these wells at much higher vacuum and therefore, not as many vertical wells are required.

Mixed Horizontal and Vertical Well Systems

Horizontal collectors allow for the benefit of early gas collection but they are not as efficient as vertical wells because the permeability of refuse is greater horizontally than vertically and vertical wells do apply vacuum in the horizontal plane. Therefore horizontal collectors create a horizontal layer of efficient gas collection, but vertical vacuum distribution is not as good. As a result, there is the requirement for tighter vertical spacing of horizontal wells to cover gas collection throughout a landfill. Vertical wells are more efficient at collecting gas in general but when they are installed in an active landfill zone they can interfere with landfilling operations due to above grade well heads and lateral piping.

A hybrid system would consist of horizontal collectors (to collect gas across the horizontal plane of active landfill areas, including near surface gas) and vertical wells (to collect gas from areas at or near final or interim grade or in areas which are not active for filling). A hybrid system is advantageous in that it offers interim control with horizontals in active areas (including sufficient surface emission control) while keeping wells out of the way of landfilling operations. Vertical wells are installed when there is no risk of damage from operations.

Connection of the Leachate Collection and Removal System to the Landfill Gas Collection System

The connection of the leachate collection and removal system (LCRS) to the landfill gas collection system allows for landfill gas collection beneath the garbage mound along the bottom or around the perimeter of the landfill. The connection of the LCRS is made by installing a lateral pipe connection with corresponding wellhead to an LCRS riser pipe, clean-out, or other access point.

Deep, Multi-Depth Vertical Wells

The deeper a well is imbedded in waste, the greater the vacuum that can be applied before the well will short circuit with ambient air. Two-depth or three-depth vertical wells (multiple nested well pipes in the same borehole or adjacent wells of varying depths) may be advantageous by operating the deeper zones at greater vacuum than the shallow zones. Deep zones would be operated preferentially over shallower zones. If additional landfill gas is present as seen by positive pressure in the well, shallower wells can be brought on-line sequentially from bottom to top. This condition of pressure can exist because of the reduced vertical versus horizontal permeability of waste.

Maximize Borehole and Well Diameters

One way to assist in maximizing the production of and extending the life of each individual vertical well is to increase the pipe diameter and install the well in a larger borehole. Landfill gas extraction wells are commonly constructed with pipe diameters ranging from two to six inches within boreholes that range from eight to thirty-six inches. However, the smaller diameter wells may ultimately limit the amount of landfill gas flow that can be achieved in the well. Therefore with the design of vertical well systems, larger diameter pipe with a minimum of four inches is preferred, with a provision to increase to six inches or more if higher landfill gas production is expected. Larger diameter wells are also more resilient to pinching and can accommodate the insertion of pumps for liquid removal. In shallow, dry landfills however, smaller diameter boreholes and casings may be acceptable and more effective with closer well spacing. Larger diameter boreholes ensure that the well is protected against settlement as they help avoid plugging of pipe perforations. They also reduce the likelihood refuse will fall back into the borehole before the well is placed, decreasing the amount of gravel pack around the well. Finally, larger diameter wells offer the greater surface area to apply vacuum to the waste.

Enhanced Seals on Landfill Gas Wells and Boreholes

Landfill gas extraction wells function based on the application of a vacuum to the landfill. The amount of vacuum that can be applied is limited to a large extent by the seal between the perforated collection zone and the nearest source of air infiltrating the landfill. One source of air infiltration for vertical wells is through the well borehole and for horizontal collectors it is through the well trench. Typical well design uses bentonite or bentonite soil mixtures near the surface as part of the well boring backfill to reduce the potential for air to be pulled into the well. Compacted backfill soil can also be considered but may not be practical and adds risk to damaging the well casing pipe. A well's connecting pipes are typically sealed using three different techniques: 1) bentonite clay seal, 2) compacted clay seal, or 3) plastic well bore seal. A good seal is critical for proper well performance therefore multiple seals are often used.

Landfill Gas Well Dewatering

Wells are unable to pull gas through liquid. In some cases, leachate or landfill gas condensate can perch within the refuse and create wet zones in the landfill. Keeping well screens free of liquid is essential for proper performance. The most practical method of keeping liquid out of wells is to prevent its entry. Perched water can be found in landfills that use clay for daily or intermediate cover. One method used with some success is to place a bentonite seal opposite perched water in the waste.

Problems arise in identifying the perched liquid levels (this is best done using a down-hole camera) and the ability to accurately place the seal. Another method is to conduct field investigations of liquids levels in the waste prior to installation and avoid those areas in the design. A third method is to utilize solid pipe at depths where liquids levels are suspected. Also, laterals should always be sloped away from the well head to avoid condensate backflow.

Another issue is biological build-up on the well screen or filter pack due to the liquids passing into the screen. Methods are also available for flushing the screen and filter pack and can be employed to improve both the dewatering and subsequent gas collection from the well. If liquid is hindering the performance of a well, another alternative is to install a leachate pump. Leachate pumps can successfully remove liquids; however, the process is typically very slow.

Horizontal collectors are also prone to flooding in landfills with high water addition (by rain or waste). The easiest way to prevent this is to request the landfill operator build a high point on the deck for the horizontal well installation. This requires significant planning and coordination with the designer of the landfill's storm water drainage. All landfill decks must drain and "high" spots could introduce complications in the fill sequence. Assuming the coordination can be accomplished, water on the deck will drain away from the horizontal wells to the low points on the deck during installation. To prevent flooding after the collector is buried, the ends of the collector (i.e., the solid pipe portion near the edge of the landfill) should be designed with the proper slope to drain liquids out of the collector. The minimum slope for the collector ends is approximately 5%.

Horizontal well pipes should be installed at the top portion of the trench that is excavated to allow liquid to drain below them. At very wet landfills, a drainpipe can be installed at the lowest point of the horizontal collector trench to drain accumulated leachate. The horizontal permeable layers, as an alternative to horizontal collectors, can also serve to mitigate this problem.

Landfill Gas System Piping

Landfill gas piping should be designed to carry the necessary volume of landfill gas and it is critical to prevent it from becoming a limiting factor in the ability to collect gas. Such piping is comprised of lateral piping that connect the wells to the main headers, and main header piping, which conveys large quantities of gas to the control system. This BMP includes provisions for ensuring that landfill gas piping is properly designed and installed, including the following elements:

Maximize piping sizes. Specific pipe sizes (i.e., diameters) have limitations on the amount of gas that can be moved through the pipe. With landfill gas, the amount of gas that will be generated and

recovered is always uncertain, and the variability in applied vacuum levels can also affect gas flow. As such, it is critical to design piping systems for the high end of the range of expected gas flows for the area of the landfill that the pipe will serve. The design can take into consideration the expected working life of the piping so that the pipe sizing is not based on future flows that the pipe would never see, as long as provisions are made to upgrade the piping when needed. Larger pipe sizes also help against condensate formation and pipe blockage by allowing gas flow to continue despite moderate condensate buildup.

Install piping on native soil. Wherever possible, landfill gas piping, particularly main header lines, should be installed on native soil to prevent undue affects of landfill settlement. For piping installed on refuse, settlement can cause unintended low points where condensate can collect and block gas flow. Piping on native soil outside the refuse boundary avoids this problem and also allows the piping to be installed with less slope, making design and installation easier.

Increased pipe slopes. In all cases, it is considered a BMP to maximize the pipe slopes for all landfill gas system piping. When installed on native soil, the piping should have a minimum slope of 1% with a provision to increase to 2% whenever feasible. For piping on refuse, the minimum slope should be 3% for areas expected to have low to moderate differential settlement and 5% in areas expected to exhibit heavy settlement. Where these slopes cannot be achieved, the piping should be designed with multiple access points and cleanouts for inspection and dewatering. They should also undergo a more rigorous and frequent pipe inspection program. Pipes can be run down or across landfill slopes to increase slope.

Above or below grade piping. Above grade piping systems are preferred over below grade systems in most cases. Above grade piping can be more easily inspected, repaired, and upgraded, promoting maximum effectiveness. However, to protect against weather effects, above grade piping systems must be staked to control movement from thermal expansion/contraction or landfill erosion, provide UV protection to protect plastic pipe against the sun's influence, etc. The only exceptions would be cold weather locations where frequent freezing temperatures necessitate burying the pipe, or in active areas where above grade piping could be damaged. If piping must be buried, it should be designed in accordance with the BMPs for buried pipe.

Looped piping systems. Despite the best design and construction standards, landfill gas piping may fail due to damage, breakage, or settlement. Therefore, landfill gas piping systems that include looped headers can be considered. These looped systems allow vacuum to reach all areas of the landfill from more than one direction. A landfill gas system would have a primary piping loop around the entire refuse area. For large landfills, however, multiple interior loops, including

temporary, movable ones, may be warranted. Looped piping systems equalize vacuum throughout the gas system and reduce downtime for those portions affected by non-functioning piping. With these looped systems, including isolation valves allows non-functioning pipe sections to be isolated for repair and flow directions changed to restore vacuum to the problem area.

Pipe specifications. Beyond the size and slope of the pipe, the type of pipe grade specified is important as well. Plastic piping systems are commonplace in the landfill gas industry and still considered BMPs. However, specifying high grade pipe is important for the effectiveness and longevity of the piping system. This includes using Schedule 80 PVC over Schedule 40 and using higher quality HDPE pipe (e.g., SDR 17). Above grade PVC pipe must be protected against UV radiation, and above grade HDPE should be staked to prevent movement due to temperature extremes. Special allowance should be made for HDPE thermal expansion and contraction because of its substantially greater coefficient of thermal expansion than PVC.

Adequate condensate systems. Landfill gas piping systems should be designed with an adequate number and size of condensate sumps and traps to remove condensate from the gas lines while not affecting gas system operation. Automated condensate systems are preferred with either electric or pneumatic pumping systems. These systems continuously drain sumps, traps, and tanks and move the condensate to its final point of disposition.

4.2.2 Best Management Practices for Gas Mover Equipment and Vacuum Control

Barometric Control of the Landfill Gas System

The amount of gas stored within the void volume of refuse changes depending on the atmospheric pressure. When the atmospheric pressure is high, greater quantities of landfill gas are stored in the void volumes because the gas is compressed. When atmospheric pressure is low, the amount of gas stored in the void volumes is less because the gas loses some of its compression and vents from the waste. One way to help reduce gas emissions is to increase the gas flow when a weather event causes a drop in barometric pressure. Conversely, air infiltration can be reduced by decreasing gas flow when barometric pressure is increasing. This procedure is accomplished by using automatic controls that throttle the rate of landfill gas extraction inversely to the rate of barometric pressure change.

There are several methods of implementing this control. The simplest method is to increase and decrease landfill gas collection system flow rate based on the rate barometric pressure is changing. The flow rate can be changed by automatically increasing and decreasing the blower speed using a

variable speed drive. Variability frequency blower equipment is becoming the norm when new blowers are purchased or existing systems are upgraded.

Redundant Flare Station Equipment

Flare stations are designed to operate 24 hours per day, 365 days per year; however, no matter how good the equipment, there will be times when shutdowns and service are required. Some shutdowns will be short duration while others could involve replacement or rebuilding key equipment that could require several days to repair.

Nothing can be done to eliminate shutdown, however much can be done to reduce downtime. Notification of a shutdown is critical. This is normally accomplished using an automatic dialer. The simplest and least costly approach to controlling the repair time is to have a thorough spare parts inventory. Spare parts inventory can include consumable parts (i.e., thermocouples, U.V. scanner tubes) as well as entire replacement assemblies (i.e., a motor blower assembly). Back-up blower and control equipment is an important part of any BMP for redundant flare station equipment.

