

Hitachi Zosen
INOVA

A photograph of a natural landscape featuring a large, mature tree with a thick trunk and dense green foliage in the background. The foreground is filled with numerous clumps of tall, green grasses. The sky is a clear, bright blue.

**ASH ANALYSES AND
WASTE CLASSIFICATION
ASSESSMENT**

APPENDIX
21

APPENDIX 21: Ash Analyses and Waste Classification Assessment



-5-3A:2.-3 80768:

Customer: Marc Stammbach

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Level 17, 40 Mount Street,
North Sydney NSW 2060, Australia

Your Reference: Incinerator ash analyses and waste classification against Western Australia guidelines

SGS Report Number: ENV25214-WA (SE160165)

Date of Receipt of Samples: 12/12/2016

Sample/work Description: Comprehensive analyses for four incinerator ash samples and Landfill waste classification against Western Australia guidelines

This work has been carried out in accordance with your instructions. The results and associated information are contained in the following pages of the report. Should you have any queries regarding this report please contact the undersigned.

Reported by: Angus Ku
Senior Chemist

Report authorised by: Paul P
Senior Analystical Consultant

Date: 23rd December 2016

Date: 23rd December 2016



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9TMMBQV

Four ash samples were delivered to SGS for waste analyses and classification. Based on the analytical results of the samples (as it) and the toxicity characteristic leaching procedures (TCLP), the classification of the samples were summarised as follows:

| 9BMPLF | .LBRF | 8FBROI |
|---|---|--|
| SE160165-1 Bottom Ash Class III Putrescible | Landfill TC | LP Cd=0.44 mg/L, Pb=0.45 mg/L, Ni=0.34 mg/L |
| SE160165-2 APC Residue | Class III Putrescible Landfill Cd=160 mg/kg, | TCLP Cd=0. 29mg/L, |
| SE160165-3 Bottom Ash/APC Residue = 8/1 | Class III Putrescible Landfill TCLP Cd=0.54mg/L | Pb=0.11mg/L 9mg/L |
| SE160165-4 Boiler + EP ash | Class V Intractable Landfill | TCLP Cd=21mg/L |



9BMPLF /FRDQKPSKON

Four incinerator ash samples from one of the European EfW plants were delivered to SGS on 12/12/2016 for an analyses and waste classification. The samples were logged in as follows:

:BCLF ' + 9BMPLF 2/

| Your Reference | SGS sample number |
|---|-------------------|
| Bottom Ash SE160165-1 | |
| APC Residue SE160165-2 | |
| Bottom Ash/APC Residue = 8/1 SE160165-3 | |
| Boiler + EP Ash SE160165-4 | |

4FSIOER+

A very long list of analytes are mentioned as chemical generators have some ideas of the analytes associated with their process, their input and their output. Generally, waste analytes are not required.

Since the four samples were incinerator ashes from a large amount of manufactured industrial chemicals (be they organic or inorganic). It was also logical to assume that most of the organic materials would have been burned during the incineration process. However, as a precautionary principle, an extended list of organic analyses were conducted in this study in case any organic chemicals generated from the possible incomplete combustion should have been overlooked.

Along with organic analyses, a number of inorganic tests were also performed including pH, fluoride, cyanide etc and, most importantly, heavy metals.

Based on the preliminary results of the ash samples, toxicity characteristic leaching procedures (TCLP) further analyses were decided based on the guideline. Final assessment for the waste classification would then be based on both the direct ash analytical results and the TCLP results.

cal of interest by various waste classification guidelines. Generally, waste generators have some ideas of the analytes associated with their process, their input and their outputs, and consequently many analytical tests were also performed including pH, fluoride, cyanide etc and, most importantly, heavy metals.

the burned municipal wastes, it was not likely that the wastes would contain (be they organic or inorganic). It was also logical to assume that most of the organic materials would have been burned during the incineration process. However, as a precautionary principle, an extended list of organic analyses were conducted in this study in case any organic chemicals generated from the possible incomplete combustion should have been overlooked.

Based on the preliminary results of the ash samples, toxicity characteristic leaching procedures (TCLP) further analyses were decided based on the guideline. Final assessment for the waste classification would then be based on both the direct ash analytical results and the TCLP results.

The samples were visually examined and big lumps were re grinded to smaller particles in order that homogenous aliquots taken for analyses could be as representative as possible of the bulk samples. All the methods of the individual analyses were summarised below:

40:16/ 9=44-8A

A portion of sample is digested with Nitric acid to decompose organic matter and Hydrochloric acid to complete the digestion of metals and then filtered for analysis by ASS or ICP as per USEPA Method 200.8.

A portion of sample is digested with nitric acid to decompose organic matter and hydrochloric acid to complete the digestion of metals. The digest is then analysed by ICP OES with metals results reported on the dried sample basis. Based on USEPA method 200.8 and 6010C.

