REPUTATION RESOURCES RESULTS

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Evaluation of Odour Generation Rates Within Landfill Gas Zones

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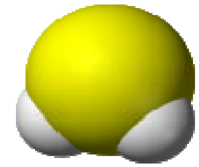
Hypothesis



- Hydrogen sulfide (H_2S) concentrations – and therefore odour concentrations- in landfill gas were increasing from historical levels at the Waterloo Landfill.

- This was also the anecdotal experience at other landfills.

- Odour generation in different landfill zones could vary by age as well as gas generation rate.

Why would H_2S Concentrations Change?

- Increased diversion rates have removed a lot of metals from the landfill waste stream as well as wood and leaf waste.
- H_2S reacts with metals readily and is absorbed by high carbon materials like wood and leaf waste.
- This is one working theory.

Why is it Important ?

- Encroaching commercial and residential development around the landfill have caused a heightened odour concern
- H_2S generation in different zones of the landfill needed to be studied to optimize gas collection design to reduce odour
- Working designs for gas collection may need to be reevaluated to account for increased H_2S

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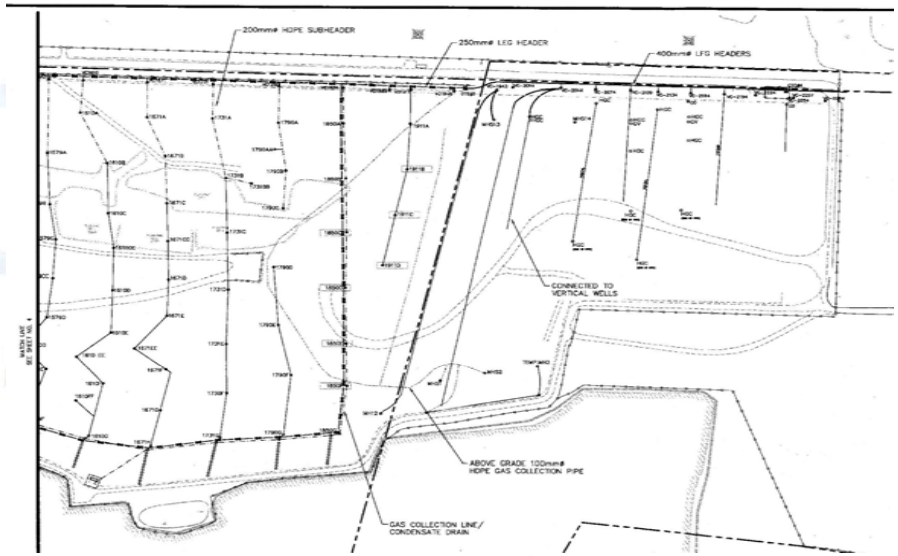
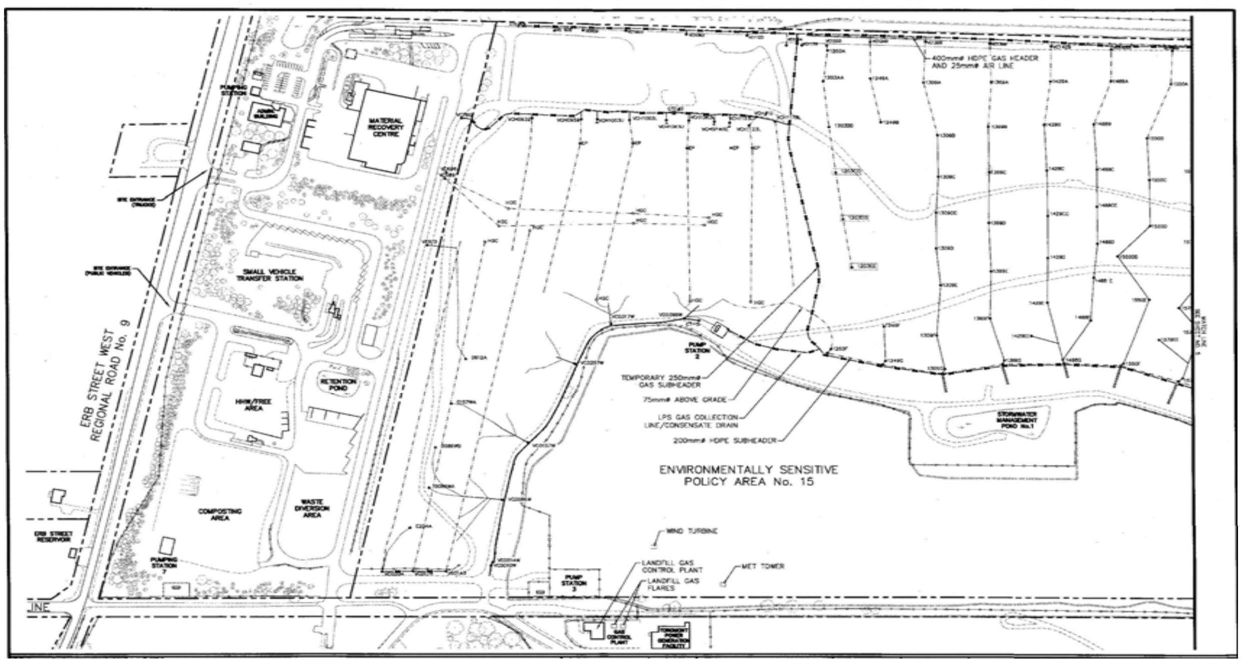
The Gas System