The next level of redundancy is to have spare equipment installed and ready to run. Sometimes the controls can be programmed to start spare equipment if a failure of the operable equipment occurs. As an alternative to redundancy, increased operations, maintenance, monitoring, testing, and inspection can achieve the same objectives of minimizing system downtime and excess emissions that occur during downtime. See BMP below for "Enhanced Landfill Gas Operations and Maintenance" for additional details.

Maximize Capacity of Gas Mover Equipment

Blowers have multiple operating limitations including maximum flow, minimum flow, maximum vacuum, minimum speed to dissipate motor heat, and blower surge considerations. The designer needs to carefully consider blower selection to ensure the landfill gas collection rate falls within blower operating range with some cushion to increase flow in the future. The goal is to provide sufficient blower capacity (including motor horsepower) to collect all gas generated and available for collection from a landfill. This BMP also includes adequate pipe sizes to and from the blower to avoid flow restrictions.

4.2.3 Best Management Practices for Landfill Gas Control Systems

Maximize Capacity of Gas Control Equipment

For this discussion assume that the gas control equipment is an enclosed ground flare. (Candlestick or open flares are also not considered a BMP because they have lower combustion efficiency and likely do not destroy methane as well.) The function of a flare is to destroy methane and non-methane organic compounds. This is accomplished by burning the gas at a sufficient gas temperature with adequate oxygen present in the exhaust and holding the combustion products for sufficient time to allow adequate destruction.

This BMP has the two goals of increasing the gas combustion capacity and improving the destruction efficiency. Increasing the capacity is achieved by making the flare larger. Increasing the destruction efficiency is usually achieved by increasing gas mixing with oxygen, increasing the combustion temperature, or increasing the combustion retention time. The common element between increasing capacity and increasing destruction efficiency is increasing the flare size (i.e., longer flame retention time). Increasing flare size is practical provided the manufacturer can simultaneously increase the flare turndown. This then provides improved combustion capacity without penalizing the low flow performance.

Table 5. Best Management Practices Landfill Gas Collection and Control Systems

Area	Best Management Practice	Description
	Design	
Landfill Gas Collection Components	GC-1 Horizontal collectors or surface collectors	Use horizontal collectors to collect landfill gas before vertical wells are installed
	GC-2 Tighter spacing of vertical landfill gas wells / increase density of gas extraction wells	Vertical wells closely spaced to increase the overlap of the radius of influence and inter-well spacing determines the collection efficiency of a gas well system, ensuring that the waste mass between gas wells is under a negative pressure at all times
	GC-3 Mixed horizontal and vertical well systems	Horizontal collectors installed in active areas while vertical wells are placed where not at risk from damage from operations
	GC-4 Connection of leachate collection and removal system layer to landfill gas collection system	LCRS connected to the landfill gas CS to collect landfill gas along bottom of landfill
	GC-5 Deep multi-depth vertical wells	Wells placed at multiple depths in the same boring at a higher vacuum and wells can alternate between shallow and deep
	GC-6 Maximize borehole and well diameters	4 or 6 inch pipe diameter used for wells if high landfill gas production anticipated

Table 5. Best Management Practices Landfill Gas Collection and Control Systems

Area	Best Management Practice	Description
	GC-7 Enhance seals on landfill gas wells and boreholes	Improved seals allow more vacuum to be applied to landfill gas wells
	GC-8 Dewater landfill gas wells	Employ various methods to prevent water from blocking the flow of gas to the landfill gas wells
	GC-9 Best design for landfill gas system piping	Design system piping to not limit landfill gas flow
Systems and Operations & Maintenance		
Operations and Maintenance (gas mover equipment and vacuum control)	OM-1 Barometric control of landfill gas system	Vacuum applied to wells changed based on change in barometric pressure
	OM-2 Redundant flare station equipment	Spare equipment available so equipment downtime is lessened
	OM-3 Maximize capacity of gas mover equipment	Design of blower system so it does not limit gas collection
Gas Control Systems	CS-1 Maximum capacity of gas control equipment	Increases flare capacity and destruction efficiency typically by increasing flare size

4.3 Odour Control Technologies and BMP

There are a variety of techniques, methods and management options a landfill may employ to suppress and/or control the emanation of odour off-site. A literature review was undertaken to determine the techniques and options available and in-use at landfilling sites. It was found that these aspects of control can be categorized into two general areas; planning and management as well as systems and operational practices. The following sections provide detail of the practices and options.

4.3.1 Systems and Operational Practices for Odour Control

Systems and operational practices for odour control can be divided into options relating to cover materials, cell design, the leachate system, the gas collection system, and other odour counteractant systems. Twenty-one systems and operational best management practices for odour control are identified and defined in Table 6.

Table 6. Systems and Operational Practices for Odour Control

Number	Option	Effect	Comment
		Cover Material	
CM-1	Minimize uncapped operational area	Reduces the area available for odour emissions	Odourant emission rates are greater for surfaces without a low permeability cap.
CM-2	Minimize uncapped final level area	Reduces the area available for odour emissions	Odourant emission rates are greater for surfaces without a low permeability cap.
CM-3	Promote immediate restoration (greening) of surface soils	Achieves significant reduction in a potential emission source	Biological/chemical filtration/attenuation of gases through soils with active plant growth and will help to attenuate odourous compounds that may exit. Necessary on all sites with an engineered clay capping layer to prevent damage to the cap.
CM-4	Utilize engineered capping layer at final fill areas	Achieves significant reduction in a potential emission source	Installation of capping must be to a high standard to prevent cracking (clay cap) or defects (synthetic cap) allowing emission of landfill gas.
CM-5	Place adequate depth of daily cover over all operational areas, maintain depth of cover over time on temporary capped areas and type of cover material is appropriate	Emission rate reduced via waste surface, increases opportunity for action of bio-filtering	Thickness of cover correlates with reduced odour emissions. Sandy and clay cover soils not as effective as loamy-type soils, due to difficulties of placement. Ability to place and retain cover thickness over time is important (i.e. rain wash, placement on cell sides, movement etc.)
		Cell Design	
CD-1	Minimize size of cell sides	Reduces the area available for odour emissions	Cell sides have a high emission rate factor and can represent a large surface area.
CD-2	Minimize slope of cell sides to <1:3	Improved daily cover and compaction	Steep slopes cannot be properly compacted and covered with adequate depths of soil, enabling an easy path for landfill gas emissions.

Table 6. Systems and Operational Practices for Odour Control

Number	Option	Effect	Comment
		Leachate System	
LS-1	Place all leachate manholes, wells, etc. under active gas extraction	Removes odour source	Well and manhole covers do not form gas-tight seals and odours will escape. Extraction under low pressure will provide a positive means of capturing odourous compounds and enable disposal by a safe route (i.e. flaring, engine fuel).
LS-2	Fully contain all leachate storage vessels	Contains odour source	New, acidic leachate contains odourous compounds which require full containment to prevent odour release.
LS-3	Dose leachate stored for long periods	Removes odour source	If leachate is required to be stored for long periods it should be dosed with a compound (i.e. hydrogen peroxide) to prevent anoxic conditions and reduce odours.
LS-4	Dose or pre-treat leachate if discharged to sewer	Removes odour source	Similar to above, disposal to sewer without dosing or pre-treatment is likely to lead to the release of dissolved odourous compounds within the sewer and escape enroute via the manhole covers, vent pipe, etc.
LS-5	Remote siting/location of leachate aeration lagoons	Removes odour source	Remote location from possible receptors removes a possible odour source.
		Gas Collection System (In addition to those identified in Table 5)	
GC-10	Determine the effective capture area of gas extraction wells	Measure the effectiveness of the landfill gas well collection system	Individual wells will have specific capture volumes, dependent on well depth and diameter, well pipe perforation size and extent, waste type, waste density, leachate levels, extraction pressure, collection pipework size etc.
GC-11	Monitor the effectiveness of the gas extraction wells and the extraction system	Ensures the continued performance of the gas management system	The effectiveness of a gas collection system varies with time and requires routine monitoring of key parameters to confirm its continued collection efficiency.
GC-12	Ensure gas engine exhausts are vertical and as high as feasible	Ensures adequate air dispersion	Combusted landfill gas can still produce odourous compounds and maximum dispersion is achieved by increasing the exhaust height and orientation.
GC-13	Utilize shrouded gas flares	Ensures effective destruction of odourous compounds	Same comment as above and also important to achieve adequate time and temperature.

Table 6. Systems and Operational Practices for Odour Control

Number	Option	Effect	Comment
GC-14 (similar to GC-8)	Ensure landfill gas is adequately dewatered before entering the gas flare	Prevents dispersal of an odourous substance	Leachate condensate contains dissolved odourous compounds, which if passed through the flare will release them without necessarily achieving the destruction temperature.
GC-15	Locate gas flares/engines away from receptors	Removes an odour source	Remote location from possible receptors removes a possible odour source.
GC-16	Maintain pollution control equipment*	Ensures the continued performance of the gas management system	Mechanical and electrical items require regular and routine maintenance and calibration for efficient operation. Checks for odourous emissions from flares and engine exhausts should be regularly undertaken. Routine maintenance should include monitoring for fugitive emissions on valves and seals, blocked pipework, collection efficiency.
Other Systems			
O-1	Utilize odourant counteractants (masking, neutralizing or suppressing agent)	Counteracts odour source	Effectiveness not guaranteed and spray can produce odour complaints. Public concern over the use of sprays potentially masking the presence of harmful compounds. Can be utilized at specific odourous site activities, site boundary and adjacent to receptors, active working area.

*gas flare, engine exhaust, storage tank vents, lagoon aerators, seals of boreholes, pipework integrity

4.3.2 Planning and Management Options for Odour Control

Decisions pertaining to site selection and location, delivery routes, waste acceptance policy, operational policy and communications encompass the planning and management options for odour control. Eleven options have been identified and are noted in Table 7 below.

Table 7. Landfill Planning and Management Options for Odour Control

Control Mechanism	Application	Comments
PM-1 Locate site away from receptors (remote)	Site accepting putrescible or odorous wastes.	Identified at the initial site selection stage of the project development. Site selection stage needs to balance a variety of competing factors.
PM-2 Route delivery vehicles to avoid sensitive receptors	Route arranged to minimize contact with receptors. Vehicles properly sheeted/covered Avoid delivery of highly odorous wastes when adverse wind direction.	Determined at the stage of site selection or planning application. Reduces extent of exposure of receptors to the odour source. Limits the magnitude of the odour source term (length). Odour impact dependant on wind direction; avoid deliveries when wind direction likely to impact large number of receptors.
PM-3 Putrescible wastes delivered immediately (before degradation begins)	Ensure special handling at disposal to minimize odour.	Start of waste degradation before disposal produces offensive odours during delivery to landfill site. Degraded wastes are more odourous than usual and special handling is required during disposal.
PM-4 Prohibit highly odorous waste streams (unless suitably pre-treated to reduce odour)	Wastes with highly offensive odours (i.e. seafood, animal by-products). Wastes that may subsequently react to produce offensive odours (i.e. sulphate-bearing). Wastes with odours that cannot be contained by covering/tarping.	Reduces highly odourous sources. Minimizes odour exposure during delivery. Very effective if pre-treatment is used.
PM-5 Cell size: prevent imbalance between odorous leachates and establishment of methanogenic conditions	Whole site. Essential part of site operational plan.	Reduced production of odourous gases at source. To be used with phased capping and installation of gas control infrastructure. Good practice.
PM-6 Avoid disposal of odorous wastes in poor wind dispersal conditions	Select disposal area on landfill remote from sensitive receptors. Deep trench and cover immediately with non-odourous wastes.	Can be used when adverse wind directions apply if the exposure time is limited. Relatively simple to apply. Effective and lower cost. Requires careful management.
PM-7 Undertake waste excavation only when wind direction is suitable and for the minimum exposure time	Installation/repair of landfill gas and leachate infrastructure.	Difficult to prevent significant short-term odour releases from decomposed wastes and landfill gas. Requires careful pre-planning and management.