This method uses an alkaline digestion to solubilise both water-soluble and water-insoluble forms of hexavalent chromium in solids. The solution is then pH adjusted and the hexavalent chromium concentration in solution determined colourimetrically.

Discrete Analyser. A buffered distillate or water sample is treated with chloramine /barbituric acid reagents and the intensity of the colour developed is proportional to the cyanide concentration.

Hydrogen cyanide is liberated from an acidified alkali soil extract by distillation and purging with air. The hydrogen cyanide gas is then collected by passing it through a sodium hydroxide scrubbing solution. The scrubbing solution will then be analysed for cyanide by the appropriate method.

pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, sediments and sludges, an extract with water (or 0.01M CaCl₂) is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H⁺.

Fluoride can be measured in soil as water extractable or 'total' by Ion Selective electrode. In this method the solid sample is weighed and then fused with sodium hydroxide at 600 °C. The sample is carefully neutralise with hydrochloric acid and the solution of the melt is cooled and made up to volume. The final solution is then compared to synthetic Digestion Matrix standards with analysis by ISE electrode for a total fluoride result after being calculated back to original mass.

Cr6+ is determined colourimetrically by reaction with dphenylcarbazine in acid solution. A red-violet colour of unknown composition is produced.

A buffered distillate or water sample is treated with chloramine /barbituric acid reagents and the intensity of the colour developed is proportional to the cyanide concentration by Aquakem DA .

Mercury by Cold Vapour AAS in Soils: After digestion with nitric acid, hydrogen peroxide and hydrochloric acid, mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500

Total Recoverable Hydrocarbons: Determination of Hydrocarbons by gas chromatography after a solvent extraction. Detection is by flame ionisation detector (FID) that produces an electronic signal in proportion to the combustible matter passing through it. Total Recoverable Hydrocarbons (TRH) are routinely reported as four alkane groupings based on the carbon chain length of the compounds: C6-C9, C10-C14, C15-C28 and C29-C36 and in recognition of the NEPM 1999 (2013), >C10-C16 (F2), >C16-C34 (F3) and >C34-C40 (F4). F2 is reported directly and also corrected by subtracting Naphthalene (from VOC method AN433) where available.

Additionally, the volatile C6-C9 fraction may be determined by a purge and trap technique and GC/MS because of the potential for volatiles loss. Total Petroleum Hydrocarbons (TPH) follows the same method of analysis after silica gel cleanup of the solvent extract. Aliphatic/Aromatic Speciation follows the same method of analysis after fractionation of the solvent extract over silica with differential polarity of the eluent solvents .

The GC/FID method is not well suited to the analysis of refined high boiling point materials (ie lubricating oils or greases) but is particularly suited for measuring diesel, kerosene and petrol if care to control volatility is taken. This method will detect naturally occurring hydrocarbons, lipids, animal fats, phenols and PAHs if they are present at sufficient levels, dependent on the use of specific cleanup/fractionation techniques. Reference USEPA 3510B, 8015B.

(SVOCs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols (etc) in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D).

SVOC Compounds: Semi-Volatile Organic Compounds (SVOGs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D).

Contaminants of interest in a waste material are leached out of the waste with a selected leaching solution under controlled conditions. The ratio of sample to extraction fluid is 100g to 2 L (1 to 20 by mass). The concentration of each contaminant of interest is determined in the leachate by appropriate methods after separation from the sample by filtering. Base on USEPA 1311.

Extraction Fluid #1: This fluid is made by combining 128.6mL of dilute sodium hydroxide solution and 11.5mL glacial acetic acid with water and diluting to a volume of 2 litres. The pH of this fluid should be 4.93 } 0.05.

Extraction Fluid #2: This fluid is made by diluting 5.7mL glacial acetic acid with water to a volume of 1 litre. The pH of this fluid should be 2.88 } 0.05.

Unpreserved water sample is filtered through a 0.45 m membrane filter and acidified with nitric acid similar to APHA3030B.

Determination of Fluoride by ISE: A fluoride ion selective electrode and reference electrode combination, in the presence of a pH/complexation buffer, is used to determine the fluoride concentration. The electrode millivolt response is measured logarithmically against fluoride concentration. Reference APHA F- C.

Mercury by Cold Vapour AAS in Waters: Mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption



spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500.

Metals by ICP-OES: Samples are preserved with 10% nitric acid for a wide range of metals and some non-metals. This solution is measured by Inductively Coupled Plasma. Solutions are aspirated into an argon plasma at 8000-10000K and emit characteristic energy or light as a result of electron transitions through unique energy levels. The emitted light is focused onto a diffraction grating where it is separated into components .