South



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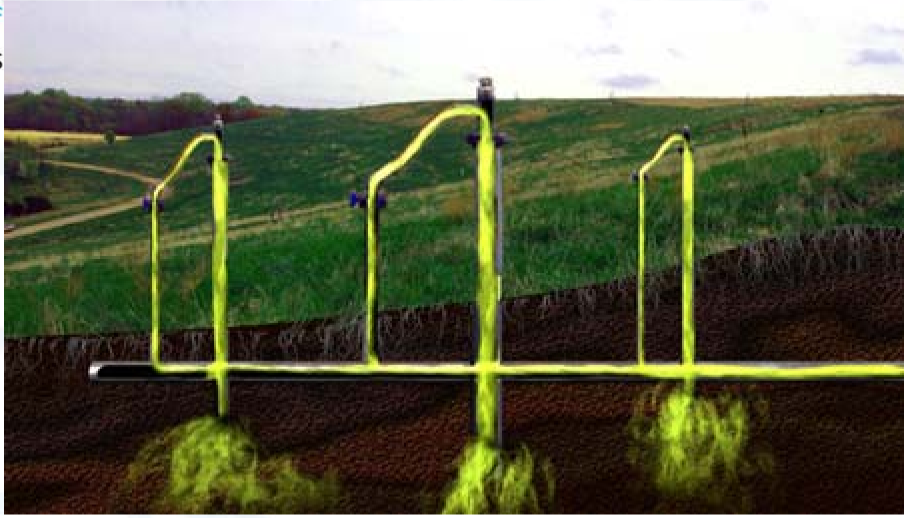
The Study

1. Measure reduced sulfur compounds in the different legs of the collection system.

2. Measure Flow rates and other gas parameters in all the separate legs of the system.

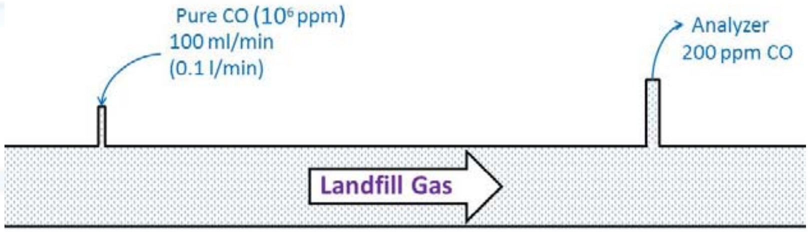
3. Determine a production rate for reduced sulfur compounds in the different zones of the landfill

The Problem



- Most of the points to be measured were burried or were in below ground chambers
- Traditional flow measurement would have not been possible or would involve confined spaces.
- Access points would have needed to be drilled into flammable gas mains

Dilution Flow Measurements



Flow of Landfill Gas = $\frac{10^6 \text{ ppm}}{200 \text{ ppm}} \times 0.1 \text{ l/min} = 500 \text{ l/min}$

- Pure carbon monoxide was injected at a steady flow rate using a specially calibrated mass flow controller
- A sample of gas was removed from the gas line, conditioned and analyzed using a Rosemount continuous emission monitor (CEM)

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FLOW MEASUREMENTS

- Landfill Gas is a complex mixture with high moisture and numerous different constituent components
- The sample gas was drawn through a heated line and then some special conditioning was done before the gas was put into the analyzer

Dilution Flow Measurements

Access point 1429						
time	indicated CO - MFC	CO flow (lpm)	CO reading (ppm)	Net CO (ppm)	Gas Line Flow (lpm)	GasLine flow (cfm)
3:50	0	0.00	10			
400	0.05	0.19	230	220	855.78	30.22
415	0.08	0.30	365	355	848.55	29.97
430	0.11	0.41	495	485	854.01	30.16