Table 7. Landfill Planning and Management Options for Odour Control

Control Mechanism	Application	Comments
PM-8 Housekeeping: avoid odours from deposits of garbage / road sweepings	All site areas.	Used primarily for aesthetic purposes but creates improved perception of operations. Minimal effect on odour emissions. Simple and low cost.
PM-9 Conduct odour monitoring in all areas of site including odour controls and pollution control infrastructure	Site and boundary walk around. Use of specialized equipment to identify potential emission sources. Identified odour emission sources rectified. Use of specialist equipment to measure odourous gas concentrations.	Good practice to continually monitor and measure the performance of odour control methods. Use of equipment to quantify odour release rates and odour types is useful for identifying possible sources. Simple and raises awareness. Public consultation and liaison is a useful means of assessing odour impacts and helping to deal with unforeseen odour release sources.
PM-10 Keep record of site activities in diary	All site activities noted on daily basis. Include sub-contractor activities.	Record of all site activities that can be referenced to determine if specific activities led to an odour complaint. Include all subcontractor activities involved in potential odour-release activities.
PM-11 Record local meteorological data (weather station)	Site specific wind speed and direction, rainfall and pressure data.	Provides ability to assess the prevailing weather conditions at the time of a complaint. Provides data to help benchmark future air dispersion modeling studies. May be referenced for data to assist with atmospheric pressure effects on gas emissions studies or other studies.
PM-12 Consult / communicate with site personnel and public	All site operatives and contractors and local residents.	Raises awareness of all site staff of the potential impact of their activities. Routine and regular liaison with the public to learn of their concerns (Community Relations Committee) Site Open House engages the public and raises their awareness of the operational constraints facing landfill operators.

4.4 Industry Standard for Odour Control in Ontario

Industry standards for odour control in Ontario were derived through a combination of in-house knowledge of the landfill industry (based on client experience and tracking of landfill projects), discussions with Ontario Ministry of Environment landfill regulators and an Environment Canada representative that has tracked Canadian landfills with gas control system for many years, and a survey that SNC-Lavalin Inc. carried out for a number of representative Ontario landfill operators (for both private and municipally owned sites). Survey responses were received from Cities of Ottawa, Hamilton and North Bay, the Regions of Halton, Peel and Waterloo as well as the private sector (BFI, Niagara Waste Systems and Lafleche Environmental Inc.).

Industry standards for odour control rely primarily on gas collection and flaring systems for the larger landfill sites in Ontario only (e.g. for site capacities of several million tonnes of waste or more). Although odour control is improved with the installation of such systems, it usually represents only one of several reasons for its installation which also include in no particular order: gas utilization for energy production (economic incentive), reduction of greenhouse gas emissions and control of subsurface gas migration. The earliest landfill gas control systems in Ontario were installed in the late 1980's for two very large Metro Toronto Landfills that were active at that time. Both were coupled with gas utilization systems. The majority of the more than 20 existing landfill gas control systems in Ontario were constructed between the mid-1990's (e.g., Waterloo, Cambridge, Britannia) and present (North Bay, London, Hamilton and St. Thomas). To put the advent of active landfill gas collection systems in perspective for Ontario, estimates of the total number of sites with such systems has been tabulated below for the past decade (based on Environment Canada surveys and in-house data):

Table 8. Historical Summary of Ontario Landfills with Landfill Gas Recovery

Year	Ontario Landfills With Landfill Gas Recovery
1999	14
2003	17
2005	19
2008	23
2010	38 (anticipated)

These figures include both active and closed landfills owned and operated by both the private sector and municipalities. The anticipated spike between now and 2010 is the result of the regulatory requirement for all landfills with capacities greater than 1.5 million tonnes to actively collect landfill gas.

Most of the landfills providing active gas management rely on vertical gas extraction wells installed through completed sections of the landfill. Some of these landfill sites have employed hybrid systems of horizontal wells coupled with vertical wells for gas collection (Waterloo, Halton, Hamilton, Ottawa WMF, Keele Valley, and Britannia). The City of North Bay is also proposing to supplement an existing system of vertical collectors with horizontal collectors for gas extraction in the near future. As defined previously, horizontal wells are installed within the buried waste to allow the gas to flow, under vacuum, from the landfills to the flaring system and/or gas utilization system. Horizontal wells introduce an effective solution to interim gas control allowing active gas collection to take place long before final landfill elevations are reached. Using this approach, a layered series of gas collection zones are created in the uncapped portion of the landfill, thereby capturing landfill gas before it migrates to the surface and creates the potential for off-site odours. Horizontal collection wells or trenches are inexpensive, easily installed and very effective. Both Waterloo and Halton Region landfills have realized dramatic reductions in gas odours using this method.

A minority of landfills have their landfill gas collection systems connected to their leachate management systems to prevent odour emissions from pumping stations, manholes, cleanouts, etc. associated with leachate and/or landfill gas entering such systems. Most of the sites with hybrid collection systems also collect gas from their leachate systems for the purpose of odour control.

Gas treatment from the Ontario landfills with active gas management systems is limited to high temperature destruction of gases using flares. When combustion is used, two different types of flares can be employed: open or enclosed flares. Open flame flares (e. g., candle or pipe flares), the simplest flaring technology, consist of a pipe through which the gas is pumped, a pilot light to spark the gas, and a means to regulate the gas flow. The simplicity of the design and operation of an open flame flare is an advantage of this technology. Disadvantages include inefficient combustion, aesthetic complaints, and monitoring difficulties. Sometimes, open flame flares are partially covered to hide the flame from view and improve monitoring accuracy. Although most sites are currently employing one or more enclosed flares, a few are utilizing open flares including Peterborough, North Sheridan, and Cornwall landfill sites. The City of Hamilton has also employed an open flare for the destruction of gas extracted from their leachate management system for the last few years. Enclosed flame flares are more complex and expensive than open flame flares. Nevertheless, most flares designed today are enclosed, because this design eliminates some of the disadvantages associated

with open flame flares. Enclosed flame flares consist of multiple burners enclosed within fire-resistant walls that extend above the flame. Unlike open flame flares, the amount of gas and air entering an enclosed flame flare can be controlled, making combustion more reliable and more efficient. Some of the sites that have enclosed flares include North Bay, Cambridge, Glenridge Quarry Landfill, East Quarry, Tom Howe, Green Lane, Waterloo, and London.

A number of the larger sites referenced above have had odour sources in addition to the landfilled waste including compost windrows, leachate management systems, receipt of biosolids, contaminated soils, and leachate seeps.

Relatively few landfills have used other odour mitigation measures beyond gas collection. Some examples that have been used at the larger sites include application of odour neutralization and masking agents (Hamilton and Lafleche) using both permanent and mobile equipment, hydrogen peroxide added to leachate for odour control at Halton, activated carbon filters on leachate vents (Hamilton and Ottawa WMF) and indoor air purification system installed for a neighbour at Hamilton's Glanbrook Landfill. Most of these technologies were experimented with or were tried on a temporary basis and have since been abandoned.

Daily cover at the larger Ontario landfills is applied using soil, wood chips, shredded industrial/commercial wastes, traps, foams, etc. Anecdotal feedback from site operators and from our own staff experience at numerous landfills indicates that soil and wood chips provide the best odour control for daily cover. Alternative covers such as foams, tarps, and other materials are generally adequate but not under all meteorological conditions or sometimes during its removal prior to filling in that area on the following day.

Detailed odour studies or investigation have been carried out at about half of the larger landfills (Waterloo, Ottawa WMF, Glanbrook, Oxford County, Keele Valley, Britannia, etc.). Many other sites (with or without gas management) have conducted air quality assessments which included a basic odour assessment as part of their recent facility approvals (Lafleche, Niagara Waste Systems).

Odour complaints have been received by the operators of many of the Ontario landfill sites that were surveyed. Most of these complaints were the result of compost operations at the landfill and secondarily from the landfill and its leachate. Complaint numbers are generally a handful or less per year from the nearest receptors (1.5 km or less from the site). Spikes of complaints have been noted during times of proposed expansion, during installation of systems or general discontent with site operations. It is noted that some of these sites have seen a significant decrease in the number of

complaints related to odour as result of the installation of gas collection systems (i.e. Waterloo, Hamilton, and Niagara Waste Systems).

5.0 SUMMARY AND CONCLUSIONS

Since 2006, the Ottawa WMF has been the source of many community complaints relating to odour. Although WMCC has implemented a landfill gas collection and control system as well as various odour control measures, large numbers of odour complaints continue to be received. SNC-Lavalin Inc. was retained by the Ministry of Environment to provide an expert opinion regarding the measures taken and the technologies employed at the WMCC Ottawa WMF site to control odours.

To develop our expert opinion, the following work was completed: a review of Ministry-provided information pertaining to the site, a site visit, a review of publicly available information concerning similar landfill issues, their approaches and odour mitigating solutions, a survey of representative Ontario landfill operators, and sourcing of best management practices and industry standards.

The project team compiled and reviewed available literature on the technologies and practices for odour control at landfills which is primarily undertaken through landfill gas collection and destruction systems. Twenty best management practices were identified with respect to landfill gas collection and control systems. These practices are:

- Horizontal Collectors or Surface Collectors (GC-1)
- Tighter Spacing/Increased Density of Vertical Landfill Gas Wells (GC-2)
- Mixed Horizontal and Vertical Well Systems (GC-3)
- Connection of the Leachate Collection and Removal System to the Landfill Gas Collection System (GC-4)
- Deep, Multi-Depth Vertical Wells (GC-5)
- Maximize Borehole and Well Diameters (GC-6)
- Enhanced Seals on Landfill Gas Wells and Boreholes (GC-7)
- Landfill Gas Well Dewatering to ensure gas flow is not blocked (GC-8)
- Proper Design of Landfill Gas System Piping (GC-9)
- Determination of the effective capture area of gas extraction wells (GC-10)
- Monitoring the effectiveness of the gas extraction wells and the extraction system (GC-11)
- Ensuring gas engine exhausts are vertical and as high as feasible (GC-12)
- Utilization of shrouded gas flares (GC-13)
- Ensuring landfill gas is adequately dewatered before entering the gas flare (GC-14)
- Locating gas flares/engines away from receptors (GC-15)
- Maintaining pollution control equipment (GC-16)
- Barometric Control of the Landfill Gas System (OM-1)

- Redundant Flare Station Equipment (OM-2)
- Maximize Capacity of Gas Mover (Blower) Equipment (OM-3)
- Maximize Capacity of Gas Control (Flare) Equipment (CS-1).

A landfill operator may employ a variety of techniques, methods and management options to suppress and/or control the emanation of odour off-site. A literature review was undertaken to determine the techniques and options available and in-use at landfilling sites. An industry survey was conducted to gather Ontario-based information. It was found that these aspects of control can be categorized into two general areas; planning and management as well as systems and operational practices.