Photomultipliers or CCDs are used to measure the light intensity at specific wavelengths. This intensity is directly proportional to concentration. Corrections are required to compensate for spectral overlap between elements Reference APHA 3120 B.



-NBLVSKDBL QFRTLRSR

:BCLF (+ -NBLVSKDBL QFRTLRSR BNE >FRSFQN -TBBZLKBRRKKGKDBSKON HTKEFLKNF SIQFRIOLE UBLTFR

| | QD160165.00 11 | QD160165.00 22 | QD160165.00 33 | QD160165.00 44 | BfUJI H HhZkm fUjY_cff | BfUJI HH OmmkZiWcVZ KUjY_cff | BfUJI HHH OmmkZiWcVZ KUjY_cff | BfUJI HS QZWmkZ KUjY_cff |
|---|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|---------------------------|---------------------------------|----------------------------------|-----------------------------|
| Aimmig >lb | Aimmig >lb >OB kZsOBzZicYnZ | | Aimmig Ulb / >OB kZicYnZ BfUJI | | BihwZhmku mcih Kcgcm | WihwZhmku mcih Kcgcm | BihwZhmku mcih Kcgcm | WihwZhmku mcih Kcgcm |
| >hUqmZ MUjgZ | KZUWb UmZ WihW. 'ga/e a(| KZUWb UmZ WihW. 'ga/e a(| KZUWb UmZ WihW. 'ga/e a(| KZUWb UmZ WihW. 'ga/e a(| >QKO1 'ga/K(| >QKO2 'ga/K(| >QKO3 'ga/K(| >QKO4 'ga/K(|
| RPG | | | | | | | | |
| RPG B16-B35 | | | | | | | | |
| jZmkifZng | | | | | | | | |
| bqYkiWUkVihl | | | | | | | | |
| 'UkigUmcWl(:210 M/> :110 M/> :110 M/> :110 M/> 450 | | | | | | | | |
| RPG B10--B35 | | | | | | | | |
| jZmkifZng | | | | | | | | |
| bqYkiWUkVihl | | | | | | | | |
| 'UfejUmcWl(:210 M/> :210 M/> :210 M/> :210 M/> 28 | | | | | | | | |
| O>GI | | | | | | | | |
| MUjmbUfZnZ :0.1 M/> :0.1 M/> :0.1 M/> :0.1 M/> M/> | | | | | | | | |
| 2- | | | | | | | | |
| gZmbqfUjmbUfZn | | | | | | | | |
| Z :0.1 M/> :0.1 M/> :0.1 M/> :0.1 M/> M/> M/> M | | | | | | | | |
| 1- | | | | | | | | |
| gZmbqfUjmbUfZn | | | | | | | | |
| Z :0.1 M/> :0.1 M/> :0.1 M/> :0.1 M/> M/> M/> M | | | | | | | | |