- There is some CO present in LFG so it was necessary to subtract that value from the readings
- All of the locations were done with at least 3 different CO injection rates
- All flowrates derived from the net readings were within 10% of each other

Reduced Sulfur Sampling

- Samples were collected from the landfill gas collection system using standard tedlar bag/lung sampler techniques
- The bags were transported to RWDI's offices for same day analysis

Reduced Sulfur Measurements

- Initial analysis was undertaken using a GC/FPD
- The GC Measurements were to characterize the reduced sulfur compounds
- The analysis showed that the only detectible reduced sulfur compound in the gas was hydrogen sulfide
- The samples analyzed by GC were collected from all parts of the landfill and included newer and older areas

Characterizing The Reduced Sulfur Compounds

Summary - Waterloo Landfill				
July 10-11				
	Hydrogen Sulphide	Methyl Mercaptan	Dimethyl Sulphide	Dimethyl Disulphide
Sample	(ppm)	(ppm)	ppm)	(ppm)
1309-T1	200	nd	nd	nd
1309-T2	257	nd	nd	nd
1309-T3	228	nd	nd	nd
1369-T1	19	nd	nd	nd
1369-T2	35	nd	nd	nd
1369-T3	29	nd	nd	nd
1549-T1	1,323	nd	nd	nd
1549-T2	1,592	nd	nd	nd
1549-T3	1,644	nd	nd	nd
1910-T1	139	nd	nd	nd
1910-T2	164	nd	nd	nd
1910-T3	141	nd	nd	nd
VC1850	842	nd	nd	nd
VC1948	790	nd	nd	nd
VC1579-T1	642	nd	nd	nd
VC1579-T2	722	nd	nd	nd
VC1579-T3	722	nd	nd	nd
VC1579-T4	750	nd	nd	nd

Reduced Sulfur Analysis

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- Once it was determined that the only significant reduced sulfur compound in the landfill gas was hydrogen sulfide the analysis was then performed using continuous TRS analyzer which is a better quantitative instrument than the GC

Results of Testing

Table 1. Erb Street Landfill Gas Flows and Emission Rates					
Extraction well sources	Flow (cfm)	Flow (m^3/h)	H_2S (ppm)	H_2S (g/m^3)	Emission rate (g/hr)
VC1203	Sampling ports submerged in water				
VC1249	13.4	22.8	285	0.40	9.0
VC1309	45.6	77.5	126	0.18	13.6
VC1369	8.3	14.1	28	0.04	0.5
VC1429	30.1	51.1	73	0.10	5.2
VC1488	15.1	25.7	23	0.03	0.8
VC1550	22.0	37.4	989	1.38	51.5
VC1579	No measureable flow				
VC1610	14.2	24.1	106	0.15	3.6
VC1671	62.9	106.9	98	0.14	14.6
VC1731	43.6	74.1	204	0.28	21.0
VC1790	58.0	98.5	328	0.46	45.0
VC1850	54.6	92.8	485	0.68	62.7
VC1911	No measureable flow				
VC1948	52.4	89.0	1640	2.28	203.3
VC2014	164.5	279.5	262	0.36	102.0
VC2074	18.2	30.9	1240	1.73	53.4
H1	572.6	972.9	467	0.65	632.7
H2	82.8	140.7	1195	1.66	234.1
VC0612	5.4	9.2	387	0.54	4.9
VC0157W	156.8	266.4	2	0.00	0.7
VC0158W	116.1	197.3	100	0.14	27.5
Portable Flare	188.2	319.8	1490	2.08	663.5
Gas Collection Plant	1536.5	2610.5	418	0.58	1519.7
H1 and H2 are the main header trunk lines . The flows at H1 and H2 represent a cumulative flow					
from VC2014, VC 2044, VC 2074 ,VC 2109 VC 2134, VC 2194, VC 2257 and all other points south of VC2074					

Results of Testing

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- The results of the testing showed that the newer waste was generating higher concentrations of hydrogen sulfide and was therefore producing more odour.
- The newest portion of the landfill had gas that was nearly 1500 ppm hydrogen sulfide