Systems and operational practices for odour control were divided into options relating to cover materials (CM) and practices, cell design (CD), the leachate system (LS), other odour counteractant systems (O) and, the gas collection system (GC). A total of thirteen systems and operational best management practices for odour control were identified (in addition to the twenty options specific to landfill gas collection and control systems). Decisions pertaining to site selection and location, delivery routes, waste acceptance policy, operational policy and communications encompass the planning and management options for odour control. Twelve planning and management options were identified.

For this study, a report card was developed to illustrate best management practices and industry standards in comparison to options implemented at the Ottawa WMF. Check marks in the Industry Standard column indicate that the best management practice is an Industry Standard. Table 8 provides the Report Card.

With respect to landfill gas collection and control systems, Industry Standard measures include:

- Relying on uniform vertical well installations (General Practice)
- Maximizing borehole and well diameters (GC-6)
- Enhancing seals on landfill gas wells and boreholes (GC-7)
- Best design for landfill gas system piping (GC-9)
- Maximizing the capacity of gas mover (blower) equipment (OM-3)
- Maximizing capacity of gas control (flare) equipment (CS-1)
- Determining the effective capture area of gas extraction wells (GC-10)
- Monitoring the effectiveness of the gas extraction wells and the extraction system (GC-11)
- Ensuring gas engine exhausts are vertical and high as feasible (GC-12)

- Utilizing shrouded (enclosed) gas flares (GC-13)
- Ensuring the landfill gas is adequately dewatered before entering the landfill gas flare (GC-14)
- Locating gas flares/engines away from receptors (GC-15)
- Maintaining pollution control equipment (GC-16)

Industry Standard operational measures for odour control (other than landfill gas collection) include:

- Minimizing the uncapped operational area (CM-1);
- Promoting the immediate restoration (greening) of surface soils (CM-3);
- Placing adequate depth of daily cover over all operational areas, maintaining depth of cover over time on temporary capped areas and ensuring the type of daily/temporary cover material is appropriate (CM-5);
- Minimizing slope of cell sides to 1V:3H (CD-2); and,
- Remote siting of leachate aeration lagoons (LS-5).

Industry Standard planning and management options for odour control include:

- Attempting to locate site away from receptors (PM-1);
- Routing delivery vehicles to avoid sensitive receptors (PM-2);
- Delivering, where practical, putrescible wastes immediately (PM-3);
- Regular site housekeeping activities (PM-8);
- Keeping a permanent record of site activities in a diary (PM-10); and,
- Consulting and communicating with site personnel and the public (PM-12).

Comparison of Site to Industry Standards and Best Management Practices

WMCC has met or exceeded the industry standard in Ontario for odour control based on the timing, number, and extent of odour mitigation measures implemented at their Ottawa WMF as compared to an "average" condition established for other Ontario landfills of similar size. Our assessment of the Ottawa WMF has indicated that it is generally carrying out or has attempted:

- A greater number of odour/gas control mitigation measures (e.g. gas extraction system of vertical and horizontal collectors, filter gas from leachate pump station, odour neutralization system, air injection wells in the buffer, minimization of active tipping face, reduction in organics and biosolids received at the site);
- A larger magnitude of individual odour control systems (e.g. gas well field, spare blower, odour neutralization nozzles, final cover enhancement to material originally approved); and,

- In some cases has implemented odour control measures well before other Ontario landfills of similar size.

Generally WMCC has indicated practice of due diligence as reflected by the timing, number, and extent of odour control measures as previously discussed. In comparison to the twenty identified BMPs for landfill gas collection and control systems (GC), the Ottawa WMF has implemented fourteen BMPs. (One BMP relating to redundant flare station equipment was not able to be verified.)

Further, the Industry Standard in Ontario for landfill gas collection and control systems however involves the implementation of ten practices. All ten of these practices are also in-place at the Ottawa WMF.

WMCC has carried out various investigations and site improvements and prepared a number of reports/documents with respect to odour control because of legal proceedings and Ministry directives over the past two years. WMCC completed these activities in a timely manner. Further, the implementation of the three main odour control measures for the Ottawa WMF prior to the development of the Voluntary Abatement Plan was required (pre-2006) indicates that WMCC in fact demonstrated a certain degree of pro-action with respect to odour control from the site.

The single negative practice noted relates to the historic cell development procedures (early development of the entire fill area) which has not allowed for optimum/best cover material placement practices which may have resulted in a reduction in the ability to effectively control odours from these areas. For instance at some other landfill sites, discrete portions of the landfill are filled to final grade as soon as possible so that these areas may be capped and have environmental control systems installed. Even though the Ottawa WMF site's sequential development was not ideal with respect to landfill gas control, areas nearing completion could have received final cover of low permeability soils sooner than what did occur.

The recently disturbed final-covered areas and the interim-covered areas of the site (areas awaiting garbage placement but not currently in use) were not observed to be vegetated. Greening of soils may prevent damage to the soil cap, and grassy soil above a crack will help to attenuate odourous compounds that may exist. Given the restoration (greening) of surface soils is a best management practice, the Ottawa WMF did not appear to fully implement the objective of this practice.

In summary, WMCC has implemented a sizable number of best management practices for both odour control and in relation to landfill gas collection and control specifically. On the whole, more

BMPs are in-place at the Ottawa WMF than compared with the average similarly sized landfills used in formulating the industry standard. It appears WMCC have implemented a variety of reasonable measures in a timely manner to avoid the discharge of odour from the site.

Legend	
√	YES - Application in-place
X	NO - Application not in-place
/	UNKNOWN

Table 9. Assessment of Measures Employed at Ottawa WMF to BMP and Industry Standard

Best Management Practice	Application at Ottawa WMF	Comment	Industry Standard	Comment
Landfill Gas Collection and Control System				
GC-1 Horizontal collectors or surface collectors	√	Site installed 6 horizontal collectors in 2005 and will implement surface collection in future via the 'beanie cap'.	X	Most active gas systems rely on wells only.
GC-2 Tighter spacing of vertical landfill gas wells	√	General application of well spacing at 60 meters, although in some areas (e.g. north central slope and southwest slope) have tighter spaced wells.	X	Most sites rely on fairly uniform spacing of wells.
GC-3 Mixed horizontal and vertical well systems	√	Both horizontal and vertical system employed although primary reliance on vertical.	X	Most active gas systems rely on wells only.
GC-4 Connection of leachate collection and removal system layer to landfill gas collection system	X	Not in use at site.	X	Is becoming more common.
GC-5 Deep multi-depth vertical wells	X	Well details unavailable although it appears multi-depth wells are not in-use	X	Not very common anywhere.
GC-6 Maximize borehole and well diameters	√	Newer boreholes and wells are larger diameter per WMCC standard.	√	

Table 9. Assessment of Measures Employed at Ottawa WMF to BMP and Industry Standard

Best Management Practice	Application at Ottawa WMF	Comment	Industry Standard	Comment
GC-7 Enhance seals on landfill gas wells and boreholes	√	Clay and bentonite seals utilized in newer installations.	√	
GC-8 Dewater landfill gas wells	√	Dewatering employed.	X	
GC-9 Best design for landfill gas system piping	√	Piping design adequate at 100 to 150 mm dia.	√	
GC-10 Determine the effective capture area of gas extraction wells	√	Landfill gas collection system efficiency study completed in 2006.	√	
GC-11 Monitor the effectiveness of the gas extraction wells and the extraction system	√	Technicians recently employed to complete monitoring etc.	√	
GC-12 Ensure gas engine exhausts are vertical and high as feasible	√	Flare system approved by Ministry therefore emissions are below regulatory standards.	√	
GC-13 Utilize shrouded gas flares	√	2 enclosed flares in-use.	√	
GC-14 Ensure landfill gas is adequately dewatered before entering the gas flare	√	Dewatering employed.	√	
GC-15 Locate gas flares/engines away from receptors	√	Flare system approved by Ministry therefore emissions are below regulatory standards and location assumed appropriate.	√	
GC-16 Maintain pollution control equipment	√	Equipment appears to be adequately maintained.	√	

Table 9. Assessment of Measures Employed at Ottawa WMF to BMP and Industry Standard

Best Management Practice	Application at Ottawa WMF	Comment	Industry Standard	Comment
Landfill Gas Systems and Operations & Maintenance				
OM-1 Barometric control of landfill gas system	X	Technique not employed.	X	
OM-2 Redundant flare station equipment	/	Redundant equipment list not available.	X	
OM-3 Maximize capacity of gas mover equipment	√	Capacity adequate; system designed by reputable engineering firm; detailed calculations not completed to confirm.	√	
CS-1 Maximum capacity of gas control equipment	√	Capacity adequate; system designed by reputable engineering firm; detailed calculations not completed to confirm.	√	
Systems and Operational Practices for Odour Control				
CM-1 Minimize uncapped operational area	√	Daily working area has been reduced over time.	√	
CM-2 Minimize uncapped final level area	X	In recent past site has worked to final cap however it appears some areas likely should have been capped earlier.	X	
CM-3 Promote immediate restoration (greening) of surface soils	X	Interim cover areas did not appear to have vegetation. Final covered areas were vegetated but various locations disturbed due to well installation.	√	
CM-4 Utilize engineered capping layer at final fill areas	√	Engineered final fill planned for landfill top. Sloped areas do not appear to have engineered cap.	X	

Table 9. Assessment of Measures Employed at Ottawa WMF to BMP and Industry Standard

Best Management Practice	Application at Ottawa WMF	Comment	Industry Standard	Comment
CM-5 Place adequate depth of daily cover over all operational areas, maintain depth of cover over time on temporary capped areas and ensure types of cover material are appropriate	√	Depth and type of daily and interim cover stated in the Design and Operation Report is adequate.	√	MOE approvals required for Ontario landfills employing alternative covers.
CD-1 Minimize size of cell sides	NA	Site utilizes area fill method.	√	
CD-2 Minimize slope of cell sides to <1V:3H	√	Overall landfill side slopes are appropriate.	√	4H:1V is closer to industry standard
LS-1 Place all leachate manholes, wells, etc. under active gas extraction	√	A portion of the leachate collection system is connected to the landfill gas extraction system.	X	
LS-2 Fully contain all leachate storage vessels	√		X	A number of Ontario landfills have leachate evaporation or treatment ponds.
LS-3 Dose leachate stored for long periods	NA	Leachate not stored for long periods.	X	
LS-4 Dose or pre-treat leachate if discharged to sewer	√	Leachate is pre-treated before discharge to sewer.	X	
LS-5 Remote siting/location of leachate aeration lagoons	NA	No leachate aeration lagoons on-site.	√	
O-1 Utilize odourant counteractants (masking, neutralizing or suppressing agent)	√	System has been utilized in past but currently out-of-service.	X	Such systems have only been employed at handful of Ontario landfills.