| | | | | | | | | | | | | | | | | | | | | |
|-------------------|-------|----------|----------|----------|----------|--------|-------|------|--------|----------|------------|------------|----------|----------|----------|----------|----------|----------|----------|-----|
| AUkeng, AU 250 | 250 | 0.26 | 120 | 2.00 | 170 | 0.79 | 0.5 | 0.33 | 0.33 | 50000 M/ | 50000 M/ | 1D+05 M/ | 2D+05 M/ | | | | | | | |
| AZKqfeng, AZ :0.5 | M/ | > 0.5 M/ | > 0.5 M/ | 1 | | | | | | 00 | 0.1 | 100 | 0.1 | 4000 | 10 | | | | | |
| Aikih, A 190 | 190 | 1.80 | 62 | 62 | 110 | 1.50 | 1.50 | 190 | 190 | 5.1 | 50000 M/ | 50000 M/ | 1D+05 M/ | 2D+05 M/ | | | | | | |
| BUYgeng, BY 13 | 1333 | 0.44 | 160 | 0.29 | 0.29 | 0.54 | 430 | 430 | 221 | 100 | 0.1 | 100 | 0.1 | 4000 | 10 | | | | | |
| Bbkgeng, Bk 120 | 120 | M/ | > 52 | 52 | 130 | M/ | > 110 | 110 | M/ | > M/ | > M/ | > M/ | > M/ | | | | | | | |
| Bkkgeng | | | | | | | | | | | | | | | | | | | | |
| GZpUoUZhmg, Bk6 | 0.5 | 0.05 | M/ | > 0.5 M/ | > 0.5 M/ | 500 | 0.5 | 500 | 0.5 | 500 | | | | 0.5 | 2000 | 50 | | | | |
| BIVUfm, BI 20 | 2000 | > 10 | 1000 | > 13 | 1330 | > 20 | | | | 2200 | > 50000 M/ | 50000 M/ | 1D+05 M/ | 2D+05 M/ | | | | | | |
| BijZk, Bn 1600 | 1600 | 1.30 | 480 | 0.66 | 100 | 100 | 0.31 | 0.31 | 1600 | 0.01 | 0.01 | 50000 M/ | 50000 M/ | 1D+05 M/ | 2D+05 M/ | | | | | |
| Hkih, EZ | 25000 | M/ | > 3000 | 3000 | M/ | > 7 | 7000 | M/ | > 9100 | 9100 | M/ | > M/ | > M/ | > M/ | | | | | | |
| KZUY, OV 1200 | 1200 | 0.45 | 1200 | 0.11 | 1000 | 0.19 | 300 | 900 | 333 | 1500 | 0.1 | 1500 | 0.1 | 4000 | 1 | 60000 | 10 | | | |
| Kombeng, Kc 15 | 1533 | 13 | 0.13 | 13 | 1333 | 21 | 0.21 | 13 | 1333 | 15 | 0.15 | 40 | 40 | M/ | > M/ | | | | | |
| LUhaUhzZ, Lh 450 | 450 | M/ | > 470 | 470 | M/ | > 450 | 450 | M/ | > 450 | 450 | M/ | > 50000 M/ | 50000 M/ | 1D+05 M/ | 2D+05 M/ | | | | | |
| LZkWnkq | | 0.05 | 0.0001 | 10 | 1000 | 0.0003 | 0.2 | 0.2 | 0.0001 | 75 | 0.01 | 750 | 0.1 | 3000 | 1 | | | | | |
| LifqVYZhng, Li 13 | 1333 | 13 | 0.13 | 5 | 53 | 14 | 0.14 | 11 | 11 | 13 | 0.13 | 20 | 2200 | 0.02 | 1000 | 0.5 | 10000 | 5 | 4000 | 50 |
| McWeZi, Mc 87 | 877 | 0.34 | 2533 | 12 | 0.12 | 94 | 94 | 19 | 0.19 | 68 | 6888 | 0.21 | 3000 | 0.2 | 3000 | 0.2 | 3000 | 2 | 1D+05 | 20 |
| Obijbikni, O 4400 | 4400 | 0.47 | 3208 | 200 | 0.11 | 0.11 | 390 | 6900 | 0.40 | 0.40 | 410 | 0.19 | 0.19 | M/ | > M/ | > M/ | > M/ | | | |
| QZfZheng, QZ | | 3 M/ | > 3 M/ | > 3 M/ | 9 | | | | | | 99 | 0.06 | 0.06 | 50 | 0.5 | 50 | 0.5 | 2000 | 50 | |
| CcfoZk, >a | 440 | 0.05 | 11 | 11 | 10 | 0.01 | 4 | 440 | 0.05 | 33 | 3333 | 0.05 | 180 | 1 | 80 | 1 | 1800 | 10 | 7200 | 100 |
| Fch, Qh | 100 | 0.05 | 320 | 320 | 0.05 | 160 | 0.05 | 1100 | 1100 | 0.05 | M/ | > M/ | > M/ | > M/ | > M/ | | | | | |
| SUhuYeng, S | 2220 | 0.4 | 0.4 | 23 | 2330 | 0.8 | 0.08 | 13 | 1830 | 0.05 | 0.05 | 20 | 2200 | 0.2 | 50000 M/ | 50000 M/ | 1D+05 M/ | 2D+05 M/ | | |
| TchW, Th | 5700 | 110 | 1000 | 010000 | 13 | 0.00 | 13.00 | 5600 | 5500 | 46 | 0.00 | 45.00 | 360 | 96000 | 1800 | 50000 M/ | 50000 M/ | 1D+05 M/ | 2D+05 M/ | |

#5%*, NON BPPLKDBCLF



Based on the analytical results, the four ash samples should be classified as follows (against the Western Australia guidelines)

| 9BMPLF | .LBRF | 8FBROI |
|---|--------------------------------|--|
| SE160165-1 Bottom Ash Class III Putrescible | Landfill TC | LP Cd=0.44 mg/L, Pb=0.45 mg/L, Ni=0.34 mg/L |
| SE160165-2 APC Residue | Class III Putrescible Landfill | Cd=160 mg/kg, TCLP Cd=0.29mg/L, Pb=0.11mg/L |
| SE160165-3 Bottom Ash/APC Residue = 8/1 | Class III Putrescible Landfill | TCLP Cd=0.54mg/L, pb=0.1 9mg/L |
| SE160165-4 Boiler + EP ash | Class V Intractable Landfill | TCLP Cd=21mg/L |

.ONDLTRKON+

For all the four incinerator ash samples, even though all the organic parameters results were well below the Class I Inert Landfill limit, some of the heavy metal concentrations were high enough, rendering the samples being classified as Class III and Class V respectively.