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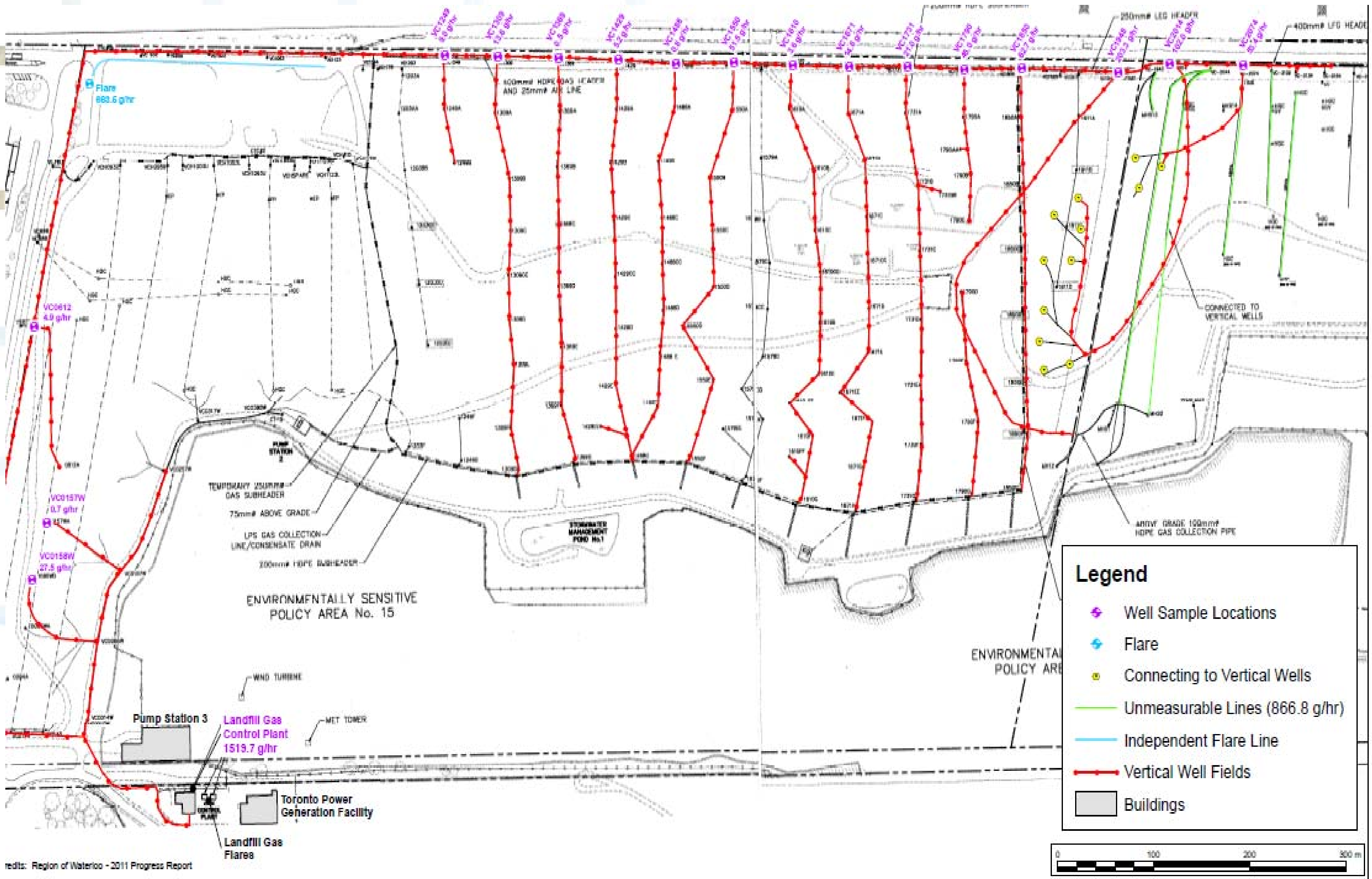
Hydrogen Sulfide Production



Credits: Region of Waterloo - 2011 Progress Report

Results of Testing

- The aggregate hydrogen sulfide concentration when the EFW facility was installed was approximately 80 ppm
- It was also determined that there were portions of the collection system that did not have the appropriate gas flow rate

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CONCLUSIONS

Overall gas production cycles in new landfill areas are assumed to be the same as in older areas when designing gas collection systems. In terms of odour causing hydrogen sulphide production, this may not be an adequate design criterion. Collection efficiency may need to be increased in newer cells if proper odour control is to be achieved.

The increased amount of hydrogen sulfide being fed to the EFW plant may be an issue with ongoing maintenance of the facility.

CONCLUSIONS

Now that the protocol has been established in is relatively easy to repeat measurements. This would provide a worthwhile check of the system going forward.

In areas where it is known that there is increased hydrogen sulfide production, there needs to be greater diligence with maintaining cover integrity, to avoid gas leaks.