Table 9. Assessment of Measures Employed at Ottawa WMF to BMP and Industry Standard

Best Management Practice	Application at Ottawa WMF	Comment	Industry Standard	Comment
Landfill Planning and Management Options for Odour Control				
PM-1 Locate site away from receptors (remote)	NA	Established landfill, planning activities cannot be undertaken retroactively.	√	Most Ontario landfills have at least a few neighbouring dwellings.
PM-2 Route delivery vehicles to avoid sensitive receptors	NA	Established landfill, planning activities cannot be undertaken retroactively.	√	
PM-3 Putrescible wastes delivered immediately (before degradation begins)	√	Waste delivery occurs immediately.	√	This occurs to the extent practical only.
PM-4 Prohibit highly odorous waste streams (unless suitably pre-treated to reduce odour)	√	Site employs waste qualification process to manage wastes before entry to site.	X	
PM-5 Cell size: prevent imbalance between odorous leachates and establishment of methanogenic conditions	NA	Site employs area-fill method (not cells).	X	
PM-6 Avoid disposal of odorous wastes in poor wind dispersal conditions	√	Near future planned activity.	X	
PM-7 Undertake waste excavation only when wind direction is suitable and for the minimum exposure time	√	Near future planned activity. Also waste receipt values have declined significantly recently due to policy implementation.	X	
PM-8-Housekeeping: avoid odours from deposits of garbage / road sweepings	√	Housekeeping activities appear adequate.	√	
PM-9 Conduct odour monitoring in all areas of site including odour controls and pollution control infrastructure	√	Monitoring undertaken regularly.	X	

Table 9. Assessment of Measures Employed at Ottawa WMF to BMP and Industry Standard

Best Management Practice	Application at Ottawa WMF	Comment	Industry Standard	Comment
PM-10 Keep record of site activities in diary	√	Activities noted on company website and on-site.	√	
PM-11 Record local meteorological data (weather station)	√	Weather station in-place.	X	
PM-12 Consult/communicate with site personnel and public	√	Variety of communication methods employed (website, open houses, direct contact).	√	
Total # Practices	**45**		**45**	
# Practices Implemented	**34***		**23**	

* status of one unknown, one not applicable

Comments on the Design and Operation Plan

The various Design and Operations (D&O) Plans prepared for the site in general as well as those specific to the landfill gas collection and flaring system are consistent with industry standards and compliant with regulatory requirements in this province. Further, a number of engineered systems and operational techniques described in these documents incorporate best management practices. The D&O Plans for the site were generally noted to be sparse on detail regarding odour management.

Landfill Odour Management Process

Management of odours by prevention begins at the site selection stage. In the case of the Ottawa WMF however, the site has been established for over 30 years and receptors have been allowed to settle in the vicinity of the site due to local planning decisions. A variety of management techniques are available for managing and controlling odour risk at landfill sites. Mitigation measures that limit the extent of off-site odours are based on reducing the rate of odourous emissions from a source; by increasing the thickness of cover materials and/or changing the type of cover material on landfill surfaces and utilizing odourous landfill gas in an active gas management system. The report card above notes the techniques that have been employed at the Ottawa WMF for odour mitigation. The majority of these techniques were initiated before the Voluntary Abatement Plan was required by the

Ministry in 2006. WMCC has demonstrated proactive management of landfill odours in that they have prepared for and attempted to control odour through the history of the site.

Addressing Areas of Concern in a Timely Manner

In May of 2006, the Ministry officially required WMCC produce a Voluntary Abatement Plan (VAP) for odour in which five actions were required. Within one month of the request, WMCC provided a summary of abatement activities underway outside of the VAP as well as a response to the five actions. The Ministry accepted the VAP in June 2006 and required actions be completed by early August. WMCC completed the work before the submission deadline and implemented a variety of recommendations from various reports within the year. In March 2007, the Ministry concluded however that the VAP did not meet its objectives and Provincial Officer's Orders were subsequently issued.

Ten conditions were required of WMCC in the May 2007 Order and four conditions were required in the December 2007 Order. The company met all conditions by the stated deadlines and submissions were made to the Ministry detailing the response. The Ministry confirmed that WMCC had completed the conditions required in the two Orders.
It is therefore concluded that all areas of concern (defined to be the variety of actions and orders required by the Ministry) were addressed in a timely manner by WMCC.

Various Andre Simard and Associates (ASA) technical reports (provided by the Ministry) were reviewed to ascertain what issues were identified and to determine if the issues were rectified over a reasonable timeframe. In the May 2006 report the focus of the assessment was the performance of the landfill gas collection system. The report concluded that the "globally, the landfill gas collection system is performing well." Recommended tasks to increase the performance of the system related to measuring the landfill gas quantity at the flare, investigating air intrusion in the piping, considering operating at higher vacuum, and checking gas temperature and residual nitrogen at each wellhead. No specific information was located in the information provided which would verify whether these recommendations were implemented.

ASA reports (several in the year 2007) focus on the performance of the system as measured by air emissions from the landfill (surface emission monitoring). In each report, high emissions are noted relative to identified areas on the landfill mound and recommendations are made relating to the integrity of the soil cover and vacuum adjustment at the wells located in the area of the high readings. The higher readings appeared to be local to the north and south slopes but at various locations relative to east and west, depending on the date of the survey. The reports also note any improvements observed in relation to the previous assessment. In the 27 August 2007 report, it is noted that emissions of landfill gas have greatly reduced due to the reconnection of the southwest

extraction wells and the positioning of the final cover on the north and south slopes. The 2007 August and September WMCC Monthly Reports were reviewed for actions taken to mitigate odour specifically in relation to the surface emission monitoring results. These actions were found to include capping, repair of leachate seeps, reconnection of landfill gas wells, and monitoring and balancing the landfill gas field. No other specific information was located to verify the recommendations were/are implemented.

Given that WMCC have hired personnel specifically for the landfill gas system, it is assumed that the regular completion of these surveys and the implementation of the recommendations will result in adequate operation of the system.

Although the site continues to experience odour complaints, odour mitigation is expected to improve as the Ottawa WMF is progressively closed out (completed to final grades and capped), and as long as WMCC strictly adheres to the recommendations made in the RWDI report.

6.0 REFERENCES AND WEBSITES

References

McKendry, P., Looney, J.H., McKenzie, A., 2002, *Managing Odour Risk at Landfill Sites: Summary Report*

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Facility Operations, Odour Control. http://wastemanagementottawa.ca/en/facility-operations/odour-control (accessed July 2008)

Appendix A

Notice to Reader

NOTICE

This document contains the expression of the professional opinion of SNC-Lavalin Inc. ("SLI") as to the matters set out herein, using its professional judgment and reasonable care. It is to be read in the context of the agreement dated 20 May 2008 (the "Agreement") between SLI and Ontario Ministry of the Environment (the "Client"), and the methodology, procedures and techniques used, SLI's assumptions, and the circumstances and constraints under which its mandate was performed. This document is written solely for the purpose stated in the Agreement, and for the sole and exclusive benefit of the Client, whose remedies are limited to those set out in the Agreement. This document is meant to be read as a whole, and sections or parts thereof should thus not be read or relied upon out of context.

SLI has, in preparing any cost estimates, followed methodology and procedures, and exercised due care consistent with the intended level of accuracy, using its professional judgment and reasonable care, and is thus of the opinion that there is a high probability that actual costs will fall within the specified error margin. However, no warranty should be implied as to the accuracy of estimates. Unless expressly stated otherwise, assumptions, data and information supplied by, or gathered from other sources (including the Client, other consultants, testing laboratories and equipment suppliers, etc.) upon which SLI's opinion as set out herein is based has not been verified by SLI; SLI makes no representation as to its accuracy and disclaims all liability with respect thereto.

SLI disclaims any liability to the Client and to third parties in respect of the publication, reference, quoting, or distribution of this report or any of its contents to and reliance thereon by any third party.

Appendix B

List of Ministry Provided Documentation

1 - ANNUAL REPORTS:

1998 – scanned – 232 pages
1999 – scanned – 230 pages
2000 – scanned – 208 pages
2001 – scanned – 243 pages
2002 – scanned – 235 pages
2003 – scanned – 234 pages
2004 – scanned – 246 pages
2005 – scanned – 239 pages
2006 – scanned – 262 pages
2007 – scanned – 252 pages

2 - VOLUNTARY ABATEMENT PLAN (VAP) AND SUBMISSIONS:

Letter – May 11, 2006: from MOE to WMCC – scanned, 3 pages
Letter – June 8, 2006: from WMCC to MOE – scanned, 5 pages
Appendix A–report April 2006 ASA LFG vertical migration (project 2294)– scanned, 21 pages
Appendix B – letter July 21, 2004 LFG measurements – scanned, 4 pages
Appendix C – LFG generation curve – scanned, 2 pages
Appendix D – drawing showing LFG collection system – missing from file
Appendix E – areas of final and interim cap – scanned, 2 pages
Appendix F – proposed schedule of work – scanned, 1 page
Letter – June 26, 2006: from MOE to WMCC - scanned, 1 page
Letter – July 21, 2006: cover letter from WMCC to MOE including 2 reports(see below) – scanned, 4 pages
Report – Assessment of the LFG collection system performance (project 2293). prepared by Andre Simard. Dated April 2006 – scanned 21 pages
Report – Assessment of the LFG collection system performance – Complementary Study. Prepared by Andre Simard. Dated July 2006 – scanned, 67 pages
Letter – January 26, 2007: from WMCC to MOE – scanned, 2 pages
Report – Assessment of LFG vertical migration. Dec 2006 – scanned, 21 pages
Proposed Schedule- A – scanned – 2 pages
Proposed Schedule B – scanned 2 pages
Letter – March 12 2007 – scanned, 2 pages
Proposed Schedule March 7 2007 – scanned 2 pages

3 – PROVINCIAL OFFICER'S ORDER (5830-6Z2PPW, ISSUED MAY 11 2007)/CONFIRMED BY DIRECTOR'S ORDER (5830-6Z2PPW-1, ISSUED MAY 25 2007) AND SUBMISSIONS:

PROVINCIAL OFFICER'S ORDER: scanned – 14 pages
DIRECTOR'S ORDER: scanned – 4 pages

SUBMISSIONS:
- Ordered Condition #1 – Summary Action Report – scanned
Includes: - June 1 2006 email: 1 page
- LFG Odour Management Action Plan June 1 2007: 5 pages
- Schedule of completed LFG Actions Enhancements: 1 page

- Ordered Condition #2 – Retain Qualified Person – scanned
Includes: - List of consultants – 1 page

- Ordered Condition #3 – Odour Sources Survey Report – scanned
Includes: - Ottawa landfill odour source summary june 29/07 – 22 pages
- March 15 report – scanned 6 pages
- March 16 report – scanned 10 pages

- Ordered Condition #4 – Emissions Survey Report –
Includes: - Emission survey cover letter Aug 31 2007 – 1 page
- LFG vertical migration Dec 2007 – 31 pages
- May 2007 report LFG vertical migration – 27 pages
- Survey Aug 2007 – 34 pages
- Survey July 2007 – 34 pages
- September 2007 survey – scanned 33 pages
- November 2007 survey – scanned 30 pages

- Ordered Condition #5 – Ambient Air Monitoring Report – scanned
Includes: - Ambient air aug 31 2007 cover letter – 1 page
- Ambient air oct 15 2007 cover letter – 1 page
- Ambient monitoring report Aug 31/07 – 30 pages
- Ambient monitoring report Oct 10/07 – 33 pages

- Ordered Condition #6 – Continuous Monitoring Report – scanned
Includes: - Continuous monitoring cover letter Aug 31/07 – 1 page
- Continuous Odour Report Aug 31/07 – 16 pages

- Ordered Condition #7 – Landfill Cover Report – scanned
Includes: - Landfill cover material report June 29/07 – 12 pages

- Ordered Condition #8 – Operations Manual – May 2007 Operations and Maintenance Manual for the Landfill Gas Collection and Flaring System of the Ottawa Landfill

- Ordered Condition #9 – Monthly Progress Report – scanned
  Includes: - May 2007 progress report – 2 pages
  - June 2007 progress report – 2 pages
  - July 2007 progress report – 2 pages
  - Aug 2007 progress report – 3 pages
  - Sept 2007 progress report – 2 pages
  - Oct 2007 progress report – 2 pages
  - Nov 2007 progress report – 2 pages
  - Dec 2007 progress report – 2 pages

- Ordered Condition #10 – Contingency Work Plan – scanned
  Includes: - Potential Contingency Measures for Odour – 14 pages

4 – PROVINCIAL OFFICER'S ORDER 7160-79THQR and submissions
- issued December 19, 2007
- Order and Appendix I– scanned – 19 pages

Planned construction activities:
- January 2008 – 1 page
- February 2008 – 1 page
- March 2008 – 1 page
- April 2008 – 1 page

Beanie Cap application – scanned, 30 pages
Final Closure Plan March 28 2008 – scanned, 118 pages
2 drawings of site – scanned, 2 pages

AIR CERTIFICATE OF APPROVAL 8-4105-98-006 and application documents
Approval of temporary flare

5 – AIR CERTIFICATE OF APPROVAL 8-4076-99-006 and application documents
- issued December 17, 1999, approval is for use/operation of 1st flare

APPROVAL DOCUMENTS:
Includes: - Certificate of approval 8-4076-99-006 – scanned, 5 pgs

6 – AIR certificate of approval CERTIFICATE OF APPROVAL 4339-6PPJ7Y
- issued May 26, 2006, approval is for temporary flare

APPROVAL DOCUMENTS:
Includes: - Certificate of approval 4339-6PPJ7Y – scanned, 5 pgs

7 – AIR certificate of approval 0741-6S9NPE and application documents
- issued Nov. 28, 2006, approval is site wide approval including 2nd flare

APPROVAL DOCUMENTS:

Includes: - Certificate of approval 0741-6S9NPE – scanned, 7pgs

- Condition 7 SUBMISSIONS:

Includes: - Quarterly Report (Sept 1/07-Nov 30/07) – 2 pages
- complaint database (sept 1/07-nov30/07) – 73 pages

- Quarterly Report (Dec 1/07-Feb 29/08) – 2 pages
- complaint database (dec 1/07-feb 29/08) – 21 pages

8 – Waste Disposal Site Certificate of Approval A461002 and application documents

- issued August 17, 1994 and amendments
- approval for operation of landfill site
- Ottawa District Office had approval and application documents scanned

APPROVAL DOCUMENTS:

Includes: - A461002 dec 20 2006 amendment – scanned, 4 pages
- A461002 march 7 2008 amendment – scanned, 5 pages
- A461002 nov 10 2006 amendment – scanned, 3 pages
- Certificate of approval A461002 – scanned, 27 pages
- D and O amendment A461002 – scanned, 3 pages
- June 14, 2006 approval of grits – scanned, 1 page
- sewage treatment plant waste – scanned, 2 pages

APPLICATION DOCUMENTS:

Includes: - 1994 Development and Operations report – scanned, 196 pages
- April 2003 update report – scanned, 118 pages
- Design report Jan 1989 – scanned, 94 pages
- Final contours map 1993 – scanned, 6 pages
- Jan 89 Hydro-g. study Part 2 – scanned, 84 pages
- Jan 89 Hydro-g. study – scanned, 308 pages
- June 20 2000 letter – scanned, 1 page
- March 28 2000 letter – scanned, 2 pages
- October 15 1989 application – scanned, 3 pages
- Sept 2006 application – scanned, 56 pages

9 – Miscellaneous Documents:

- Operations and Maintenance Manual, Purge Well and Forcemain system, revised January 2002 – scanned, 134 pages
- History of gas system – scanned, 7 pages
- Misting system – scanned, 24 pages
- Site enhancements – scanned, 2 pages

- Contract for a lined cell – scanned, 178 pages
- Performance monitoring report air injection barrier test program, sept 1998 – scanned 48 pages
- 2006 complaint database – scanned, 22 pages
- 2007 complaint database – scanned, 84 pages
- Pictures of site – jpg attached, 14 pictures
- Master monitoring plan, December 1994 – scanned 17 pages

1 drawing "Gas System – As Constructed January 2007, Ottawa Landfill" Number 91712G-GW07 (February 13, 2007) by WMCC

Appendix C

Summary of Requirements – Regulation 232

Summary of Landfill Standards Under Regulation 232/98

A. Mandatory Air Emissions Control

These standards (now approximately 10 years old) require the collection of landfill gas for new or expanding sites larger than three million cubic metres (approximately 2.5 million tonnes). Although the precise quantities and nature of air emissions from each site may vary somewhat, air emissions control for larger landfills is considered good environmental practice.

For sites not included under the mandatory trigger, air emissions control may still be required in some cases. For example, factors such as waste type, site location close to a populated area and operational practices may indicate that air emissions should be controlled even though the site is smaller than three million cubic metres.

A proposed amendment to this regulation will require that all operating or new or expanding landfills having a waste capacity greater than 1.5 million m3 will be required to have gas recovery systems in-place by 2010.

B. Hydrogeology and Surface Water

The new standards require that the hydrogeologic and surface water conditions be assessed.

- Hydrogeologic Assessment. Required for site specific design or to ensure the conditions for use of a generic design are present, and to establish an effective groundwater monitoring program and leachate contingency plan.
- Surface Water Assessment. Required to minimize or mitigate disturbance to existing surface water features, to determine the potential effects of surface water discharges and to establish a surface water monitoring network.

C. Design Report

Landfill sites must be well designed for groundwater and surface water protection to prevent effects from site operation and to facilitate site closure and post-closure care. The site design report required by the standards must describe all site features in sufficient detail to confirm the design will be acceptable. The design report must address:

- site boundaries, buffer area, waste fill area and contours, surface water control works, on-site roads and structures and final cover design,
- the design of any liner and leachate collection system,
- any air emission control works,
- monitoring facilities for groundwater, leachate and surface water,

- a contingency plan for leachate control and
- site closure and post-closure care requirements.

D. Site Design for Groundwater Protection

The new standards include two design approaches for achieving groundwater protection, either of which is acceptable:

- Site specific design. This approach allows a proponent to design the landfill to suit the local environmental setting provided the ministry's reasonable use limits (see sidebar) for groundwater protection are met. The site specific design approach is performance-based with the design required to meet the reasonable use limits for the site.
- Generic design. This approach allows the landfill owner to select one of two generic designs specified in the standards, provided the conditions for their use are met. The designs incorporate single and double liner systems and have been developed to ensure they will meet the ministry's reasonable use limits. The advantage of generic designs is the added certainty they bring to the approvals process.

E. Site Operations and Monitoring

Good site operation and maintenance is necessary to ensure that environmental control works and monitoring facilities continue to function properly. Good operational procedures are also important in minimizing potential nuisance effects such as litter, noise, odour and dust.

The new standards require that an operations report be prepared describing the operation and maintenance procedures for the site. Depending on the size and operational requirements of the site, the report must address:

- a waste control program to ensure unacceptable wastes are not accepted for disposal,
- site supervision and security,
- waste disposal and covering activities,
- site monitoring, and
- a complaint response plan.

F. Closure and Post-Closure Care

Once a landfill site has reached capacity, final closure must be completed in a manner that ensures the long-term protection of the environment. The post-closure period for a

landfill depends on its location, the level of engineering and the type of waste that has been deposited. The post-closure period may extend from many decades to several hundreds of years.

Site closure activities and post-closure care requirements include:

- notification procedures concerning the upcoming closure of the site,
- completion and ongoing maintenance of the final cover and landscaping,
- confirmation of the planned end use for the site, and
- final construction, operation and maintenance of environmental controls and monitoring facilities.

Post-closure care and reporting will be required for as long as contaminants remain in the site and pose a potential concern to the environment.

G. Financial Assurance

Financial assurance is required for private sector landfill sites to ensure that funds are available for site closure, post-closure care and contingencies. Financial assurance may be in the form of a cash deposit, letter of credit, surety bond or other securities acceptable to the ministry. Financial assurance is not required for a site owned by a municipality.

The amount of financial assurance for a particular landfill will depend on factors such as site design, type of waste, level of engineering and environmental setting, and is to be reviewed periodically to ensure that it is sufficient to cover the estimated costs.

Appendix D

Ontario Landfill Telephone Survey Response

Landfill Site Name: **Cambridge Landfill**

Site Owner/Operator: **Region of Waterloo**

Contact Name: **Mike Greenhill**

Contact Number: **(519) 575-0169**

Cambridge landfill was closed in 2003 and is now operating as transfer station

Landfill Statistics

- size (volume and/or weight and/or area)

Approximately 2 million tonnes

- total tonnage to date

Same as above

Landfill Gas Collection and Utilization System

- When first installed? ***1996***
  Initial # horizontal wells: ***5***
  Initial # vertical wells: ***42***
- Has the system been expanded since initial installation?
  Current # horizontal wells: ***5***
  Current # vertical wells: ***67 (25 horizontal wells were installed in 2007)***
- Flare(s) in-use? ***Yes, only when required***
- Details (number, capacity) ***1(one), 1600 cfm***
- Has the capture and flare rate increased? ***Has decreased***

- What was the primary reason the system was installed?
  1. ***to protect the environment by preventing the migration of LFG into the atmosphere,***
  2. ***to protect the facility by preventing indoor air quality problems.***

Other Gas Control Systems

- Have other types of active gas control systems been implemented (e.g. gas controls on leachate collection system, composting, biosolids, contaminated soils,)?
  Please provide any detail.
  1. ***Leachate collection system (capacity: 20-22 m^3/day),***
  2. ***Composting (15 acres). Volume: unknown.***

Odour Control / Counteractant Systems

- Any odour neutralization system? ***No***
- Any odour masking system? ***No***
  Please provide details.
- What was the timing of installation? ***N/A***
- What was the motivation for installation? (e.g. complaint driven, cost driven, compliance driven, ...) ***N/A***

Odour Studies/Assessment

- Have odour studies or assessments been completed? ***No***
  - Date?
  - What aspects were studied? (i.e. cover, leachate treatment, gas collection, special wastes or processing - contaminated soils/ composting/ biosolids)
  - What were the main conclusions and recommendations?

Other

- Where is the nearest residence (distance)?
- ***The site is in a remote area and nearest residential property is a farm that lies some 500 meters away.***

Is there a history of odour complaints? If yes, please explain.
Minor complaints were recorded prior to landfill closure in 2003.

- Have alternative cover strategies been employed? (i.e. biocover, tarping, sprays, ...) If yes, please explain.
  Tarping was the only cover used while landfill was in operation and it proved to be very effective.
- Are there any other strategies you have utilized to manage odour? If yes, please explain. (i.e. limiting or eliminating highly odourous waste receipt, increasing cover amount, reducing the extent/size of the active working area, containing the leachate management system ...) ***No***

Landfill Site Name: **City of Cornwall Waste Disposal Site**

Site Owner/Operator: **City of Cornwall**

Contact Name: **Neil Dixon**

Contact Number: **(613) 937-1777**

Landfill Statistics

- size (volume and/or weight and/or area)
  3,283,000 m^3
- total tonnage to date
  1.837,960 m^3

Landfill Gas Collection and Utilization System

- When first installed? ***1999***
  Initial # horizontal wells: ***none***
  Initial # vertical wells: ***12***
- Has the system been expanded since initial installation? ***Yes***
  Current # horizontal wells: ***none***
  Current # vertical wells: ***34***
- Flare(s) in-use? ***Yes, only when required***
- Details (number, capacity) ***1(one), 600 cfm***
- Has the capture and flare rate increased? ***With the expansions,yes***

- What was the primary reason the system was installed?
  Odour control

Other Gas Control Systems

- Have other types of active gas control systems been implemented (e.g. gas controls on leachate collection system, composting, biosolids, contaminated soils,)?
  Please provide any detail.
  Leachate collection system

Odour Control / Counteractant Systems

- Any odour neutralization system? ***No***
- Any odour masking system? ***No***
  Please provide details.

- What was the timing of installation? ***N/A***
- What was the motivation for installation? (e.g. complaint driven, cost driven, compliance driven, ...) ***N/A***

Odour Studies/Assessment

- Have odour studies or assessments been completed? ***No***
    - Date?
    - What aspects were studied? (i.e. cover, leachate treatment, gas collection, special wastes or processing - contaminated soils/ composting/ biosolids)
    - What were the main conclusions and recommendations?

Other

- Where is the nearest residence (distance)?

  The nearest residential property is located 600 meters away.

Is there a history of odour complaints? If yes, please explain.

Odour complaints were recorded over the years.

Have alternative cover strategies been employed? (i.e. biocover, tarping, sprays, ...) If yes, please explain.

No

- Are there any other strategies you have utilized to manage odour? If yes, please explain. (i.e. limiting or eliminating highly odourous waste receipt, increasing cover amount, reducing the extent/size of the active working area, containing the leachate management system ...) ***Trying to reduce the tipping face and the total open area.***

Landfill Site Name: **Glanbrook Landfill**

Site Owner/Operator: **Owned by the City of Hamilton and is operated by Waste Management of Canada (WMC)**

Contact Name:

Contact Number:

Landfill Statistics

- size (volume and/or weight and/or area)
  72 ha of the site has been assigned for waste disposal and 146 ha has been allocated as a buffer zone.
- total tonnage to date
  The site has been designed to accept 11,800,000 m3 of waste.

Landfill Gas Collection and Utilization System

- When first installed?
  The Landfill Gas Collection and Utilization System has been installed in 2007. The leachate collection system (LCS) manholes were sources of gas (odour) emission which resulted in the filing of complaints by local residents.
  Initial # horizontal wells
  Initial # vertical wells
  Eleven leachate collection manholes have been installed around the perimeter of the landfill.
- Has the system been expanded since initial installation?
  Current # horizontal wells
  Current # vertical wells
- Flare(s) in-use?
- Details (number, capacity)
- Has the capture and flare rate increased?

A portable, active landfill gas flaring system was installed sometime after June, 2006. This system delivered suction from a single vacuum blower drawing gas at a rate of 250-300 cfm. A second blower was installed to the active landfill gas flare system in November, 2006. This installation improved the gas capture rate to 500 cfm.

- What was the primary reason the system was installed?

The primary reason for the system's installation was to reduce odour.

Other Gas Control Systems

- Have other types of active gas control systems been implemented (e.g. gas controls on leachate collection system, composting, biosolids, contaminated soils,)?
  Please provide any detail. ***n/a***

Odour Control / Counteractant Systems

- Any odour neutralization system?
- Any odour masking system?
  Please provide details.
- What was the timing of installation?
- What was the motivation for installation? (e.g. complaint driven, cost driven, compliance driven, ...)

Odour Studies/Assessment

- Have odour studies or assessments been completed?
  - Date? ***An odour sttudy was completed in 2007***
  - What aspects were studied? (i.e. cover, leachate treatment, gas collection, special wastes or processing - contaminated soils/ composting/ biosolids)
  - What were the main conclusions and recommendations?

Other

- Where is the nearest residence (distance)?
  The nearest resident is located 120 m northwest of the site.
- Is there a history of odour complaints? If yes, please explain.
  There has been a history of complaints.
  There have been 45 complaints received up to mid 2007.
- Have alternative cover strategies been employed? (i.e. biocover, tarping, sprays, ...) If yes, please explain.
  Yes, alternative cover strategies have been employed. Because on-site soil resources were depleted daily covers including plastic film, woodchips and clay have been used.
  Woodchips were the least affective strategy as they have the highest permeability to gas.

Clay covering was the most affective strategy in controlling odour at the landfill. Plastic film is as affective as covering with soil because point source release points are created in the form of holes, tears and other defects.

- Are there any other strategies you have utilized to manage odour? If yes, please explain. (i.e. limiting or eliminating highly odourous waste receipt, increasing cover amount, reducing the extent/size of the active working area, containing the leachate management system ...)

  Reducing the tipping face and the active working areas.

Landfill Site Name: **Halton Region**

Site Owner/Operator: **Halton Waste Management Site**

Contact Name: **Grant Buitenhaus**

Contact Number: **(905) 825-6000**

Landfill Statistics

- size (volume and/or weight and/or area)
  4 million metric tonnes
- total tonnage to date
  1.6 million metric tonnes

Landfill Gas Collection and Utilization System

- When first installed? ***2006***
  Initial # horizontal wells ***Four horizontal trenches 600 m long***
  Initial # vertical wells ***20 vertical wells***
- Has the system been expanded since initial installation? ***No***
  Current # horizontal wells ***Four horizontal trenches***
  Current # vertical wells ***20 vertical wells***
- Flare(s) in-use? ***One large enclosed flare, not in-use***
- Details (number, capacity) ***n/a***
- Has the capture and flare rate increased? ***n/a***
- What was the primary reason the system was installed?
  - Lfg collection and utilization,
  - Improvement of the environmental conditions and to address odour complaints.
    The gas collection and utilization system was installed to improve the environmental conditions and to address odour complaints.

Other Gas Control Systems

- Have other types of active gas control systems been implemented (e.g. gas controls on leachate collection system, composting, biosolids, contaminated soils,)?
  Please provide any detail.
  The leachate collection system is connected to the lfg collection system.

Odour Control / Counteractant Systems

- Any odour neutralization system? ***Mobile odour neutralization unit***

- Any odour masking system? ***Yes***
  Please provide details. ***Masking agent Ecolo was sprayed over the composting area***
- What was the timing of installation? ***2004***
- What was the motivation for installation? (e.g. complaint driven, cost driven, compliance driven, ...) ***Complaint driven***

Odour Studies/Assessment

- Have odour studies or assessments been completed?
  Air Quality Assessment was completed prior to the installation of gas collection and utilization system in 2006
  - Date?
  - What aspects were studied? (i.e. cover, leachate treatment, gas collection, special wastes or processing - contaminated soils/ composting/ biosolids)
    Gas Collection System, Composting, Leachate Collection System
  - What were the main conclusions and recommendations?

Other

- Where is the nearest residence (distance)? ***200m***
- Is there a history of odour complaints? If yes, please explain.
  In the last 10 years only two odour complaints were recorded
- Have alternative cover strategies been employed? (i.e. biocover, tarping, sprays, ...) If yes, please explain.
  Tarps (TARPOMATIC), wood chips, sprays.
- Are there any other strategies you have utilized to manage odour? If yes, please explain. (i.e. limiting or eliminating highly odourous waste receipt, increasing cover amount, reducing the extent/size of the active working area, containing the leachate management system ...) ***None***

Landfill Site Name: **Laflèche Landfill**

Site Owner/Operator: **Laflèche Waste Disposal Facility**

Contact Name: **Don MacDonnell**

Contact Number: **Tel: (613) 538-2776**

Landfill Statistics

- size (volume and/or weight and/or area)
  300,000 tonnes/year
- total tonnage to date
  1.3 million tonnes

Landfill Gas Collection and Utilization System

- When first installed? ***2004***
  Initial # horizontal wells: ***25 wells***
  Initial # vertical wells: **None (*Test wells were installed last winter)***
- Has the system been expanded since initial installation?
  Current # horizontal wells: ***25 wells***
  Current # vertical wells: **None (*Test wells were installed last winter)***
- Flare(s) in-use? ***Yes, only when required***
- Details (number, capacity) ***n/a***
- Has the capture and flare rate increased? ***n/a***
- What was the primary reason the system was installed?
  - ***Lfg collection and utilization Certificate of Approval,***

Other Gas Control Systems

- Have other types of active gas control systems been implemented (e.g. gas controls on leachate collection system, composting, biosolids, contaminated soils,)?
  Please provide any detail.
  Leachate collection system (2004)

Odour Control / Counteractant Systems

- Any odour neutralization system? ***No***
- Any odour masking system? ***No***
  Please provide details.
- What was the timing of installation? ***N/A***

- What was the motivation for installation? (e.g. complaint driven, cost driven, compliance driven, ...) ***N/A***

Odour Studies/Assessment

- Have odour studies or assessments been completed?
  Air Quality Assessment was conducted prior obtaining the Certificate of Approval
  - Date? ***2006***
  - What aspects were studied? (i.e. cover, leachate treatment, gas collection, special wastes or processing - contaminated soils/ composting/ biosolids)
    Landfill gas collection system
  - What were the main conclusions and recommendations?

Other

- Where is the nearest residence (distance)?
  The nearest residential property is located 1.5 km away.

Is there a history of odour complaints? If yes, please explain.
Seven complaints were recorded in 2007.

- Have alternative cover strategies been employed? (i.e. biocover, tarping, sprays, ...) If yes, please explain.
  Tarping and wood chips are the covers used.

Are there any other strategies you have utilized to manage odour? If yes, please explain. (i.e. limiting or eliminating highly odourous waste receipt, increasing cover amount, reducing the extent/size of the active working area, containing the leachate management system ...) ***No***

Landfill Site Name: **Walker East Landfill (Niagara Waste Systems)**

Site Owner/Operator: **Walker Bros.**

Contact Name: **Alison Braithwaite**

Contact Number: **(905) 680-3769**

Landfill Statistics

- size (volume and/or weight and/or area)
  No data available.

- total tonnage to date
  850,000 tones per year. The estimated total is about 17.7 million cubic meters over a planning period of approximately 20 to 25 years.

Landfill Gas Collection and Utilization System

- When first installed? ***1997***
  Initial # horizontal wells ***(Unknown)***
  Initial # vertical wells ***(None)***

- Has the system been expanded since initial installation? ***South End 2006***
  Current # horizontal wells ***(None)***
  Current # vertical wells ***(Unknown) 20-25 new wells will be installed 08-09***

- Flare(s) in-use? ***Yes***
- Details (number, capacity) ***n/a***
- Has the capture and flare rate increased? ***Yes***
- What was the primary reason the system was installed?
  - ***Lfg collection and utilization,***
  - ***Improvement of the environmental conditions and to address odour complaints.***

Other Gas Control Systems

- Have other types of active gas control systems been implemented (e.g. gas controls on leachate collection system, composting, biosolids, contaminated soils,)?
  Please provide any detail.
  The leachate collection system is connected to the lfg collection system.

Temporary pipes installed over the areas of concern.

Odour Control / Counteractant Systems

- Any odour neutralization system? ***None***
- Any odour masking system? ***None***
  Please provide details.
- What was the timing of installation?
- What was the motivation for installation? (e.g. complaint driven, cost driven, compliance driven, ...)

Odour Studies/Assessment

- Have odour studies or assessments been completed?
  - Date? ***EA was completed in 2006***
  - What aspects were studied? (i.e. cover, leachate treatment, gas collection, special wastes or processing - contaminated soils/ composting/ biosolids)
    Gas Collection System, Composting, Leachate Collection System
  - What were the main conclusions and recommendations?
    Some measures that may further reduce the impact of landfill related odour emissions, include:
    - ***The landfill working face should be kept as small as practical to reduce emissions.***
    - ***Final or interim cover should be applied as soon as possible with completed cells to reduce the potential for fugitive gas releases.***
    - ***Regular maintenance of the landfill cap and interim cover areas should be conducted to reduce the cracks and fissures due to erosion and settling.***

Other

- Where is the nearest residence (distance)? ***Adjacent***
- Is there a history of odour complaints? If yes, please explain.
  The number of complaints increases significantly during the implementation phase of different projects and is for the most part related to the odour issues.
- Have alternative cover strategies been employed? (i.e. biocover, tarping, sprays, ...) If yes, please explain.
  Soil cover in accordance with Regulation 232

- Are there any other strategies you have utilized to manage odour? If yes, please explain. (i.e. limiting or eliminating highly odourous waste receipt, increasing cover amount, reducing the extent/size of the active working area, containing the leachate management system ...) ***None***

Landfill Site Name: **Region of Peel Landfill Sites**

Site Owner/Operator: **Region of Peel**

Contact Name: **Rick Maj**

Contact Number: **905-855-2641**

Landfill Statistics

- size (volume and/or weight and/or area)

  There are two closed landfills that have gas collection systems in Peel Region. The larger of the two is 250 acres and the smaller one is 100 acres.

- total tonnage to date

  The larger (250 acre) landfill has taken in 13 million tonnes. The smaller (100 acre) landfill has taken in 3.5 million tonnes.

Landfill Gas Collection and Utilization System

- When first installed?

  The larger site had its landfill gas collection system installed 1994.

  The smaller site had its landfill gas collection system installed in 1985.

  Initial # horizontal wells

  The larger site had kilometers of vertical wells initially installed. A definite number was not given.

  Initial # vertical wells

  The larger site had 35 vertical wells installed initially.

  The smaller site had approximately 50 vertical wells installed in the first phase.

- Has the system been expanded since initial installation?

  The system has been expanded since the initial installation.

  Current # horizontal wells

  The larger site has 80 vertical wells installed.

  Current # vertical wells

  The smaller site has 250 vertical wells installed

- Flare(s) in-use?
  The smaller site has a perimeter gas collection system in place to prevent gas migration off-site.
  The gas collection system in the larger site is oriented in the middle of the landfill. It produces 5 MW of power.

- Details (number, capacity)

- Has the capture and flare rate increased?
  The capture and flare rate has increased significantly at the larger landfill with the addition of vertical wells.
  The capture and flare rate has increased minimally at the smaller landfill as only 15 vertical wells have been installed in the last five years.

- What was the primary reason the system was installed?
  Initially the large site wanted to reduce the amount of odour the site produced, however the gas collection system is currently being used for economic reasons as the power produced is being sold.
  The smaller site's primary reason for installing the gas collection system was due to health and safely risks of surrounding residents. The landfill experienced significant gas migration off-site into building foundations and into basements. The smaller site may also be used to produce power in the future, however at a smaller scale than the larger site.

Other Gas Control Systems

- Have other types of active gas control systems been implemented (e.g. gas controls on leachate collection system, composting, biosolids, contaminated soils,)?
  Please provide any detail.
  One of the landfills in Peel Region utilizes a passive venting system. This system uses wind turbines to passively drive out gas.

Odour Control / Counteractant Systems

- Any odour neutralization system?

  No

- Any odour masking system?

  No

Please provide details.

- What was the timing of installation?

  n/a

- What was the motivation for installation? (e.g. complaint driven, cost driven, compliance driven, ...)

  Although an odour neutralizing and masking system is not used, Peel Region actively monitors the surface of its closed landfills utilizing a "Quad". This device's sensitivity measures mg/L or ppm (Parts Per Million). By monitoring, cracks in the cover layer are identified and repaired before a significant amount of gas is able to migrate off-site.

Odour Studies/Assessment

- Have odour studies or assessments been completed?
  - Date?

    Odour studies were completed when both the large and small site were opened landfills. These landfills are now closed landfills.

  - What aspects were studied? (i.e. cover, leachate treatment, gas collection, special wastes or processing - contaminated soils/ composting/ biosolids)

    The studies included hydrocarbons and vinyl chloride.

  - What were the main conclusions and recommendations?

    The studies showed that both hydrocarbon and vinyl cholride concentrations were at acceptable levels.

Other

- Where is the nearest residence (distance)?

  The nearest resident to the larger landfill, which is currently a golf course, is approximately 50 m away (distance to property line).

The smaller landfill essentially forms a boundary with the closest neighbour, therefore the distance to the property line is 0. The smaller landfill is currently a park.

Is there a history of odour complaints? If yes, please explain.

Because the landfills are now closed and capped there are not complaints, however the installation of the gas collection system at the larger site was prompted by odour complaints.

- Have *alternative cover strategies been employed? (i.e. biocover, tarping, sprays, ...) If yes, please explain.**n/a***
- Are there any other strategies you have utilized to manage odour? If yes, please explain. (i.e. limiting or eliminating highly odourous waste receipt, increasing cover amount, reducing the extent/size of the active working area, containing the leachate management system ...)

  The only cover strategy employed at both sites was covering with "dirt" and wood chips. A dramatic increase in development in Peel Region provided the landfill with free dirt for daily covering. Odour was managed by covering the landfilled material daily, not allowing it to be exposed to the atmosphere over night.

Landfill Site Name: **Sheppard Landfill - Calgary**

Site Owner/Operator: **Corey H. Colbran – City of Calgary**

Contact Name: **Blair M. Schultz**

Contact Number: **(403) 369-1963**

Landfill Statistics

- size (volume and/or weight and/or area)

  Unknown
- total tonnage to date

  Unknown

Landfill Gas Collection and Utilization System

- When first installed?

  The LFG collection system was first installed in November 2005.

  Initial # horizontal wells

  There weren't any horizontal wells installed.

  Initial # vertical wells

  There were 60 vertical wells installed initially.
- Has the system been expanded since initial installation?

  No, the system hasn't been expanded since the initial installation.

  Current # horizontal wells

  There aren't any horizontal wells.

  Current # vertical wells

  There are currently 60 vertical wells.
- Flare(s) in-use?

  Yes there is a flare in use.
- Details (number, capacity)

  The only detail I could get is that the flare is an enclosed flare.
- Has the capture and flare rate increased?

  The capture rate has decreased. The initial estimate estimated a sustainable capture rate of 1200 cmh (cubic meters per hour), however the site operates at a sustainable capture rate of 200-250 cmh.
- What was the primary reason the system was installed?

  The reason for the installation was to comply with the Alberta Provincial government initiatives to capture harmful gas that would have otherwise been emitted to the atmosphere.

Other Gas Control Systems

- Have other types of active gas control systems been implemented (e.g. gas controls on leachate collection system, composting, biosolids, contaminated soils,)?
  Please provide any detail.
  There are leachate sumps that remove free-water (in aqueous phase) from the LFG. Once the water in the aqueous phase is removed the LFG is sent through a refrigeration process which removes the water in vapour phase. The treated LFG is then used to drive a 380 KW generator which creates energy.

Odour Control / Counteractant Systems

- Any odour neutralization system? ***None***
- Any odour masking system? ***None***
  Please provide details.
- What was the timing of installation? ***n/a***
- What was the motivation for installation? (e.g. complaint driven, cost driven, compliance driven, ...)
  The landfill site is located close to a sewage treatment facility which uses lagoons in their treatment process. Although odour complaints are made, they are attributed to the lagoons as oppose to the landfill. Odour neutralization/masking would be pointless due to the odour created from the off-site point source.

Odour Studies/Assessment

- Have odour studies or assessments been completed?
  - Date?

  Odour studies were completed prior to and after installing the LGF collection and utilization system.
  - What aspects were studied? (i.e. cover, leachate treatment, gas collection, special wastes or processing - contaminated soils/ composting/ biosolids)

  The study focused on methane emission through the cap of the landfill.
  - What were the main conclusions and recommendations?

  Initially there were a lot of hotspots (preferential pathways) for methane emission into the atmosphere, however once a sustainable LFG capture rate was found there wasn't a significant amount of LFG being emitted into the atmosphere.

Other

- Where is the nearest residence (distance)?
  Unknown distance
- Is there a history of odour complaints? If yes, please explain.
  There were complaints, however they were the result of the sewage treatment lagoons.
- Have alternative cover strategies been employed? (i.e. biocover, tarping, sprays, ...) If yes, please explain.
  In late 2006, a bioreactor was installed. It uses a geomembrane at the top and bottom. The bioreactor provides an additional 130 cmh.
- Are there any other strategies you have utilized to manage odour? If yes, please explain. (i.e. limiting or eliminating highly odourous waste receipt, increasing cover amount, reducing the extent/size of the active working area, containing the leachate management system ...)
  Due to the nature of the odour creating activities at the neighbouring sewage treatment plant, odour management is pointless.

Landfill Site Name: **Trail Rd. and Nepean Landfills**

Site Owner/Operator: **Transportation Utilities and Public Works**

Contact Name: **Peter Filipowich**

Contact Number: **(613) 580-2424 ext.22843**

Landfill Statistics

- size (volume and/or weight and/or area)
  Unknown
- total tonnage to date
  Unknown

Landfill Gas Collection and Utilization System

- When first installed? ***Unknown***
  Initial # horizontal wells: ***None***
  Initial # vertical wells: ***The system utilizes 79 vertical wells.***

- Has the system been expanded since initial installation? ***No***
  Current # horizontal wells: ***None***
  Current # vertical wells: ***The system utilizes 79 vertical wells.***
- Flare(s) in-use? ***Yes***
- Details (number, capacity) ***1(one), enclosed***
- Has the capture and flare rate increased? ***The capture rate has increased to approximately 1500 cfm.***

- What was the primary reason the system was installed?
  The implementation was driven by the Provincial government issuing an RFP. Implementing this new system promotes Green Power as well as creating a means of cost recovery.

Other Gas Control Systems

- Have other types of active gas control systems been implemented (e.g. gas controls on leachate collection system, composting, biosolids, contaminated soils,)?
  Please provide any detail.

Odour Control / Counteractant Systems

- Any odour neutralization system? ***No***

- Any odour masking system? ***No***
  Please provide details.
- What was the timing of installation? ***N/A***
- What was the motivation for installation? (e.g. complaint driven, cost driven, compliance driven, ...) ***N/A***

Odour Studies/Assessment

- Have odour studies or assessments been completed? ***Yes***
  - Date?
    Two recent studies have been conducted encompassing all these aspects.
    In 2001 a study was done to expand the facility.
    In 2005 a study was conducted due to a zoning issue. This resulted in the establishment of a 500 m buffer from the site in anticipation of development
  - What aspects were studied? (i.e. cover, leachate treatment, gas collection, special wastes or processing - contaminated soils/ composting/ biosolids)
  - What were the main conclusions and recommendations?

Other

- Where is the nearest residence (distance)?
  The nearest resident is 1.3 km from the site.
- Is there a history of odour complaints? If yes, please explain.
  There has been one complaint in the last six and a half years.

- Have alternative cover strategies been employed? (i.e. biocover, tarping, sprays, ...) If yes, please explain.
  Biocover, tarping, and sprays are utilized to manage the odour.
- Are there any other strategies you have utilized to manage odour? If yes, please explain. (i.e. limiting or eliminating highly odourous waste receipt, increasing cover amount, reducing the extent/size of the active working area, containing the leachate management system ...) ***No***